Lecture Notes in Educational Technology

Christina Hong
Will W. K. Ma *Editors*

Applied Degree Education and the Future of Learning

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Lecture Notes in Educational Technology

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Preface

Applied Degree Education and the Future of Learning

As an unprecedented single event, the global pandemic wrought by the COVID-19 coronavirus disrupted the world for longer than anyone might have envisaged.Globally, the pandemic disrupted sectors in catalytic ways, catapulting digital transformation across industries, workplaces, and workforces. In its eventual aftermath, the full social and economic impact of COVID-19 may not be fully realized for years to come. An Australian report highlights the intensity of the shift:

> *Some refer to it as the double disruption, the convergence of digital transformation and the global pandemic which together, have accelerated the adoption of technology at a speed none of us thought possible. In a matter of months, businesses have leapt ahead years in their digital journey. How we work, when we work and where we work are all being redefined. (Digital Transformation Expert Panel, 2020)*

In the education sector, from compulsory to post-compulsory education, across pre-school, schools, universities and professional education providers, COVID-19 sent shockwaves that also forcibly redefined our approaches to learning and teaching almost literally, overnight. Over successive periods, the ebb and flow of COVID-waves demanded operational risk management, resilience and flexibly responsive preparedness from leaders and their management teams. Most revealing of all, it required just-in-time solutions, to enable learners and teachers to continue with their educative processes in the face of lock-down and amid often inequitable access to technology and Wi-Fi bandwidths.

The pandemic significantly impacted the higher education sector globally. Moreover, the impact of the pandemic on international student mobility led to significant number of students unable to travel or enter country borders. The consequent drops in international student revenues and consequent domino-effect on institutional sustainability resulted in retrenchment and cost-cutting in those institutions with a traditionally high reliance on in-bound international student numbers.

Turning Adversity into Advantage

As we emerge out of the worst of the pandemic and progressively transition to the 'next normal', what are the innovations and shifts being made by educators, institutions and agencies that are likely to transform the future of learning? As economies gear-up, re-establish and look to accelerate in the wake of COVID-19, the demand for a highly skilled and technologically adept workforce is expected to increase: How is the applied degree sector responding to this demand? What are the biggest challenges and opportunities for institutions and how are leaders now planning to navigate the future? How is the applied degree sector responding to the need to up-skill and re-skill disenfranchised workers?

The pandemic taught us that the physical, in-person experience of campus-based life is important in building human connection and social cohesion. That practical hands-on learning, the essential element of applied degree learning and teaching, while possible to virtually simulate, is no replacement for real-world authentic learning and teaching engagement. Moving forward, digitalisation will remain a key component of higher education. Given the rapid technological acceleration that has occurred in the education sector and across industries and the world of work, what indeed is the 'next normal' for applied degree learning and teaching? What changes to the traditional paradigm will need to be enabled to optimize student access, engagement, and success? How are local and global themes such as sustainability, innovation and technology, entrepreneurship, and the need for future ready skills and multiliteracies be integrated into curricula and institutional agendas? What does the future of learning look like and how is it the same or different from what we know now?

Outline of the Book

In this edition we seek to involve academic and practitioners to share case studies, engage in critical discussion and spearhead thought leadership.

The book starts with an introductory chapter, and it is then divided into four parts, including: Part I: *Future ready values and competencies for the future of learning*; Part II: *Innovative pedagogies in applied degree learning and training*; Part III: *Driving student access, engagement, and success through digital technologies*; Part IV: *Lifelong learning, partnering and the future of work*.

The Introductory chapter is entitled, *The Case for Applied Degree Education: The Future of Learning for the New World of Work*. This chapter discusses and defines the applied degree sector on its social and economic value as it delivers professionally orientated skilling, upskilling and reskilling solutions for the emergent future of work. The chapter further proposes that the applied degree sector will need to work in closer partnership with their industries and professions adopting an ecosystem approach to ensure the applied knowledge, advanced skills currency, and global relevance of their work ready, future ready graduates.

Part I: *Future ready values and competencies for the future of learning* is divided into seven chapters. *Preparing Engineers for 2035: Transforming Australia's Engineering Education for Emerging Roles and Expectations* discusses the Engineering 2035 project as proposed by the Australian Council of Engineering Deans to reshape Australian engineering education for future professional engineering graduates. *A New Norm of Learning: Accommodating 21st Century Learners' Needs*, through comparison and analysis of various curricula,argues the case for interdisciplinary curricula that can be delivered cross-institutionally, enabling flexible online learning with self-selected courses to suit individual student's specific needs. *The Structure of Domain-specific Competence in the Occupation of Technicians at Vocational Schools in Germany* focuses on the structure of domain-specific competence in the occupation of technicians at vocational schools in Germany.*Futures Literacy: The Concept and Potential Application in Applied Degree Education* reviews the concept of futures literacy and analyzes its applicability to English language curriculum design in the context of tertiary-level applied degree education.*Creativity under COVID-19: How technology has enhanced and promoted student engagement online* examines how features such as chatrooms and share-screens in selected video-conferencing tools enhance the hybrid mode of teaching and learning in the context of creativity and how technology has enhanced online student engagement in the said context. *Competency-based Workplace Learning and Assessment: A Framework and Models for Future Research* presents a framework for the assessment of workplace learning by empirical method based on research and upon experiences of vocational training in Workplace Learning and Assessment (WLA) implementation.*Embedding Uncertainty in the Learning Process—An Evaluation Case-study of VUCA Model in Education* discusses the VUCA environment: Volatile, Uncertain, Complex, Ambiguous and evaluates how the principles of VUCA can be applied in learning environments from the perspective of four design elements (epistemic, instrumental, and spatial, social, and temporal).

Part II: *Innovative pedagogies in applied degree learning and training* is divided into eight chapters. *Remote Teaching and Learning in Applied Engineering: A Post-Pandemic Perspective* provides a rationale for a variety of course delivery models at various stages of the pandemic and highlights the approaches to overcome some of the pressing challenges of remote education. *Applying Hybrid Mode in Different Pedagogical Approaches on Design-related Tertiary Education Programmes in Hong Kong* investigates the learning experiences and challenges of design students under hybrid teaching mode.*An Investigation of Using Blended Learning Pedagogy to Sustain Student Interest in Basic Science Subjects* presents current practice and evaluates the effectiveness of blended learning activities to enhance students' engagement and motivation in learning science.*Budding the Next Entrepreneur in the Applied Learning Education* describes two successful case examples of how technology is used, applied, and backbones innovation projects completed by Final Year Project (FYP) students. *Does online practice based on an adaptive curriculum work better than written feedback for EAP?* examines the impact of feedback in teaching English for Academic Purposes (EAP). Findings suggest that the use of rubrics, adaptive curricular and the role of practicing "positioning" are recommended. *Improving Students' Learning Experience Using Simulated Environments in Applied Degree Education in Architecture, Engineering, and Construction* introduces several approaches in creating simulated environments for applied degree programs, including Virtual Reality, Augmented Reality, Mixed Reality, and the A Real Organization Unit Simulated as Life system, to improve the student learning experience. *Developing an Online Practicum in Professional Education: A Case Study from UK Teacher Education* presents a case study of the transition to a fully online practicum for UK university students training to be teachers. The evaluation suggests that online supervision requires participants to work harder to establish a positive working alliance and sense of belonging across time-space-digital media. *New Intervention Strategy in Teaching and Learning under Covid-19 Pandemic: Nursing Simulation on Health Worker Training in Tertiary Education, Hong Kong* evaluates the effectiveness of using nursing simulation as an alternative mode to replace on-site fieldwork placement in health worker training.

Part III: *Driving student access, engagement and success through digital technologies* is divided into eight chapters. *A Reflection Case to Covid-19 Pandemic: Online Learning Experience* explores the shift to online learning during the coronavirus epidemic and attempts to identify roadblocks and hurdles in the process. Six major themes are identified: online learning experience; support; engagement; group work; time; and assessment. *Product Design Education in the wake of COVID-19: New Technologies Enabling Experiential Learning Relevant to Future Practices* discusses a university-industry collaboration (UIC) research project in Product Design subjects. The case analysis identifies a convergence of innovative technologies; new ways to optimize student engagement and the development of future ready skills. *How do Moroccan Higher Education Students Behave during the Remote Education in Time of COVID-19?* assesses how Moroccan higher education students behaved during the transition from face-to-face education to a complete remote education.*Technology-Enhanced Student-centric Learning in Information and Multimedia Technologies in the New Normal Era* proposes a deconstructed teaching strategy with virtualized practical sessions to maximize the understanding of the practical implementation.*Enhancements of Vocational Students' Engagement of Workplace Learning in the Industry-university Collaboration Learning Environment: A Case Study in the Greater Bay Area* investigates vocational students' engagement in work-based learning from an industry-university collaboration perspective to enhance the students' professional skills in dynamic situational work contexts. *Engaging Students through Technology-enhanced Interactive Activities Outside the Classroom* reports on the adoption of different technology-enhanced interactive activities in a database subject.*Reflexivity on Delivering Experiential Learning before and since Coronavirus Pandemic* offers an autoethnographic and reflexive account on delivering experiential learning in higher education in Hong Kong.*COVID-19 and Contactless Learning and Teaching: The Impact of Active Participation and User Acceptance* analyzes the impact of contactless learning and teaching. A mobile app integrated with iBeacon technology was developed to deliver learning materials.

Part IV: *Lifelong learning, partnering and the future of work* is divided into six chapters. *Making Connections Between Work and Study—Maximising the Value of Degree Apprenticeships* discusses contemporary degree apprenticeships which blend practical skills-based elements with a recognized course of academic study.*Re-engineering the Food Industry: Where do We Go from Here?* discusses the importance of the discipline of food engineering as a change agent for the future of the universal food industry and the need for a re-engineering of food education. *The Relevance of Applied Education to Urban Sustainability: A Case Study of a Degree Programme in Horticulture, Arboriculture and Landscape Management in Hong Kong* examines the challenges and opportunities in implementing an existing vocational degree program and its transformation into an applied degree. Knowledge classification, workplace training and the cultivation of transferable skills at individual, program, industry and social levels are discussed. *From Deindustrialization to Reindustrialization: A Repositioning of Vocational Education and Training for Improving Synergy and Connection within the Social Structure in Hong Kong* argues that the Vocational and Professional Education and Training (VPET) initiative should become a new paradigm for incorporating the strategic planning of STEM with digitalization and craftsmanship as innovative features to better promote VPET in Hong Kong. *Globalisation and the Massification of Higher Education in the Hong Kong Context: Dealing with the Challenges of Globalisation* considers the impact on educating a workforce suitable for the much-touted knowledge-based economy through the review of past and current research covering the subject matter. *Facilitating Transformational Change in Applied Degrees in Engineering: A BRAVE New World* introduces a transformational model of applied engineering education, the BRAVE Model, incorporating five distinct concepts, Belonging, Relationships, Authenticity, Variety and Employability. *Foregrounding Design Thinking in Project-based Learning amid the Transition to the New Normal*, based on the five-stage model of Design Thinking, highlighting how non-linear Design Thinking can engage students in multidisciplinary partnerships with different stakeholders.

Editors

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Reference

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About the Editors

Prof. Dr. Christina Hong, Ph.D. is the President, Technological and Higher Education Institute of Hong Kong (THEi). Christina has a strong background in educational management and leadership with an emphasis on organizational change management, curriculum transformation, technology enhanced learning, and teacher praxis across the school, VET and higher education sectors. Christina's prior roles include senior executive roles in the TAFE and university sectors in Australia as well as national educational reform and tertiary education leadership roles in New Zealand. Christina is particularly interested in how tertiary institutions foster C21st employability skills, the dynamic of innovation ecosystems and collaboration through internationalization and applied research activities. She is highly sought after as an international consultant and speaker, including, Hong Kong SAR and Greater Bay Area (China) technology innovation Ed-Tech start-up panels, UNESCO global projects and APAC education forums. Christina initiated the International Conference on Applied Education, Technology and Innovation (AETI) in 2019, and with Dr. Will Ma has co-edited two thematic publications: Applied degree education and the future of work (2020) and this current edition.

Will W. K. Ma, Ph.D. is the Head of the Learning Commons & Digital Innovation, Technological and Higher Education Institute of Hong Kong (THEi). The Learning Commons & Digital Innovation is responsible for providing physical learning space, information technology services, physical and online learning resources for staff and students to promote applied research and to enhance learning. He is the Chairman of the Learning & Teaching Committee and is a champion of staff development, especially in technology-enhanced learning. Dr. Ma's research focuses on the use of information systems for communication, knowledge sharing and knowledge creation. He has publications in *Computers & Education*, *Computers in Human Behavior*, *Journal of Computer Assisted Learning*, *International Journal of Communications, Law and Policy*, and *Information & Management*. He is co-editor of the Journal of Communication and Education (2015–Present), and editor of Cogent Social Sciences, Taylor & Francis Online (2017–2019). He is the Editor of Springer's *Educational Communications and Technology Yearbook* series.

Chapter 1
The Case for Applied Degree Education: The Future of Learning for the New World of Work

Christina Hong

Abstract As the higher education sector transitions, post the disruption of the global pandemic to the 'next normal', this chapter contends that the applied degree sector will increasingly add social and economic value as it delivers professionally orientated skilling, upskilling and reskilling solutions for the emergent future of work. With the advent of Industry 4.0 and as new technologies, rapid digitalization and automation are increasingly embedded across all areas of life, the new workforce will rapidly require more advanced technical knowledge, skills and attitudes. Investment in digital skills comprising a combination of skillsets that make workers adaptable to technological change along with the essentially 'human' DELTA qualities and skills will be necessary. The applied degree sector will need to work in closer partnership with their industries and professions adopting an ecosystem approach to ensure the applied knowledge, advanced skills currency and global relevance of their work ready, future ready graduates.

Keywords Applied degree education · Industry 4.0 · Education 4.0 · The future of jobs · The new world of work

1.1 Introduction

There is a Chinese proverb that goes, *a crisis is an opportunity riding a dangerous wind.* Given the experience of the global pandemic, the sentiment expressed in the proverb seems particularly pertinent. The pandemic plunged education sectors across the globe into a state of crisis, forcing institutions to either quickly and flexibly adapt and adopt new ways of working to ensure continuity of learning and teaching provision. Or alternatively, to suspend all learning and teaching for an indefinite and ultimately, unsustainable period. Across education sectors, and more specifically in relation to the higher education applied degree sector, apropos the context of this chapter, institutions and schools were fortunately able to respond and pivot

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to online and remote learning and teaching. The pandemic has propelled us into 'unprecedented' times and consequently accelerated the uptake of digital learning and teaching, just as it has served to accelerate the digital transformation of work, workplaces and industrial and professional settings. As Gallagher (2021) in *Peak Human Workplace: Innovation in the unprecedented era* states:

> We are living and working in the 'unprecedented era'. It is extraordinary not only for the scale and gravity of the mega challenges we face, including climate change, a global pandemic and globalisation – for the world has faced similar trials before. It's when these challenges combine with the profound transformation of the economy and society by digital technologies that we find ourselves in an era without precedence. (p. 4)

As the world gradually turns towards the 'next normal' and we critically reflect on the exigencies of Education 4.0 and the reindustrialization focus of Industry 4.0, in tandem with the learnings from the pandemic, there is a window of opportunity for the vocationally orientated professional higher education sector, to re-think, reimagine and re-set our education and training approaches. We must take cognizance of these new realities to ensure that our graduates are prepared and ready for the shifting new realities of the future of work. The *opportunity* that has ridden along on the back of the danger wrought by the COVID-19 crisis lies arguably, in this critical transformation.

Commentators have long contended that the educational paradigms of the last century are no longer fit for purpose for *this* century. According to the OECD *2030 Future of Education and Skills Project* (2019a) there is a need to replace old education standards with an educational framework that combines knowledge with the twenty-first century skills of creativity, critical thinking, communication and collaboration. The World Economic Forum (2020a) also echoes this sentiment: 'There is an urgent need to update education systems to equip children with the skills to navigate the future of work and the future of societies' (2020a, p. 26). The school-based teaching and learning approaches of the industrial age *sic* transmission teaching and rote learning, albeit still practiced in some jurisdictions, or the mass lecture modes of higher education are no longer wholly sufficient nor digitally progressive enough to meet the demands of delivering twenty-first century learner outcomes. The OECD's Learning Compass 2030 describes *skills* as 'the ability and capacity to carry out processes and be able to use one's knowledge in a responsible way to achieve a goal,' and distinguishes three different types of skills: cognitive and metacognitive; social and emotional; and practical and physical (OECD, 2019b). The skills and competencies required in the twenty-first century enabled by the characteristics of Education 4.0, therefore require a quite different (and to the extent that educational technologies continue to evolve and advance) emergent set of learning and teaching approaches supported by increasingly sophisticated digital toolkits.

1.2 Education 4.0

Education 4.0 refers to the shifts in the education sector in response to Industry 4.0 where digital transformation is impacting the ways in which the world of work and everyday lives are becoming increasingly automated. The World Economic Forum (WEF) *Schools of the Future Report* (2020a) identifies eight critical characteristics to equip young people in school systems with the skills to inhabit a more inclusive, cohesive and productive world. Namely, global citizenship skills, innovation and creativity skills, technology skills, interpersonal skills, personalized and self-paced learning, accessible and inclusive learning, problem-based and collaborative learning and life-long and student driven learning. Similarly, these characteristics prove relevant and attributable to Education 4.0 in response to Industry 4.0—in the context of high-quality applied degree learning experiences. Industry 4.0 and the adoption of automation and digitization including new technologies such as artificial intelligence (AI), Augmented Reality (AR) Virtual Reality (VR) and Mixed Reality (MR), big data and the Internet of Things (IoT) require new workforce competencies and capabilities.

Moreover, Education 4.0 and the future of work relies much less on *what* you know (in conceptual and theoretical terms) and much more on *how* you can demonstrate not only the synthesis and application of knowledge and skills, but also inter-operably, the integration of this synthesis in relation to the relevant new technologies in the industrial or professional field. This increasing focus on 'real-world' integration of theory and practice echoes as previously referenced, (Hong & Ma, 2020) the insights from the 2019 World Economic Forum on the *Future of Work*. Experts at Davos included the CEO of IBM, Ginni Rometty, who called for the development of a new career and education model, which she deems, '*new collar, not blue collar or white collar*' and one that requires investment in skills development and responsivity in real time to the changing skills landscape. It is this 'new collar' and focus on advanced skills application and the imperative to up-skill and re-skill, to unlearn and relearn, that is driving a stronger applied educational paradigm that more than ever before heralds the relevance and significance of the applied degree to the new economy.

1.3 Future of Jobs and the New World of Work

The World Economic Forum (2020b) released its third edition of the *Future of Jobs Report* in October 2020. The Report iterates that what used to be considered the future of work, i.e., increased automation and digitization has already happened. The global pandemic catalyzed rapid digital acceleration across almost all facets of life and professional work and increased the uptake of automation across industries. The Report anticipates that by 2025, automation and the new division of labour between humans and machines will disrupt 85 million jobs globally. This rate of displacement has been signaled over time, however, as a corollary, the Report also anticipates an upside. As the economy and job markets evolve, 97 million new roles will also be created that leverage and take advantage of distinctive human skills. These include tasks such as managing, decision-making, communicating and interacting. It is projected that 50% of those set to stay in their current roles in the next five years will need to undergo a transition process through upskilling and reskilling to more sustainable job opportunities. An imperative that needs to be urgently addressed by nations at both scale and speed.

More recently, research by the McKinsey Global Institute (Dondi et al., 2021) identifies that while manual skills will decline, the demand for technological, social and higher cognitive skills will increase. The McKinsey research goes further to define what skills are required to future-proof citizens for the future of work through identifying a set of 56 foundational skills associated with a higher likelihood of employment, stronger incomes and job satisfaction. These foundational skills fulfil the three criteria that will benefit all workers, regardless of the sector in which they work (Dondi et al., 2021, p. 2):

- Add value beyond what can be done by automated systems and intelligent machines
- Operate in a digital environment
- Continually adapt to new ways of working and new occupations.

The 56 foundational skills, are called DELTAs because they comprise both skills and attitudes are clustered into 13 skill groups and four categories comprising: Cognitive—critical thinking, planning and ways of working, communication, mental flexibility; Interpersonal—mobilizing systems, developing relationships, teamwork effectiveness; Self-leadership—self-awareness and self-management, entrepreneurship, goals achievement; and Digital—digital fluency and citizenship, software use and development, understanding digital systems (Dondi et al., 2021, p. 3). As a result of a psychometric online survey conducted with eighteen thousand people from 15 countries, the outcomes of the McKinsey research include the identification of current state proficiencies and the ranking of the top 3 DELTAs which are likely to predict better outcomes for employment, higher income and job satisfaction. Proficiency in synthesizing messages, coping with uncertainty and adaptability are the top three DELTAs relating to Employment. Self-confidence, work-plan development and organizational awareness are related to High Income. Self-confidence, coping with uncertainty and self-motivation and wellness are the top three relating to Job Satisfaction (Dondi et al., 2021, p. 10).

The McKinsey researchers contend that these findings have the potential to help shape the future of education and adult training and make three recommendations for governments to consider in: (1) reforming education systems with more curricula focus on the DELTAs; (2) reforming adult-training systems, again with a focus on the DELTAs and (3) ensuring affordability in life-long education to enable on-going attention on the DELTAs.

> Hence, just as the Industrial Revolution in the 19th century drove an expansion of access to education, today's technological revolution should drive further expansion to ensure universal, high-quality, affordable access to education from early childhood to retirement

> and to ensure that curricula include the DELTAs that will future-proof citizens' skills in the world of work. (Dondi et al., 2021, p. 11)

Mention of the nineteenth century industrial revolution and today's technological revolution, reminds us again of the pressing need to shift mindsets and approaches from what was then to what is now. As we re-think, re-imagine, re-set and transition to opportunities post-COVID, how relevant is the applied degree sector to the demands of this re-emergent post-COVID world? What is the value proposition that the applied degree education sector offers?

1.4 Addressing Employability Gaps and Skills Shortages

Once-upon-a-time, gaining a bachelor's degree, securing initial employment with the expectation of gaining promotion(s) and perhaps moving to a few other same sector jobs over a lifetime of work was sufficient for career success. With the rise of automation, AI, AR, VR, MR, big data and IoT, this 'last century' mindset will no longer suffice. Just as flipped learning has disrupted more traditional pedagogical approaches, so the traditional mindset of education-employment-career has been flipped on its head.

Moreover, the emergence of the knowledge economy has witnessed the driving of globalisation, marketisation and massification as higher education trends. The setting of widening participation targets for higher education has for example, led to an increasingly larger number of degree-level admissions and consequent increase in degree-level graduates entering the workforce. Such that there is now an oversupply of graduates in respective markets. Indeed, not only is there an oversupply of graduates, but there are skills discrepancies aka *skills gaps* identified between university graduate outcomes and the employability requirements of the industry or profession. As graduates struggle to find employment relevant to their areas of degree study, there is increasingly a *skills mismatch*, where degree graduates are employed in jobs requiring lower skill levels. The Boston Consulting Group, in a publication entitled, *Fixing the skills mismatch* (Puckett et al., 2020) remark that 'the *skills mismatch* is much less obvious than the skills gap, because it creates an illusion of employment and economic and social stability.' Increasingly, countries across the globe are experiencing a glut of over-educated and under-employed degree graduates. Headlines such as the following reveal this phenomenon: *South Korea's latest export: Jobless graduates* (Yang & Kim, 2019), *Does Australia have too many graduates?* (Go, 2021); *Are we producing too many graduates?* (Philabaum, 2015: LinkedIn), *University graduates face tough competition and low salaries as they enter Hong Kong's crowded workforce*, (Ng & Choi, 2019).

Amidst this context of an under-employed and over-qualified workforce, there is ironically, a global shortage of skilled talent, particularly in industries that are acknowledged to be strong economic drivers. An extensive Korn Ferry Report (2018) as part of their *Future of Work* series, finds that by 2030, more than 85.2 million jobs, at an estimated value of $US8.452 trillion (Korn Ferry, 2018, p. 4) could go unfilled due to unmet talent supply across industries and continents. The report, *Future of Work: The Global Talent Crunch* examines talent supply and demand in 20 economies across the world in three broad industries: finance and business services; technology, media and telecommunications; and manufacturing.

The Report finds that by 2030, the global financial and business services sector is likely to face a labor skills shortage of 10.7 million workers and unrealized output of $1.313 trillion. Specific mention is made of small but strong economies like Hong Kong and Singapore, noting that they 'have limited opportunities for expansion, so upskilling the existing workforce is critical. Human resource development holds the key both to economic development and reducing the inequality by enabling local populations to achieve their potential', (Korn Ferry, 2018, p. 15). India is the only country expected to have a surplus of highly skilled (i.e., degree level) financial and business services labor by 2030. Talent shortages in the technology, media and telecommunications (TMT) sector is also acute, with a shortage of some 4.3million workers and unrealized output forecast of $449.70 billion. Likewise, the manufacturing industry is forecast to experience a labor skills shortage of 7.9 million and unrealized output forecast of $607.14 billion. In summary, the Report finds that:

> Acute global talent shortages are clearly a looming threat, and they're driven by a shortage of skills rather than a shortage of people …While technology will reshape the future of work, organizations will be unable to leverage it without the right talent. It is only through the partnership of people and technology that the full potential of both can be realized. To secure their future, companies must look to address the talent crunch now. (Korn Ferry, 2018, p. 42)

In 2020, UK Prime Minister, Boris Johnson, acknowledged that the coronavirus pandemic had exposed the "shortcomings" of the UK's educational system and pledged to ensure there was "life-long" skills retraining opportunities. Moreover, he is quoted as saying that there are too many university graduates with degrees that do not get them the jobs they want. Johnson pledged to end the 'pointless, nonsensical gulf' between the 'so-called academic and so-called practical varieties' of education. Declaring that 'Now is the time to end the pompous, snooty and frankly vacuous distinction between the practical and the academic.' In acknowledging the skills shortage in the IT field, the UK Prime Minister also identified a shortage of UK-trained lab technicians as well as skilled construction workers, mechanics and engineers. (Sleigh, 2020). This dawning realization by a world leader of the imperative to shift the focus in higher education to more applied education and skills-based learning, including clear linkages to the needs of industries and professions in addressing the demands of new workforce requirements, is also being acknowledged in other parts of the world where hitherto, applied education and the vocational and professional education and training sector has neither been as well integrated nor as highly valued as the university education sector.

Indeed, as the enhanced focus on technological advancement and greater impetus to provide graduate employment outcomes has occurred, the convergence and consequent blurring of boundaries between the traditional academic and vocational sectors has become increasingly evident. The traditional bifurcation of vocational education and training and university higher education in many countries is giving way to the building of more permeable and complementary tertiary systems. This is exemplified by the *dual sector* education offered most prominently by colleges, institutes and universities in Australia, New Zealand, the United Kingdom and parts of Europe, namely Austria, Germany and Switzerland. Reform agendas in the vocational and higher education space,—a long awaited renaissance of sorts, with the aim of clarifying and strengthening outcomes for students, employers and the economy at large is currently being driven in several countries.

1.5 Applied Degree Education

This situated cognition around the systemic positioning and value of applied learning and in particular applied degree education is globally varied. The education systems in parts of Europe, namely, Switzerland, Germany and Finland, would perhaps exemplify best practices in this regard. In the Preface to *Vocational and professional education and training in Switzerland* (Strahm et al., 2016) the authors and publishers remark on the trend towards university education as an academic education and emphasize the need for scrutiny based on two rationales:

> Firstly, the university education path very often qualifies and educates young people further away from the requirement of the labour market. Secondly, most of the full- time school (i.e., university) education path tends to neglect the practical human qualities similar to the qualification of practical and emotional intelligence, reliability, accuracy, precision and responsibility. (Strahm et al., 2016, p. 13–14)

Switzerland has traditionally had one of the lowest rates of youth unemployment in the world coupled with a strong competitive economy. As of June 2021, Switzerland was placed first in the IMD World Competitiveness ranking which ranks 64 economies and assesses the extent to which the country promotes the prosperity and social cohesion of its people, including such qualities as investment in innovation, digitalization, welfare benefits and leadership. According to the OECD, Switzerland is expected to be one of the countries to make a strong economic recovery as the pandemic eases. The Swiss dual-track education system has an enviable globally recognized reputation and is premised on the concept of *vertical permeability*, where every qualification staircases to and allows for further professional education or specialization at a higher level. The country's success has been attributed to not only the dual track education system, but also the dual track apprenticeship system:

> In Switzerland, the dual-track system of vocational and professional education and training (VPET) with its specially developed apprenticeship programme is a central pillar and solid driver of the Swiss economy and Swiss society. (Strahm et al., 2016, p. 138.)

Similarly, the German system of vocational education and training (VET) has a long tradition of providing a dual system apprenticeship and dual-track VET model where, 'highly standardised and stratified educational and occupational routes and formal qualifications ensure a tight coupling between skill formation and occupational labour markets' (Haasler, 2020, p. 68).

VET in Finland is held in high regard with close to 50% of young people applying for vocational upper secondary studies after the completion of basic education. Nine out of ten Finns believe that VET offers high quality learning with strong working life orientation. Characteristics of the VET system in Finland includes: a broad outcomes-based approach and work-based learning with well qualified teachers, strong employment prospects, eligibility for further studies, flexible learning pathways and a modular qualifications structure that considers lifelong learning skills. Finland has two types of higher education institutions: universities and universities of applied sciences (UAS). English-taught degree programmes are offered at bachelor's and master's level and have strong ties with working life and regional development. An interesting 'fun fact' is that Finland has more UAS than it has the 'traditional' university. The Finnish higher education sector has 13 universities whereas there are 22 UAS. Moreover, numbers are increasing in the UAS sector, with Statistics Finland reporting a 4% increase in 2020, this equates to around 133,000 more students working towards a UAS degree as compared to the prior year at bachelor's, master's and doctoral levels (Statistica, 2020).

In many parts of the Asia–Pacific, countries are strategically realigning, investing and reforming post-secondary higher education systems with a greater focus on the development of applied skills and lifelong learning. Singapore, for example, has instigated Skillsfuture (https://www.skillsfuture.gov.sg/) a national movement to drive the development of an advanced economy and inclusive society through supporting Singaporeans to develop their skills mastery. Individuals are encouraged to take ownerships of their skills development and the pursuit of lifelong learning, enabled by Skillsfuture initiatives, including incentives such as, Skillsfuture monetary credits claimable against a wide range of eligible courses and industry transformation maps. From a higher education system point of view, the Singapore Institute of Technology (SIT) was privately established in 2009 and identified as an autonomous university in 2014, allowing the SIT University of Applied Learning to confer its own degrees. The number of students at SIT have grown from 500 in 2009 to over 7,000 across 42-degree programmes as of 2019. Similarly, UniSIM was initially established as a private university in 2006, then subsequently restructured into the Singapore University of Social Sciences (SUSS) and brought under the ambit of the Singapore Ministry of Education in 2017. As the country's 6th autonomous university, SUSS has a particular remit to support lifelong learning for initial degree students as well as for working adult and mature learners in the social sciences.

China is also undergoing significant reform as it looks to further accelerate digital transformation and address the challenges of the skills mismatch and the skilling and reskilling agenda. With the aim of transforming its education and skills development to deliver the talent needed for an innovative, digitized, post-industrial economy the Central Government has set in motion a timely, transparent and actionable agenda through policy proclamations in recent years. On 29 September 2020 nine Chinese government bodies including the Ministry of Education (MoE), and Ministry of

Human Resources and Social Security (MoHRSS) released the Vocational Education Quality Improvement Action Plan (2020–2023).

This Action Plan contains the broad coordination of goals for China's vocational education sector for the next three years as part of the Implementation plan on National Vocational Education Reform (Vocational Education Reform Plan), announced in February 2019. China's reform plan for vocational education to cultivate high-quality workers and technical personnel includes the establishment of 50 high-level advanced vocational schools with 150 key majors by 2022. A national standard system of vocational education that covers most industries and meets international advanced levels will be also created. The reform plan also encourages universities and enterprises to work together to promote training through the construction of a number of high-level training bases. The action plan also proposes the full roll out of school-based modern apprenticeships and Enterprise New Apprenticeships targeted at training within enterprises. Interestingly, the reform action plan also encourages the piloting of vocational education at bachelor's degree level offered by *vocational universities*. It also encourages competent higher education institutions at bachelor's level to transform into application orientated institutions, aka Universities of Applied Science, to deepen institution-enterprise integration and produce high-level skills workers (http://en.moe.gov.cn/).

Anticipating this trend, the Shenzhen Technology University (SZTU) was officially approved by the Ministry of Education in November 2018, to meet urgent demand from the advanced manufacturing industry locally and nationally. SZTU is exploring a new mode of 'university education + enterprise internship + engineering projects' to address the shortage of '*high-level innovative applied talents*. As a further advancement, a news item in the South China Morning Post, entitled *China's* 'MIT of Greater Bay Area' is a bid to turn southern region into innovation powerhouse' (Guo, 1st August, 2021) reports that as part of an ambitious plan for the Greater Bay Area (GBA), linking the cities of Hong Kong, Macau, Guangzhou, Shenzhen, Zhuhai, Foshan, Zhongshan, Dongguan, Huizhou, Jiangmen and Zhaoqing, a new university is being planned for Dongguan, opening in 2023 with a focus on science and technology to enhance the region as an economic and business hub.

In Hong Kong SAR, the greater recognition of the term *applied education* and in particular applied degree education and its distinguishing characteristics is gaining momentum. A 2018 study by McKinsey Company, observed that the Hong Kong education system is not meeting the needs of employers and identified a gap between the expectations of young employees and that of the employers. Joe Ngai, managing partner for Greater China at McKinsey and Company, as quoted in a South China Morning Post article remarks that:

> Hong Kong parents tend to encourage their children to take on education and training to become bankers, accountants and lawyers. And while these careers are vital for Hong Kong as a leading financial and banking centre, the city does not have many youths engaged in engineering, construction, technology or the creative industries. In comparison, South Korea and Singapore provide more diversified education to train talent for different industries. This lack of diversity will affect the competitiveness of Hong Kong in the long term. (Yiu, 2018)

Similarly, in a report published in 2019, entitled *Applied education: A holistic, flexible education system for the digital age*, by the Our Hong Kong Foundation, a non-government, non-profit organization, proposes key policy recommendations targeted at enhancing the Hong Kong education system for the next generation (Yiu, 2018, p. 2). This Report, finds that, the key to delivering applied education at tertiary level lies in the creation of a new University of Applied Science provider category, as a distinctive *practically orientated degree-offering institution* (Yiu, 2018, p. 24).

> The ability to translate theory to impact, thus, to drive technological development, is the key reason for governments worldwide to promote UAS as an alternative in higher education. (Wong et al., 2019, p. 25)

From the Hong Kong SAR government perspective, a *Taskforce on the Promotion of Vocational and Professional Education and Training Review Report* (2020) prepared by the Taskforce included a recommendation to explore ways to facilitate the development of applied degrees at the Bachelor's degree level (Hong Kong Qualifications Framework level 5) characterized by features which include: flexible admission requirements; an applied focus; substantial work-based learning elements in the curriculum and strong industry involvement. A pilot project comprising selected degree programmes and providers has subsequently been facilitated. The pilot programmes commenced their respective developments in 2021 with a view to further enhancing and testing the modifications required to better support the development of a new generation of applied degrees.

Supporting these initiatives, a 2021 report, published by PricewaterhouseCoopers (PwC) Hong Kong, entitled, *Vocational and Professional Education and Training: Shaping the future of work*, reinforces the observation that vocational and professional education and training or VPET in Hong Kong has yet to be positioned on par with the conventional academic route in Hong Kong (Booker et al., 2021). The social and economic value proposition of the VPET sector to the Hong Kong SAR is presented, substantiated by quantitative data and qualitative findings. The report also makes key recommendations supporting the further development and positioning of VPET, including, redefining VPET as 'applied education; formalizing applied degrees and officially establishing a publicly funded University of Applied Science at the higher education level (Booker et al., 2021, p. 26) to complete the VPET value-chain.

1.6 Universities of Applied Sciences

In European countries such as Switzerland, Germany, Austria and Finland, the VPET sector has enjoyed a long and successful history of adopting an applied education approach. Universities of Applied Sciences (UAS) are well established in these countries, providing high quality professional education with an applied focus at bachelor's through to masters and doctoral levels with requisite support and input from the industries and professions.

In the countries that have UAS, it is widely acknowledged that the UAS fulfil a triple role:

1. Training and educating a highly skilled professional workforce;
2. Connecting to and supporting workforce needs and capabilities development, including an increasing focus on facilitating innovation, lifelong learning, sustainability, and social and regional engagement;
3. Undertaking applied-orientated, practice-based research that supports these endeavors. UAS research has a focus on practical applicability, is industry demand driven, collaborative and multi-disciplinary with a feed-back loop that incorporates the findings back into UAS programme curricula.

In educating and skilling future generations, the UAS work with the local and regional industries and professions to improve, innovate and enhance the development of these industries and professions and thereby drive economic value for the benefit of society at large. UAS study programs are based on industry demand analysis with graduate capabilities identified and curricula developed with significant input from the relevant industry stakeholders. This special form of cooperation between UAS and the industries and professions assures enhanced graduate employability.

Furthermore, the UAS sector addresses the increasing demands of the global knowledge economy with its pressing need for not only initial high-level skilling, but also for re-skilling and up-skilling, in essence, the need for life-long learning. This can be seen in the wide portfolio of practice-oriented modules for young and (more) mature students offered by UAS, through both full-time and part-time study programs.

1.7 Applied Degree Education: Shaping the Future of Work

Simply put, applied bachelor's degrees coupled with delivery through University of Applied Sciences and other similarly aligned higher education institutions around the world, have a strong focus on the development of applied workplace skills *in, with* and *for* specific industries and professional domains. In applied degree programmes internships, practicums, work or clinical placements, or work integrated learning as variously termed, are compulsory components of the para-professional student's vocational learning journey. These work-place based learning experiences are often inclusive of work-based assessment and in many jurisdictions are conducted by or contributed to, by trained workplace assessors. In many jurisdictions, applied degrees provide articulation pathways which build on sub-degree qualifications such diplomas, higher/advanced diplomas and associate degrees.

In the US, Cognizant's Centre for the Future of Work, surveyed 601 business executives at leading companies and 262 educational institutions globally to gain insights into the changes that are being made in education and training programmes to meet the challenges of preparing the future workforce. The research findings, published in *Relearning how we learn, from the campus to the workplace* (Bahl &

Cook, 2020) reiterates that jobs of the future will be defined by the new tools of the trade (AI, AR/VR, big data, IoT), and as such will have a significant impact on the future of work. Interestingly however, research findings indicate that only 25% of higher education students have the necessary skill base to work and interact with emerging digital technologies.

As previously described, world leaders now faced with the imperative to ensure re-industrialization and digitalization are adequately integrated to service the socio-economic development of their nations are increasingly making future work preparation a tertiary education sector priority. It is one that pragmatically requires a dramatic transformation and focus on applied education and applied learning. The applied degree sector will need to work in closer partnership with their industries and professions to more meaningfully integrate local, regional and global networks in an ecosystem approach, thereby ensuring the global relevancy and currency of advanced level skills, knowledge and applications as they prepare work ready, future ready graduates for the new world of work.

1.8 The Growing Imperative for Applied Skills-Based Education and Training

The predominant higher education paradigm has been the transmission of conventional academic wisdom, i.e., theoretical knowledge, of the relevant discipline. The pedagogical approaches in more conventional university settings have (and perhaps more stereotypically these days) highlighted professors literally, 'professing' as they lecture to and transmit academic content to undergraduates. If, as has been argued, higher level knowledge and advanced technological skills, competencies and attitudes, (i.e., the DELTAs) are the pre-requisites for successful workforce futures, then a gear-change also needs to occur that acknowledges and accords recognition of the value and the all-important parity of esteem between and within, the conventional higher education academic university provider and that of the higher education vocational and professional education applied degree provider.

Interestingly, the notion of what constitutes an applied skills provider, is also undergoing change. Given the demands for industry-ready graduates and perhaps in the wake of frustration at not being able to secure adequate pipeline talent for their industries, it has become increasingly common for larger corporations to establish their own academies or professional training and development pathways, some eventually even becoming degree-granting. The Dyson Institute for Engineering and Technology, for example, is a private institution based in Wiltshire, England. The Institute was established in 2017, by James Dyson as a direct result of his self-declared frustration over engineering training and skills shortage in the UK. Students are salaried employees of the Dyson Company and work 3-days a week while also having tuition-fees paid for during their 4-year course of study for the Bachelor of

Engineering. While the degree was initially awarded in partnership with the University of Warwick, the Dyson Institute received its own degree granting powers in 2021, making it the first alternate provider in the UK to receive this recognition (Adams, 2020).

While the Dyson Institute is a relatively recent entrant, of the so-called 'corporate university,' the earliest examples of its type, appeared more than 60 years ago. In the US, General Motors opened the first in the mid-1950s, while McDonald's Hamburger University debuted in 1961, and Disney University and Motorola University were set up in the 1970s. In China, momentum for enterprises to establish corporate universities became evident in the late 1990s and has since been gaining ground. In more recent years, social media and gaming technology giant Tencent, established Qingteng University and e-commerce giant Alibaba established Hupan University in 2015. However, in 2021 as a result of government directives, both Qingteng and Hupan removed the word 'university' from their titles and are now referred to as Qingteng and the Hupan Academy respectively. Another notable corporate includes, Meituan, China's largest food delivery platform which offers vocational training courses (Sharma, 2021).

In Hong Kong SAR, the rise of corporate academies has occurred relatively recently to offer in-house training certificates, diplomas and customized leadership programmes to build capabilities. These include but are not limited to: Mass Transit Railway (MTR) Academy, China Light and Power (CLP) Academy and Towngas Engineering Academy. Aside from qualifications orientated delivery, 'in-house' learning and development investment in employee retention, corporate social responsibility and the facilitation of outreach programmes which tap potential talent pipelines are increasingly common in national and multinational corporates, such as the four largest professional services companies in the world, collectively known as the *Big Four*—PricewaterhouseCoopers (PwC), Ernst and Young (EY), KPMG and Deloitte. Examples of large US-based corporations that have taken the lead and invested heavily into new skills development include, Amazon which recently pledged $US700 million to retrain 100,000 US-based employees for higher-skilled jobs in technology-related areas such as machine learning and data science. Similarly, JPMorgan Chase made a five-year, $US350 million commitment to develop technical skills, invest in community college and conduct research into job and career transition. And Walmart invested more than $US2 billion in wages and training programs, including Walmart Pathways, to educate entry-level employees including the development of valuable soft skills (Hancock et al., 2020).

Moreover, it is also worthy to note that online education programmes offered by service providers on a global scale have increased, particularly during the pandemic period. Utilising Massive Open Online Courses (MOOCs), providers such as Coursera, Udacity, EdX, FutureLearn, LinkedIn Learning and the Khan Academy, as well as tech corporates around the globe, such as Google Skillshop, Amazon Web Services Academy, and entrepreneurial EdTech start-ups provide just-in-time micro learning in the form of online test-based credentials, badges and certificates. The point here, is that the alternate online education and training space is booming, there is no shortage of learning and development opportunities for lifelong learners of any age wishing to undertake micro-learning and micro-credentialing on any digital device anytime, anywhere. That said, these opportunities present a double-edged sword, on one edge as disruptive and highly competitive entities with massive global outreach to rival ‘bricks and mortar’ education and on the other, as useful added-value complements to the benefits of the more real-world and practical, ‘hands-on’ experiences of an applied degree education.

1.9 Increasing Stakeholder Traction and the Value-Add of Applied Degree Education

In a digitally enhanced workspace, there is a demand for graduates with strong digital competencies and applied skills in tandem with soft skills. Consequently, the applied degree aka the professional degree, with its balance of theoretical focus and career-orientated, practical work-integrated learning, are credentials with outcomes increasingly sought after by employers who welcome the opportunity to recruit job-ready graduates with advanced skill sets into their workplaces. Further, as the imperative for upskilling and reskilling increases, the opportunity for in-service employees to enter applied degrees is also made more flexible through the recognition of prior learning experiences including advanced standing and credit transfer.

The key point of difference between an applied degree and the more conventional ‘academic’ bachelor’s degree, is that an applied degree provides students with the requisite practical and applied skills and knowledge to be significantly more “work-ready” in orientation in regard to a specified career pathway. Theoretical concepts are integrated with applied practice so that the acquisition of skills and knowledge enable their practice application relevant to the industry or professional role. In general, a more standard academic bachelor’s degree is more theory-based and puts a strong focus on the content rather than the relevance it has to the current workforce. An applied degree relates very much to a matter of *approach,* regardless of whether the provider is a university, polytechnic or institute of technology or other higher education institute and the boundaries are indeed blurring. The differential is that the approach taken in curriculum delivery is very definitely towards not only the understanding of content knowledge in the field but also the acquisition of skills and the synthesis of both theory and skill through the application of this practice in authentic professional settings.

This applied practice approach includes therefore the more traditionally recognised ‘academic’ degree programmes that develop graduate outcomes for specific occupations or the so-termed *regulated professions.* These include, but are not limited to: construction and engineering, the built environment, medicine, dental and health care services, and education. Each of which anticipate some form of applied practice through work-based or work integrated learning, be it termed a clinical placement, practicum, internship or other project-based related real-world application and outcome. It is worthwhile to note that the end point credential or award of the applied degree qualification can be variously titled. In some countries, an applied degree is the one that is prefaced in the titled as such, for example, the Bachelor of Applied Information Technology and the Bachelor of Applied Cloud Technology in Australia, or the Bachelor of Applied Science common in the Universities of Applied Science in Europe. Professional degree qualifications, those degrees commonly taught in the conventional university sector and across top tier academic research universities which utilize applied education learning and teaching approaches, tend to be titled with reference to their disciplinary fields of study, for example, Bachelor of Medicine, Bachelor of Dentistry, Bachelor of Civil Engineering and the like. The important 'take-away' here, is that applied degrees as a type, are also delivered within domain of the conventional academic university provider and do not sit exclusively within the domain of the vocational and professional education sector.

1.9.1 New Generation Degree Apprenticeships

The recent advent of new generation degree apprenticeships has increased the focus on applied degrees premised upon mutually beneficial work/study alignments, to benefit both the employee/student and the employer in terms of up-skilling and workplace talent development. In the UK, Australia and here in Hong Kong, degree apprenticeship programmes are gaining interest and traction from industry bodies and employers alike. In the US, apprenticeships are likewise being reviewed and revised. The new National Apprenticeship Act (2021–2022) is under consideration, which aims to earmark $US3 billion to expand and manage the effectiveness of apprenticeships and participation across industry sectors.

Whereas 'apprenticeship' schemes in the past have referred mainly to trades qualifications at the sub-degree diploma and higher diploma levels, the new generation degree apprenticeships reflect opportunities to 'earn and learn' across a broad spectrum of professional domains. It is also worthwhile to note that these new generation apprenticeships, e.g., in the UK, may be undertaken at undergraduate bachelor's degree level, but also at post-graduate master's degree level. While a degree apprenticeship requires determination and perseverance on behalf of the student/employee and some resource and time investment for the employer in working with degree providers to embed work-based assessment and mentorship, overall, the cost benefit in the tripartite relationship has been found to be beneficial (Morley, 2018). In the UK, an All-Party Parliamentary Group (APPG) on Apprenticeships (2021) reviewing the implementation of the modern apprenticeship in the UK found that apprenticeships are a 'fantastic way to upskill, diversify and re-skill the workforce, ensuring businesses continue to grow as they give essential capabilities to employees' (Report, Foreword). Further, the Report finds that:

> Degree apprenticeships are growing in popularity as they allow students to learn both theoretically and vocationally, earn a salary and develop work skills, whilst gaining a high-level qualification. Degree apprenticeships are increasingly being seen as viable options

> to enter employment or to reskill, with more than 100 universities now offering degree apprenticeships. (APPG on Apprenticeships, 2021, p. 8)

1.9.2 Characteristics of Applied Degree Education: High Impact Practices

The professional and career-orientated focus of applied degrees enhances the employment prospects of graduates. Applied degrees present a distinct advantage over conventional academic degrees in that they develop not only the knowledge and skills relevant to careers in an identified profession or industry, but also enable practice application through active learning. Mention has already been highlighted of work integrated learning or work placements and internships. However, project-based learning involving authentic, real-world learning is also a key aspect of work integrated learning. These real-world projects deliver outcomes related to authentic industry problems and design briefs. In turn, these projects can be highlighted in graduate resumes as clear examples of experiences and achievements in professional scenarios, including learnings acquired in relation to the important employability skills, such as, working in teams, managing project timelines and deliverables, negotiating and communicating across stakeholder groups, giving presentations and successfully working in and navigating workplace cultures and the like.

Action research can also be framed alongside these projects to deepen the critical path and understanding of the learner's experiences. This includes highlighting metacognitive approaches as well as the potential impacts of the findings and outcomes of the project for the authentic client. As described in an earlier section, the tripartite role of the University of Applied Science and other higher education providers of similar type delivering applied degrees, includes a strong focus on applied-orientated, practice-based research supporting industrial development and innovation. Applied research, practice-based consultancies and related knowledge transfer in the applied degree sector has a focus on helping to investigate, problematize and provide possible solutions to industry problems. Applied research projects have practical applicability, are industry demand driven, collaborative and multi-disciplinary with a feed-back loop that incorporates the findings back into the applied degree thereby enhancing degree programme curricula. Student involvement in applied research whether as part of project-based learning or as a capstone final-year project activity, enriches their learning and enhances their life skills and preparedness for their professional and industry sectors. Importantly, it facilitates, *innovation literacy*, through their capacity to demonstrate entrepreneurial mindsets in engaging in design thinking practices including problematizing, ideation, prototyping/hypothesising and problem solutions finding. Graduate competitiveness in the job market is consequently enhanced, as is their potential to contribute to innovation in the workplace.

In addition, active learning can also include, particularly for applied degrees in the design and creative industries sectors, competition pedagogies, where students actively participate in design competitions pitting their domain knowledge, creative talents and skills against others. Similarly, the completion of industry-specific certifications, such as acquiring vendor certificates, such as in the field of digital technologies can add value to the graduate's resume, highlighting their developing expertise with a specific software program or advanced technical skill set.

It is relevant to note that the above pedagogical practices encompass what are described as *high impact practices* (HIP) which influence student retention and engagement (Kuh, 2008). Such high impact practices include: collaborative project-based learning, undergraduate research, internships, service and community-based learning, global outreach and capstone final year projects, all of which are integrated into the active learning approaches utilized in applied degree education. In a US-based research study, Miller et al., (2018) using data from the National Survey of Student Engagement (NSSE), explored whether HIP influenced college seniors' post-graduation plans for career and further education and whether HIP participation had a positive impact on early job attainment for these students. Results suggest that even after controlling for a variety of demographic and institutional factors, HIP participation is a significant predictor of future career plans and early job attainment. HIP participation can provide students with a career-related advantage through transferable skill development, engaging in learning opportunities, and generating evidenced-based "stories" for potential employers.

1.9.3 Industry Integration

In a supply-driven applied degree sector, the development of new degrees is identified in response to industry demand analyses and related data highlighting workforce and skilling needs. The applied degree curriculum is shaped by the degree provider in collaboration *with* and *for* the relevant industry to ensure that the knowledge, skills and applications being taught are industry-relevant and meet the workplace demands for the foreseeable future. Industry and employer consultation and network collaborations remain a mainstay of an applied degree provider's ongoing quality enhancement and assurance process from market demand through to curriculum development and approval processes, and through iterative cycles of programme delivery, review, evaluation and continuous improvement. In most programmes, where there are professional associations, professional accreditation is usually sought and therefore recognition of the student as a para-professional during their course of study by the professional body is facilitated. The opportunity to make application to become a full member of the relevant professional body after graduation, pending fulfilment of the necessary professional conditions is also integrated. As a result, the student can start engaging with their professional networks and community in the very early phases of their career development.

A further key point of distinction of applied degrees is the qualifications and professional experience profile of the academic educators as *dual professionals*. The academic faculty of applied degree programmes are most usually both academically well qualified in the discipline field as well as having relevant professional or industry experience and able to share their knowledge, experience and understanding of authentic work practices. In addition, many are also academically qualified in the discipline field of education, specifically related to vocational and/or higher education. Supplementing the core academic team, as is common across the higher education sector, is the engagement of other part-time teaching staff. In this regard, the opportunity to engage experienced practitioners from the industry or professional sector is undertaken in various modes, for example, from a one-off lecture or master class to a seminar/workshop series, or engagement as an External Examiner with an industry background, to membership of programme advisory committees, such close integration with industry and professional bodies is a feature of applied degrees. It is this close connection and collaboration with the industries and professions which also ensures feedback and feedforward, thereby informing the currency and validity of the learning content and approaches taken. A further development which also strengthens industry integration in the applied degree sector includes the role and contributions of *Professors of Practice*. This specialist role is undertaken by exceptional individuals who are extensively experienced and highly esteemed professionals in an industry or professional field. Professors of Practice are appointed to share their depth and breadth of professional expertise, leadership knowledge and their ability to further enhance and deepen connections between the staff and students of the institution with industries, businesses and related agencies.

1.9.4 Riding the Dangerous Wind: Opportunities Ahead

In view of the applied degree characteristics discussed above and the shifts in work force needs in the face of continuing rapid automation and digitalization, how does the applied degree education sector future-proof the delivery of programmes for the 'next normal' apropos the in-coming and current generation of serving employees?

1.9.5 Cultivating Human Social and Emotional Capabilities

As discussed earlier, according to the World Economic Forum (2020b), there is an urgent need to not only close the current workforce gap to meet the challenges of the Fourth Industrial Revolution but an imperative to also close the massive deficit of social and emotional capabilities in today's workforce. The crux of the argument being, that in addition to adapting to technological change, humans need to cultivate the capabilities that will enable us to add value where machines fall short. Data on this point has been increasingly made clear. A 2015 study for example, by Deming (2015) of the National Bureau of Economic Research (USA) found that human workers' success and productivity depended on both cognitive and social and emotional skills, noting that outdated models of education were over-indexing on cognitive learning, and not developing the social and emotional capabilities required for the future.

Moreover, Schwab (2020), *Global Social Mobility Report: Equality, Opportunity and a New Economic Imperative,* published by the World Economic Forum, remark that there is strong evidence that education is a key contributor to relative social mobility, namely, the social and economic status of an individual relative to their parents. Designed to help policymakers, business leaders and other stakeholders shape their socio-economic strategies in the era of the Fourth Industrial Revolution, the Report seeks to evidence and drive collaborative action for systemic change across the globe on three deeply interconnected areas which all impact social mobility: growth and competitiveness; education, skills and work; and equality and inclusion. Interestingly, the Report finds that while 80% of businesses believe the importance of human skills will be critical in the future, only 46% of higher education institutions agree, thus creating a disconnect between 'talent produced' and 'talent needed.' It will be incumbent upon on applied degree sector institutions therefore, to decide whether there is indeed an imperative to address in a more comprehensive manner, not only the essential work-based knowledge and skills, but also the human soft-skills and attitudes, including design thinking, entrepreneurship, creativity and social science skills that will be essential for surviving and thriving in the post-pandemic world and beyond.

1.9.6 Fostering Talent in Technology and Innovation

As businesses and organizations across all sectors transitioned to work-from-home arrangements and connected with customers virtually an unprecedented wave of tech adoption essentially instigated, what some commentators have estimated as a decade's worth of tech adoption and digital transformation into a single year. The shift to innovate business continuity using digital channel adoptions such as telemedicine and telehealth and the greater uptake of online retailing and localized deliveries including food and groceries has been so significant that they are likely to remain. As discussed, this rapid acceleration of digitalized services and new enterprise opportunities that arise at the intersection of technology and the new world of work, along with the supporting systems such and data analytics mean that technology, media and communications jobs will remain in high demand. The provision of high-quality programmes in areas of high workforce demand, that are relevant, current and well-aligned to market needs coupled with the development of in-demand human-skills across different industries and professional will need to be facilitated by the applied degree sector. The salient reminders of the Korn Ferry (2018) report again resonate, 'Unless governments and organizations can develop enough highly skilled workers a talent crunch threatens the rosy forecasts for technological progress and its accompanying economic growth' (p. 42).

1.9.7 Staying Ahead of the Curve

As has been discussed throughout this chapter, knowledge and skills, particularly in relation to new and emerging technologies are driving the new socio-economic agenda in the face of Industry 4.0. There is a precipitant sense of energy evident in the proliferation of start-ups and enterprise incubators that mean that the 'next big thing' is just over the horizon as technological change impacts and innovates new products and services. As innovation continues to accelerate, resultant changes in industry and professional requirements will emerge and transpire. The knotty problem however facing the applied degree sector is that educational models have to date been notoriously slow in being able to respond flexibly and quickly to shifts in market practices and needs.

Typically, a new degree or major changes to established curricula can take years, not months to effect. This slow pace of change, while mindful of the need to also ensure quality assurance mechanism are appropriately embedded, will require more serious consideration and active reform, if institutions are to maintain both relevancy and currency relative to market shifts. Alternate approaches to curriculum delivery, including consideration of aggregated learning incorporating just-in-time approaches to bite-sized micro learning or stackable credentials may well provide a way forward. The key here, is that while the 4-year degree may still appeal to school-leaver initial-degree students, the sector also needs to bear in mind that there are other learner personas, such as the professional 'up-skiller' or second chance 're-skiller' or career 're-starter', that ideally look to other models of learning delivery with more flexible access pathways and stair-casing of entry and exit points to meet their work-life demands. Essentially, learning how to learn and the pursuit of life-long learning are key aspects of the educational enterprise into the future.

Similarly, not only keeping up but *staying ahead* of the curve, in regard to ensuring that foresight analysis and futures-thinking is in play, the leadership of applied degree institutions will themselves need to be pro-active in order to maintain their currency around developments in several related fields, not least of which is technological innovation. In addition, digital transformation, agile organizational development and workforce up-skilling and re-skilling within the applied degree sector itself will need to be addressed. Digital transformation in higher education integrates advances not only in educational technologies that support and enhance blended and hybrid course models and open education resources (OER) but also in technology infrastructure and systems architecture that impact the organization as a whole and include: analytics, artificial intelligence, cloud, mobile, social networks, and storage capabilities. Educause (USA) defines digital transformation as 'a series of deep and coordinated culture, workforce, and technology shifts that enable new educational and operating models and transform an institution's operations, strategic directions, and value proposition' (Brooks & McCormack, 2020). To reiterate, there are three significant shifts requiring change and by implication, change *management* to enable effective the digital transformation, namely, culture, workforce and technology shifts.

Whereas in the past, educational institutions may have been slow to adopt new approaches and change. The way ahead requires strong, visionary, purpose driven leadership. One that embraces the need for continuous learning, curiosity and willingness to challenge, innovate and change long held conceptions of how things are done. The continuing speed of change will require technology to support informed decision making. To this extent, the use of business intelligence, data visualization and foresight analysis will be important in the leadership team toolkit. Another area of shift for leaders is the increasing focus on an ecosystem approach to collaboration. A KPMG (UK) report (2019), *Future Proofing the University* contends that 'Collaborations can be the platform by which universities can become more efficient and effective, better meet student and industry needs and build the platforms for investment in innovation (p. 18).' As applied degree sector professionals, working in a globalized sector, institutional leaders and programme teams will need to flexibly yet purposefully address ecosystem imperatives to adapt applied degree curricula, teaching approaches and stakeholder engagements locally, regionally and globally to meet the new knowledge and skills currencies in the new world of work. Given the long period of off-campus learning and consequent absence of social activities the sense of identity and institutional belonging of student cohorts to their institution has been compromised. The re-engagement of students as individuals and as programmes cohorts will require significant focus. Institutional service design will be paramount to ensure quality user experiences and the rebuilding of campus-based communities for the incoming and returning student cohorts. However, while a return to face-to-face on-campus learning is anticipated, given the continuing uncertainty around COVID-19 variants and the wholesale shift to online and remote learning over repeated periods of lockdown and the recourse to hybrid mode delivery in the intervening periods, the next normal for delivery mode may well be a hybrid flexible or *hyflex* course format that combines both face-to-face and online learning. In addressing the needs of the new and returning learner community coupled with changing industry and market demands, connectedness, collaboration, agility and fresh thinking are certainly required.

1.9.8 Future Disruption

While the opportunities for the applied degree sector have been discussed, it is also important and prudent to note that the applied degree education sector itself is not immune from the challenges of reindustrialization and Industry 4.0. AI-driven training and teaching systems that deliver personalized teaching and learning are not inconceivable. A recent article in the Times Higher Education (Ross, 2021) raises the question, *Does the rise of AI spell the end of education*? The article presents the argument that as AI becomes ubiquitous, educators may well be confronted, for example, using AI to generate 'original' essays and questions how educators will re/consider the concept of authentic assessment and ethics in this light. New technologies such as AI, will increasingly become embedded in work contexts and if applied degrees are to remain consistent with authentic assessment practices, then does it therefore follow that students should be 'allowed to use 'real world' tools in assessment exercises' (p. 34)? The big questions in this space are indeed provocative and merit further investigation. For the purposes of this chapter, the important take-away is the expectation that currently held notions and assumptions require interrogation in order to reappraise and shift thinking as more relevant paradigms appropriate to the next normal and beyond are considered.

1.10 Summary

As the higher education sector transitions, post the disruption of the global pandemic to the 'next normal', this chapter contends that the applied degree sector will increasingly add social and economic value as it delivers professionally orientated skilling and reskilling solutions for the emergent future of work. With the advent of Industry 4.0 and as new technologies, rapid digitalization and automation are increasingly embedded across all areas of life, the new workforce will rapidly require more advanced technical knowledge, skills and attitudes. Investment in digital skills comprising a combination of skillsets that make workers adaptable to technological change along with creative, entrepreneurial and essentially 'human' DELTA skills will be necessary. Additionally, there will be a requirement to continue to up-skill and re-skill workers who are already in-service or those wishing to re-start their careers as technology impacts and changes skilling needs within industries and professions over time.

The applied degree education sector, best exemplified by universities of applied sciences and providers of similar ilk, is best positioned to provide professional lifelong education in this regard. Given the applied degree sector's strong industry and professional integration, its active learning approaches, including work integrated learning and project-based learning in authentic work-based contexts, the applied degree sector equips and prepares graduates to be not only work ready but also future ready through integrating and fostering employability skills through authentic work-integrate experiences. In reimagining and preparing for the 'next normal' the applied degree sector is itself not immune from the technology shifts and innovations occurring and will also need to critically examine and take action to address the challenges and opportunities coming over the horizon. These include: the opportunity to focus on the cultivation of human, social and emotional capabilities; a focus on fostering talent in technology and innovation; approaches to stay ahead of the curve and addressing future learning disruption. In the context of the new workforce challenges and opportunities that have been discussed in this chapter, it has also been argued that the applied degree sector is presented with the opportunity to further leverage its unique value proposition. One where new thinking is required to reimagine, reset and create value that further leverages the enabling power of innovation and ecosystem collaboration.

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Part I
Future Ready Values and Competencies for the Future of Learning

Chapter 2
Preparing Engineers for 2035: Transforming Australia's Engineering Education for Emerging Roles and Expectations

Peter Lee, Caroline Crosthwaite, Carl Reidsema, Ian Burnett, Bernadette Foley, Doug Hargreaves, Robin King, Julia Lamborn, Mark Symes, and John Wilson

Abstract The Australian Council of Engineering Deans (ACED) recently concluded a project ('Engineering 2035') to reshape Australian engineering education for future professional engineering graduates. Consultations with industry leaders and others identified the need to strengthen graduate engineers' capacity for multi-disciplinary

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and cross-functional teamwork, with greater public accountability. Focus groups of prospective students revealed weak understanding of the growing range of opportunities offered by an engineering qualification of this nature. The corresponding curriculum transformation must ensure greater focus on transferable skills and contexts are delivered alongside technical content. We envisage more industry-based, problem and project-based pedagogies. We found that the engineering academic workforce is positive to such changes. Its recent adaptation of teaching methods to accommodate COVID-19 restrictions gives confidence of a good response to the emerging needs. The project identified 22 Calls for Action to the schools of engineering and ACED, and to industry, government and the professional accrediting body, Engineers Australia.

Keywords Engineering education · Professional engineers · Graduate outcomes · Academic workforce

2.1 Introduction

Modern engineering practice intersects with science and technology and a range of other disciplines; it applies and advances knowledge for useful purposes. Engineering has profound impacts on human well-being, the global economy and environmental health. Engineering is embedded in, or enables, almost every industry and aspect of our personal lives. Its role is often critical, but it may also be invisible. Professional engineering graduates will continue to lead in the solution of complex challenges with increasingly demanding environmental and socio-economic constraints. Their contributions will be critical in making significant progress on many if not all of the United Nations Sustainable Development Goals.

The professional engineering degree curriculum must enable graduates to tackle competently their immediate post-graduation phase (ideally under the supervision of one or more professional engineers) and prepare them for their future career development. Engineering educators, individually and collectively, are responsible for the design and implementation of the curriculum, working collaboratively with their peers in engineering industries.

These demands, and the professional nature of engineering—signified by the formal (often legislated) obligations of its practitioners to clients and society, codes of ethics and prescribed qualification standards—have supported periodic, forward-looking reviews of its education provision. Since the last such Australian review (King, 2008), engineering education has further diversified and adopted more problem and project-based learning. More members of the academic workforce have developed formal research capabilities in engineering education. Flipped classroom pedagogies have been adopted to improve students' engagement and learning, while blended learning (combining face-to-face and on-line learning) have

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become increasingly important to maintain educational delivery during COVID-19 restrictions.

We describe the recently concluded review commissioned by the Australian Council of Engineering Deans (ACED). The authors of this Chapter are the members of the Steering Committee, including the leaders of substantial components of the work. The review set out to examine the 'what', 'how' and 'who' of preparing Australia's future engineers. The review had the working title 'Engineering 2035', as it was conceived in 2018 recognising that a child starting school in that year will graduate from a four-year engineering degree in 2035. Their school and tertiary education is occurring entirely in the 'digital age' and will be very different from that of even today's graduates.

From the start, the review team recognised that past engineering education—with its strong technical orientation—has served Australia well. The scale and principal characteristics of current Australian education for professional engineers are summarised in Sect. 2.2.

However, significant changes have been occurring in engineering work practices and the ways in which technical work is conducted. Society's role in identifying and proposing solutions is also changing. Current and future challenges will not be solved by technical prowess alone. A further concern has been Australia's high reliance on immigration to supply its engineering workforce. For most of the past decade, at least half of the annual supply of new professional engineers was met by Australia's skilled migration schemes (EA, 2019a). This concern has been intensified by reduced immigration due to the coronavirus pandemic.

The review addressed four issues:

- The competencies required of a professional engineer operating in the emerging environment was explored through consultations with leading employers of engineers, and leaders in the profession. This was the first stage of the project and is described in Sect. 2.3.
- Perceptions of engineering held by potential engineering students and other influencers were investigated in focus groups with school students, teachers and career advisors, engineering students and graduates, and members of industry. The findings of this study are summarised in Sect. 2.4.
- Section 2.5 discusses the required curriculum and pedagogy changes to meet industry's expectations, and potentially attract more students of greater diversity, especially women and students of indigenous background.
- A survey of engineering academic staff explored their capabilities for making the desired changes to curriculum and pedagogy, and the barriers to change. The survey and its findings are discussed in Section 2.6.

From each of these studies it was evident that transformational changes to engineering education are required to meet future needs. Section 2.7 lists the 22 actions recommended to be taken by ACED and its members (the leaders of the faculties and schools of engineering), and industry, government, and Engineers Australia in its role as the professional accrediting body for engineering degree programs.

A short Conclusion reflects on the review and its principal findings.

2.2 Professional Engineering Education in Australia

Thirty-five of Australia's public universities and two small private colleges provide the professional engineering degree programs that are externally accredited by EA. These programs meet the National Stage 1 Competency Standard for Professional Engineers (EA, 2013). This standard delivers the Graduate Attributes of the international Washington Accord (IEA, 2013), of which EA was a foundation signatory in 1989. The current EA accreditation guideline (EA, 2019b) indicates that approximately 80% of the 4-year degree content (or student effort) should be in mathematics and scientific fundamentals, engineering science and design, while approximately 10% should be concerned with "*professional engineering practice, including management and professional ethics*". The remaining 10% can be in either of these domains, or other elective studies. EA also requires accredited programs to contain 'engagement with engineering practice' equivalent to at least 12 weeks of full-time employment in a professional engineering setting.

In 2019 the Australian providers offered approximately 270 EA-accredited Bachelor of Engineering (Honours) programs and 120 accredited 'entry-to-practice' Master of Engineering (MEng) programs. The 'Honours' nomenclature distinguishes 4-year integrated professional degrees from 3-year duration Bachelor degrees (AQF, 2013). The 'entry-to-practice' descriptor for the two-year MEng degrees distinguishes these programs from 'advanced' Master degrees intended for qualified professional engineers to significantly advance their knowledge and skills.

These degree frameworks have been implemented in alternative program models as depicted in Fig. 2.1. These alternatives offer students choice with respect to tech-

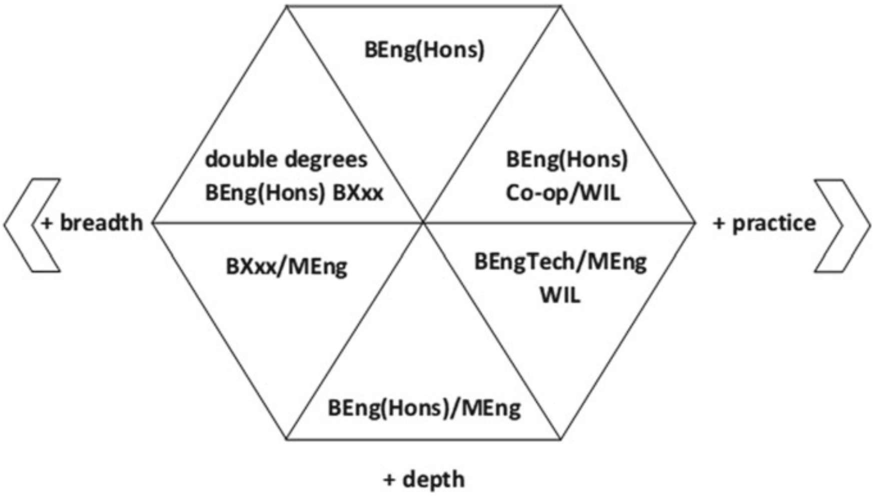

Fig. 2.1 Australian professional engineering program models

nical depth, breadth, and extended engineering practice through work integrated learning.

The upper half of Fig. 2.1 shows the BEng(Hons) and its combinations. The four-year BEng(Hons) is the standard, most commonly taken professional engineering qualification. Most large engineering schools have also operated 'double degrees' for many decades. These extend the period of study to five or more years to allow completion of a bachelor degree in science, business management, commerce, laws, or arts, in parallel with the BEng(Hons) degree. There is, however, no formal cross-linking of the studies in the two degrees, so that the additional breadth or scientific depth is not formally contextualized to enhance the engineering outcomes. Nevertheless, evidence suggests that graduates of double degree programs find the outcomes from both degrees useful in their professional engineering practice (Carroll et al., 2021).

Increased focus on engineering practice is provided by a small number of universities in 'co-op' BEng(Hons) programs that typically extend the period of formal study by up to one year with one or more industry work placements. Graduates from these programs may be awarded an additional qualification such as diploma, to recognise successful completion of the practice component.

The lower half of Fig. 2.1 shows variants of the MEng model. To meet EA accreditation requirements, the MEng itself must be structured as a two-year professional program in a defined field of engineering practice. The entry requirement to the MEng is a 3-year or 4-year bachelor degree qualification in engineering or related science.

The national higher education statistics show that in 2019 approximately 6,510 Australian ('domestic') students completed their BEng(Hons) qualification and 830 completed their five-year MEng degree in one or other of the variants (see ACED, 2020). Approximately 18% of these graduates were women, although the percentage ranged from 11 to 45% depending on the engineering branch. Australian indigenous students are also under-represented. Civil Engineering was the most commonly selected branch of engineering with approximately 30% of these graduates, followed by Mechanical Engineering (23%) and Electrical and Electronics Engineering (16%). Chemical, Mechatronics, Software, Biomedical, Mining and Aeronautical Engineering had progressively smaller proportions of graduates. These proportions reflect student demand, and therefore prospective students' perceptions and interests (see Sect. 2.4), rather than any precise estimation of industry need.

Australia also takes large numbers of international students into its professional engineering degrees. In 2019, there were approximately 3,150 and 3,360 graduates from the BEng(Hons) and MEng programs, respectively. Over the previous five years the international student enrolments into the MEng programs grew very rapidly, principally to enable graduates of bachelor level engineering programs that are not recognised by the Washington Accord, to gain such recognition through an EA accredited degree.

The size of student intakes into professional engineering degrees ranges from less than 40 in smaller regional universities to more than 1,000 in large metropolitan universities. Scale has a strong bearing on the range of programs that can be offered, and also on the capacity for educational innovation.

Australia's current engineering education is considered to be of good quality and is highly valued by graduates and employers. Annual national surveys have reported graduate engineers' employment rates and commencing salaries are higher than most other fields (QILT-GOS, 2020), and the most recent survey of employer satisfaction rated engineering graduates' capabilities the highest of all fields (QILT-ESS, 2021). It is also evident that the knowledge and skills gained in professional engineering degrees are highly valued in the finance industry, and in other sectors that require team-oriented quantitative problem-solvers.

The Australasian Association for Engineering Education (AAEE, 2021) provides support to the academic community through conferences, workshops, and a journal. Supported by both ACED and Engineers Australia, AAEE has been especially active in increasing the evidence-base for educational innovation through research, and by sharing best practice amongst the education providers.

The strength of the engineering academic community was further exemplified during 2020 by the network of Associate Deans (for education or learning & teaching) convening on-line conferences to share experiences and practices to ensure that students, unable to attend their campuses during periods of COVID-19 lockdowns and social distancing, received good quality on-line education and assessment.

2.3 The Competencies Required of Future Professional Engineers

The Engineering 2035 project commenced with a review of the current positioning of engineering education in Australia and of work on future directions being conducted elsewhere. Australian stakeholders and thought leaders, principally from engineering industry and the profession, were then consulted, specifically to gain their views on:

- emerging and future professional engineering roles
- what is meant by 'engineering thinking'
- future engineering knowledge, skills and attributes
- priorities for change
- future education pathways for entry into professional engineering and professional development.

There was considerable agreement among those consulted on the desired directions of change. They foresaw greater diversity of engineering work: it will be increasingly complex and multidisciplinary; it will privilege life cycle and societal considerations. Expectations around trust and social license to operate will increase; engineering practice will increasingly involve collaborations and interactions across a growing range of constituencies.

Professional engineers will increasingly be expected to engage in problem finding in conjunction with stakeholders and other professionals and to use holistic and systems approaches in problem solving and design. Engineers will need to meet high expectations of accuracy, reliability, and life-cycle management for the products and systems they design and maintain. They will have more advanced digital tools at their disposal. These tools will enable more creative work and higher productivity.

The consultations confirmed that industry wants to employ professional engineers who can work in multidisciplinary teams, have emotional intelligence (including empathy) and high-level communication skills, and have the required technical expertise (or can acquire it as the needs arise) to solve the engineering problems they encounter. More detail, including respondents' comments, are included in the full report on this stage of the project (Crosthwaite, 2019). Figure 2.2 captures the nature of future engineering work and the differences between the past and future expectations of professional engineers.

These expectations align with those from international work. From the UK, the 'Engineering Habits of Mind' concept (RAE, 2014), puts at the core of engineering thinking 'making things that work and making things work better' through systems thinking, adapting, problem finding, creative problem solving, visualising, and improving. This is included in Fig. 2.2. The 'T-shaped' graduate whose attributes combine a strong discipline-based stem of knowledge and skills with contextual and attitudinal breadth and transferable skills was also considered to be an ideal educational model. This has been the recent focus of Transforming Undergraduate Education in Engineering project being conducted by the American Society for Engineering Education (ASEE-TUEE, 2018).

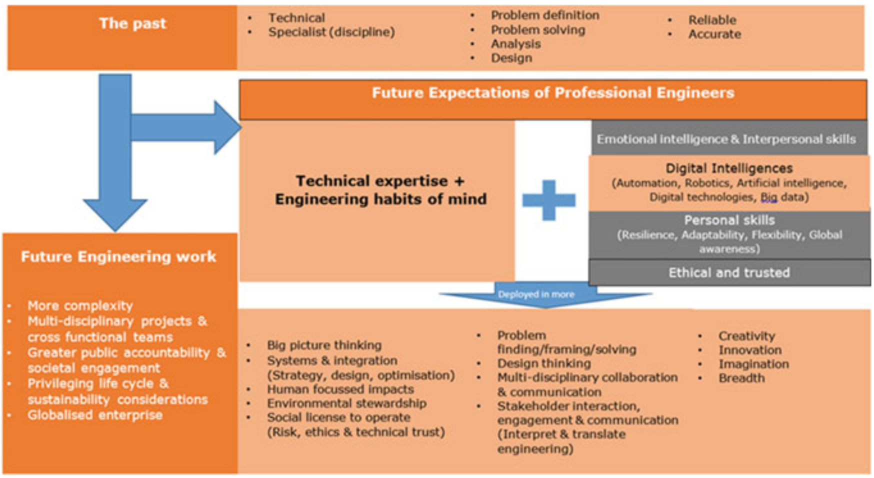

Fig. 2.2 Future engineering work and expectations of professional engineers

Those consulted also recognised changes in engineering industries and work practices. Much of Australia's engineering work is undertaken in small and medium enterprises, and via specialist service contracts, making the provision of graduate experience more difficult than in past eras. These employers need graduates to contribute to their business early after graduation. As discussed in Sect. 2.5, the educational solution to this issue is to increase curriculum focus and content on engineering practice and industry.

There was broad agreement that the curriculum balance between engineering theory and practice needs to shift towards practice. The technical skills and expertise that will continue to be expected of graduate professional engineers will need to be complemented with more intensive focus on practice. There were conflicting views on what this means for specialisations, and the roles, if any, for the currently defined engineering disciplines. As noted earlier, almost all current programs are based around traditional fields of practice, alongside emerging ones, such as mechatronics, biomedical, renewable energy, nanomaterials and humanitarian engineering.

2.4 Perceptions of Engineering by Students and Others

While industry and the profession set outcome expectations and standards for engineering education, the true customers—those who pay—are students and government. Australia's higher education system is driven by student demand. As noted in the Introduction, Australia needs to grow its engineering workforce to meet future societal demands.

Engineering educators therefore need to be confident that more prospective students understand and are enthused by the opportunities that engineering study and future careers will offer them. Engineering needs to be perceived accurately by students making their post-school study and career choices. School students and those who influence them need to be well informed about the rapidly changing opportunities offered by engineering and the characteristics required to succeed in it. The proportions of women and indigenous students in particular must be increased.

Engineering has been a pioneering and dynamic discipline since the Industrial Revolution; it has continually embraced other fields and created new specialisations. Its impacts on society and everyday life are profound and all around us. Nevertheless, and despite frequent commentary on the importance of 'STEM' (science, technology, engineering and mathematics), engineering has weak presence and visibility in the Australian school curriculum (ACARA, 2015). Mathematics and science teachers do not generally know in detail how engineering applies their disciplines and has contributed to their development. The integrative potential of engineering to demonstrate science and mathematics in action has not been well exploited. There are, however, numerous in-curriculum interventions (e.g. STELR, 2021) and extra-curricular activities (e.g. Science & Engineering Challenge, 2021) initiated by enthusiastic engineers and educators to redress this problem.

The review commissioned a study of the interpretations of engineering across a number of audiences and how these impact on the perceptions and positioning of engineering education (Lawrence, 2020). Input was sought from focus groups of Year 11 and 12 students, first and second-year university students, students and graduates in the vocational education and training sector, university graduates, mature age students, teachers, school career counsellors, and industry and employers in metropolitan and regional areas.

The study found that perceptions of engineering vary widely, with some people viewing it through traditional branches (civil, chemical, electrical and mechanical) while others focussed on its specialisations (such as telecommunications, aeronautics, etc.). Many secondary school students associate engineering with large-scale projects such as infrastructure development, construction, and production while other groups see it around more niche applications. There is also confusion around whether specialist streams (such as biomedical or robotics) are associated with engineering or science degrees. In line with professional engineers' thinking, though, engineering students are motivated to solve 'real-world' problems and want to see that engineering practice addresses societal needs.

Many school students are steered into engineering because they have high university entrance scores or have performed well in particular subjects. They are also influenced by factors such as school visits and university open days, or where their 'mentor teacher' studied. There is good awareness of double degrees, but they are usually seen as offering contrasting disciplines, rather than as augmented engineering qualifications. In essence, school students are often not sufficiently informed to consider thoroughly the diversity of engineering options now available. Greater awareness of engineering should be built from an early age. For future students, it will be their ability to absorb and filter information that drives (and limits) much of their decision making.

Secondary schools have an important role to fulfil in this regard, but for most career advisors and teachers it is a major challenge just to keep up to date with new and emerging engineering opportunities, and the alternative pathways of study that can lead into the future world of driverless vehicles, smart spaces, artificial intelligence, facial recognition, cyber-forensics, hypersonics and advanced medical devices.

Awareness of different employment options and industries tends to be delayed until students are well into their engineering degree. For students at this stage, we need to understand more about how students 'fall' into a course or discipline because they were steered or advised that way, were attracted by the 'spin' of a program, or they based their decision around other factors such as location. Although attrition from engineering degree study is not particularly high, more students move from engineering into another area of study than transfer into engineering.

If engineering is to attract more Australian students, especially women and indigenous students, major efforts will be required to change current perceptions. These need to be built on more accurate knowledge of the contributions and opportunities that future engineering must deliver to keep Australia up with its society's demands in rapidly evolving areas of endeavour and enterprise, and fast-changing workplaces, as implied in Sect. 2.3. To do this, the engineering curriculum will need to change, as discussed below. Concerted communications and marketing efforts should therefore underpin strategies for lifting the changing profile of engineering.

Engineering must be promoted as both a solutions-oriented and creative field—with creativity not only based around such qualities as inventiveness and design but also, the skills associated with enterprise, and innovation. Most current engineering marketing images show interactions between students and equipment and not necessarily interactions between students and society. Including the latter is relevant for those students who are considering study in the Sciences and for whom community, society, volunteering etc. are important considerations in their course and institutional decision-making.

The promotion of STEM in schools has increased greatly in the past decade to try to address the drop in students (and especially women) studying physical science and higher levels of mathematics. However, within the school curriculum, the 'E for Engineering' has remained relatively silent and needs to be amplified and connected across the relevant subjects to increase the awareness and interests of the engineering profession for school-leavers of both genders. These points are taken up in the Calls for Action listed in Sect. 2.7.

2.5 Changing the Engineering Curriculum and Pedagogy

The implications of the findings described in Sect. 2.3 are that critical changes need to be made to students' entry-level professional engineering degree programs. These must increase the exposure to engineering practice, deepen the core engineering thinking (habits of mind), and strengthen the coverage of the human and societal contexts in which engineering is situated. These changes need to be integrated with the desired technical engineering focus.

To explore how curriculum transformations may be made, the Engineering 2035 project team undertook further study of applicable developments in engineering education, referencing national and international best practice, and emerging educational models within the higher education sector (Crosthwaite, 2021).

The survey and consultative process asked leaders of Australian engineering education programs, and selected educators and scholars from overseas to identify exemplary engineering education programs, program models, curriculum contexts and pedagogies that have the potential to support the delivery of the 'T-shaped' engineering graduate and the greater breadth of graduate outcomes that will be required in future. Given the large engineering student numbers at many Australian universities, the scalability of initiatives, and the possible barriers to widespread implementation of desirable changes, were of particular interest.

Analysis of the survey responses and cited exemplar programs revealed strong common themes on desirable characteristics of future program models and programs. These include:

- distinctive program level philosophies;

- strong program level frameworks for engagement with industry, covering placements for work integrated learning, and methodologies for industry input into applied and practice-based courses;
- systematic use of student-centred active learning, including project-based learning throughout the program, beginning in the first year and incorporating community and industry-based and industry-sourced projects;
- collaboration with partner organisations from industry and the community
- use of human centred and empathic design projects, on-line simulations, competitions and role-plays;
- employing a range of authentic assessments including those that evaluate deployment of multiple, coordinated competencies typical of professional practice;
- the availability of enabling people, processes, systems and resources.

In summary, the future expected graduate outcomes will be delivered by degree programs that focus more on practice, address real-world complexity, and integrate the development of technical and human-social competencies in more authentic learning.

International exemplars from the United States, the United Kingdom, Singapore, Canada and Denmark offer Australian providers insights into how these desired changes may be implemented. Among the distinctive features cited across each of these programs were an embedded project-based learning model (Aalborg University, Denmark), specific modules to improve empathic communication in professional skills development (University of Georgia), and the multidisciplinary approaches taken by the Singapore University of Technology and Design.

Olin College of Engineering in the US makes use of experiential learning and hands-on engineering throughout the entire program. This adopts an interdisciplinary, project-based approach combining entrepreneurship, liberal arts and traditional engineering subjects and design. However, Olin College has a high resource base, low student-staff ratio, and a level of engagement between undergraduate project teams and industry and the local community that would be difficult to implement and scale-up in Australian engineering schools.

By contrast, the University of Waterloo in Canada runs a large-scale co-operative program involving more than 7,000 paid work placements a year across most of its undergraduate degrees. This co-op program has been running for more than 60 years and is the largest in the world. Australia's small number of industry co-op and work based learning BEng(Hons) programs currently account for approximately 5% of the domestic professional engineering graduates. Can more Australian programs engage with industry to provide student engagement with practice on a scale that is comparable with that of the University of Waterloo?

Another area for potential development is in new programs which focus more on multidisciplinary, entrepreneurial, innovative engineering applications and engineering design, such as those at Singapore University of Technology and Design. The introduction of such programs would result in a broader, more diverse national range of programs and program outcomes.

From the current Australian program models there is merit and scope in improving the role of double degrees to focus more strongly on ensuring that the non-engineering degree is designed to directly support the enhancement of the engineering degree outcomes. Further diversification of the national program models and approaches is possible.

There is no lack of ambition for contemplating such changes amongst leaders and members of the engineering academic workforce. Recommendations made in the 2007–8 review to update and clarify engineers' graduate competencies, increase student-centered learning, increase the authenticity of project work, and related matters, were taken up with project and fellowship funding from the government's Australian Learning and Teaching Council, later the Australian Office for Learning and Teaching (OLT). Arguably, the strong graduate employment and employer satisfaction ratings for engineering, as well as the engineering education research base of AAEE (reported in Sect. 2.2), are due in part to the results of that funding. However, the closure of the OLT in 2016—and corresponding loss of targeted educational research and development funding—was cited by those consulted in the present study as having limited collaborative educational changes. Small-scale initiatives by individual engineering schools and consortia, some supported by small ACED project funds and AAEE, have ensured some continuing improvement.

The Australian government has recently announced a National Partnerships and Industry Linkage Fund (NPILF, 2021) that will support universities to increase work integrated learning in all fields of education. This should be of value to engineering schools, educators and their graduates to assist them to scale-up industry-linked education in line with the directions of this review.

Other perceived barriers to the implementation of desirable changes included: the lack of access to industry; funding and resources generally; the need to augment the engineering educator workforce; academic resistance to change; constraints imposed by providers' organisational structures. These points are reinforced in the next section. A further concern raised was the possible risk to external accreditation of educational innovation aimed at producing the T-shaped graduate engineer. While this last perception is a risk, Engineers Australia's accreditation criteria accommodate innovation; EA can work with providers on implementing their innovations to minimise the risk.

Ultimately the opportunities for change will be defined by the identity and circumstances of each university and engineering school. The profiles and priorities of regional and smaller institutions must be considered and respected alongside those of large metropolitan research-intensive universities. While overseas experience demonstrates multiple ways in which the required changes may be achieved in Australian engineering schools, we also recognise that no single model will work for all institutions: engineering schools will need to define their expected student outcomes, then select the model that best suits their needs and circumstances, including the blending of on-campus and on-line pedagogies.

2.6 New Directions for the Engineering Academic Workforce

Substantial changes to engineering education will need to be supported by an academic workforce that is engaged with curriculum and pedagogical approaches that challenge traditional perceptions of the professional engineering degree. The workforce will need to have the capabilities to deliver new and desired graduate outcomes. A key factor in the curriculum change will be balancing technical knowledge and skills with an increased focus on emotional intelligence and interpersonal skills.

Historically, change in engineering education has tended to be incremental. Among the barriers to rapid and transformational change are the serious issues of scale and the teaching capabilities of the academic workforce. A previous survey had shown that most engineering academics had very little recent experience of working in industry (Cameron et al., 2011). The academic workforce is generally seen to be slow to adopt new teaching practices. However, the external threat and restrictions imposed by COVID-19, and the subsequent response by universities, including the switch to emergency remote teaching, revealed a capacity for rapid change. Academics have demonstrated flexibility and willingness to implement transformative changes in the ways they work and in their approaches to teaching. The generally positive buy-in to e-learning in engineering schools demonstrated capabilities that could be leveraged by engineering leaders to initiate a long-term and sustainable renewal of their programs.

Before COVID-19 revealed these outcomes, the Engineering 2035 project had decided to survey engineering academic staff from across all Australian university engineering schools. The focus of the survey was to understand the academic readiness or appetite for major change in teaching to meet the expectations of industry, outlined in Sect. 2.3. The survey was administered during August—November 2020, as Australia was dealing with COVID-19 lockdowns and social distancing restrictions, with almost all teaching in on-line delivery mode.

The survey instrument was based on the Theory of Planned Behaviour (TPB) (Ajzen & Madden, 1986). TPB emphasises individuals' background beliefs and perceptions about the intended behavioural change, and the external ('control') factors outside the influence of the individual. The TPB model was used to help formulate the structure of the question statements in the survey instrument. From concept mapping of the areas of educational change to deliver future graduate capabilities identified from the work described in Sect. 2.2, the survey explored seven categories of change:

- change in teaching practice
- integrating real-world situations in teaching
- increasing industry collaboration
- using e-learning
- integrating human/social dimensions within technical contexts
- using digital technologies to model engineering problems

- professional development as an engineer educator.

The survey was conducted among teaching staff across all university types, research-intensive, other capital-city, and regional. About 80% of responses were from staff in 'rank-and-file' academic roles (Level A, Associate Lecturer to Level E, Full Professor), in which teaching, research and some administration are included in their workload.

Overall, 377 academic staff completed the survey, of whom 39 were in 'leadership' positions, such as Head of Department, or Associate Dean. The sample was broadly representative of the engineering teaching workforce with respect to gender and the principal branches of engineering.

With respect to their teaching, 44% of the rank-and-file academics reported teaching in a combination of face-to-face and on-line teaching. Slightly more than a third reported teaching primarily in 'advanced technical topics', while 17.6% reported teaching primarily 'design projects', and 12.5% reported teaching primarily 'management/engineering practice'. About 75% nominated 'teaching and research' as their preferred role, rather than either just 'teaching' or 'research'.

Table 2.1 shows the survey responses in terms of percent agreement (i.e. 'completely agree (1) to 'somewhat agree' (4) on a 9-point Likert scale) with the issues associated with each of the six categories of desired change of teaching.

The differences between the 'importance' rating and the other issues (except confidence) provide insights into where actions need to be applied: such 'gaps' for the 'leadership', 'support' and 'rewards' issues may need to be addressed by the school or institution. While academics express 'confidence' in all areas they may need additional knowledge and skills development. The results in Table 2.1 point to the following findings and observations:

- Strong agreement (78%) with the importance of making substantial change. Strong agreement in the importance of the five specific change categories implies that the academic workforce is positive to the directions of change proposed.
- Three categories of change are rated very strongly on importance: 'e-learning' (90%); 'integrating real-world issues' (87%) and 'collaboration with industry' (82%). The high rating for e-learning probably reflects its importance during COVID-19 restrictions on face-to-face teaching.

Table 2.1 Percent agreement with the six targeted teaching change categories

Issue	Substantial change	Integrating real-world situations	Increasing industry collaboration	Using e-learning	Integrating human and social	Modeling with digital technologies
Importance	78	87	82	90	74	79
Confidence	89	94	86	96	80	85
Leadership	65	57	73	89	55	69
Support	65	44	69	69	N/A	57
Rewards	45	N/A	49	49	N/A	47

- The 'integrating human and social dimensions' category is rated as important (74%), but is also perceived to lack a correspondingly high level of leadership (55%), and enjoys little evidence of support or reward. Staff identified that the two biggest barriers for tackling this category area are the available time and lack of expertise.
- For all categories, academics have high confidence that they can deliver change ('confidence' ratings are greater than 'importance'). The category of least confidence (80%) is 'integration of human and social dimensions'. Addressing this will be critical to achieving the desired balance between technical engineering and the broader skills.
- The relatively low levels of agreement for leadership and support (and gaps with the importance ratings) for all categories of change, except for e-learning, indicate the need for action at school and institutional levels. The high leadership (89%) rating for e-learning most likely reflects academic perceptions that were highly sensitised by institutional responses to the COVID-19 pandemic.
- Fewer than half the surveyed population perceived the rewards for changes in teaching in any category to be anywhere close to their importance. Examples of this were: (i) 47% indicated that their "*institution rewards them for engaging with industry for professional practice learning*"; and (ii) only 40% of respondents stated that they intended to "*pursue academic promotion on the basis of their teaching and learning record during the next two years*".

The survey asked academics to identify what they consider to be the most important barriers to innovating in their teaching role. The three most common barriers identified by rank-and-file staff were 'time taken away from research' (35%) and 'student dissatisfaction' (17%) and 'lack of available funding' (15%). Staff in leadership roles rated both 'time taken away from research' and 'lack of available funding' at 23%, although 25 percent rate 'other' as the leading barrier. Rank-and-file staff had lower perceptions of the leadership and institutional support provided or available for the important dimensions of change than their leaders.

The survey also explored academics' attitudes to transformational change. They conveyed a solid (and unsurprising) disposition towards incremental change for changing their approaches to teaching. However, the response to COVID-19 suggests that rapid change to teaching is possible when a clear agenda for change has been established by university leadership.

The survey included a number of variables related to perceptions of risk and innovation. There were stronger perceptions of the 'importance of learning how to take risks' in developing roles as engineering educators than of the extent to which 'leadership encourages taking such risks', at all academic levels. These results, and others, point to the need for creating a critical mass of staff with a positive attitude and the ability to persuade others (including leadership) towards making potentially risky changes in order to achieve the transformational changes envisioned.

The survey analysis also used Exploratory Factor Analysis (EFA) (Fabrigar & Wegener, 2012) and *k-means clustering* (Likas et al., 2003) to identify eight groups for whom strategies might be developed to assist their future activities and at the same time help address shortcomings and barriers to desired change. This analysis identified three clusters (covering 37% of respondents) with strong negative attitudes towards 'intention to change', and three clusters (28%) with strong positive attitudes. The EFA process also found three statistically significant factors that contribute towards an individual's intention to change their teaching. These were 'realisation of the importance of e-learning' (31.6%), 'real-world and industry collaboration' (20.5%), and 'confidence' (10%). Notable caveats, referred to earlier, are the knowledge and skills required to deal effectively with social and human factors in engineering, and for supporting future graduate education in community settings.

These findings and others provided in the detailed survey report (Reidsema, et al., 2021) lead naturally to the question of how academic staff can be supported to undertake the required professional development to contribute to the transformational changes envisaged in future professional engineering degrees.

The survey found that overall, academic staff agree with the importance of maintaining at least an awareness of global best practice in engineering education. However, as a group, their intentions to spend time on this and other activities associated with developing their abilities as engineering educators are even lower (<60%) than their intentions to adopt the curriculum change strategies surveyed in this report. These results tend to suggest a significant cohort of academics adopt an informal or intuitive approach to teaching and learning scholarship, as identified in Jamieson and Lohman (2012) and Trigwell et al., (2000). On the other hand, as noted in Sect. 2.2, there is a strong and growing body of engineering educators with genuine expertise in research-led educational innovation.

Clearly there are high perceived barriers to many rank-and-file engineering academic staff innovating in their role as educators, with strong perceptions of negative 'impact on academic promotion' being the result of spending time on education and related development. This position reflects the historical prioritisation of academic research in engineering science over teaching or engagement with engineering practice. Combined with the restructuring currently underway across institutions to adapt to international student fee income losses, academic staff are under significant pressure to rationalise their workloads. Accordingly, future initiatives towards reshaping the engineering academic workforce should prioritise focus and support on the directions of change proposed in the Engineering 2035 study, as embodied in several of the Calls for Action listed in the next Section.

2.7 Calls for Action

The Steering Committee of the review had three principal functions: to oversee the component studies, to formulate a summary document, and develop a coherent set of recommendations for action. These are reproduced in full in the following six boxes, each addressed to a different group of the stakeholder communities. The membership of the Steering Committee has ensured that the actions have the support of the major stakeholders. In particular, the full Council of ACED has endorsed them, noting that they and their members have the largest number of actions to tackle. The summary report and the calls to action were launched in August 2021 (ACED, 2021), and implementation of the recommendations are in progress.

Box 1. Actions for the Australian Council of Engineering Deans

- Seek support from government and industry to enact and drive change
- Develop an on-going evaluation framework which will track progress of the implementation of this report to ensure the required changes are delivered
- Develop a national framework for ongoing Continuing Professional Development (CPD) for engineering academics

Actions for the Schools of Engineering

- Implement adapted curriculum exemplars as appropriate to their individual circumstances. Resources available from Government and/or industry, to implement change, should:
  - *be directed to consortia of engineering schools*
  - *have clear and detailed plans for dissemination and sharing of the methods used and other resources generated*
- Review and revise as appropriate appointment and promotion criteria for academic staff to give greater weight to:
  - *re-balancing the emphases of performance in teaching and research to give more weight to teaching development, sustained innovation and classroom performance*
  - *activities that are conducted with or in industry in a similar manner to that acknowledged within some health and creative arts disciplines*
  - *implementing industry engagement in all degree programs that lead to professional engineering qualifications*
  - *continuing professional development activities in curriculum and pedagogy innovation (see Engineers Australia Chartered Status)*
- Conduct a scoping project to identify opportunities for classifying academic staff participation in the development of professional practice learning environments as suitable activities of scholarship under Principles 1 & 2 of Part A of the Higher Education Standards Framework (Threshold Standards) 2015
- Provide greater opportunity for industry-based engineering personnel to participate in engineering education. These opportunities might be modelled

on practices already implemented in the health and creative arts disciplines, including the concepts of engineering practitioners as part of the staffing profile of Schools of Engineering. The online opportunities to achieve this outcome have expanded and been demonstrated through the past year's experiences of working from home.
- Provide greater opportunities for academic staff and students to participate in industrial projects conducted within industry itself. Again, the potential of online participation has opened more ways by which this can be achieved.

Actions for Industry

- Champion the changes in curriculum outlined in this report as necessary and appropriate.
- Assist in bringing more "real-world" experiences to the education of professional engineers by:
  - *providing examples of and increased opportunities for students to participate in engineering work through work-integrated learning and other means*
  - *encouraging industry staff to further their education in professional engineering*
  - *encouraging flows of academic and industry staff between the industry and academe*
  - *rewarding industry engineering staff who participate in such activities.* The online experience of the past year has provided greater ease of achieving this outcome.
- Provide funding and other resources for coalitions of engineering schools to implement a greater emphasis of engineering practice, including human dimensions of engineering.

Actions for Government

- Fund greater industry engagement in engineering education. The funding will facilitate:
  - *industry personnel to spend time in academe to co-teach/run projects/mentor staff and students;*

  - *academic staff to spend time in industry to acquaint themselves with modern engineering practice*
  - *development and dissemination of models by which students can gain academic credit for time spent in industry, working on industry projects*

- Fund curriculum and pedagogy projects that implement adapted-as-appropriate exemplars identified in this project. Only fund projects that:
  - *have collaborations between engineering schools which commit to sharing and disseminating results with other engineering schools*
  - *have senior academic leadership*
  - *have teams that involve the profession external to universities.*

Actions for Engineers Australia

- Ensure that identified professional engineering attributes identified by this study are incorporated into any future reviews of the Profession's competency standards
- Further demonstrate through benchmarking and exemplars how innovative and diverse program structures can be accredited within the existing or modified accreditation criteria
- Develop resources to communicate to engineering students, and industry, the meaning, process and implications of accreditation, including Provisional Accreditation, for an engineering program
- Review and revise as appropriate the criteria for Charted Professional Engineering status for academic staff to include:
  - *CPD activities related to engineering curriculum and pedagogy practice that enhance industry engagement in engineering education;*
  - *time actually spent in industry working on industry problems.*

Actions for Schools of Engineering, Engineers Australia and the Academy of Technology and Engineering (ATSE)

- Enhance the promotion of engineering as a career by engaging in activities that re-balance the focus in STEM school activities to give greater emphasis to how engineering (the "E" in STEM) can be differentiated
- Ensure that the marketing messages to potential students are cognisant of and consistent with the marketing report

- The diversity of engineering options and opportunities are better promoted in the school system to achieve the pipeline of engineers needed to achieve the goals of the nation
- Engage in activities that increase female and Aboriginal and Torres Strait Islander participation in engineering
- Engage in activities to increase the number of students undertaking engineering studies to ensure that Australia has an adequate number of engineers to meet its future needs.

2.8 Conclusions

This Chapter has presented the conduct and outcomes of a forward-looking review of Australia's professional engineering education system. The prime objective of the study has been to determine the changes needed to ensure that the curriculum and pedagogy of Australia's professional engineering degrees address the changes needed and anticipated by engineering employers. In addition to sound technical engineering knowledge and skills, future engineering graduates will need to possess good communication skills and emotional intelligence, and will routinely need to be able to work with professionals of other disciplines.

Achieving such outcomes at degree level will significantly shift the balance of professional engineering education towards practice. The intention is that future graduates will gain more of their technical engineering knowledge, including engineering design, through closer working with industry practitioners. Stronger links with industry will need to be forged. The curriculum will also emphasise more strongly the essential human and social dimensions of engineering. Each Australian engineering school will transform its professional engineering degrees in this general direction while reflecting its own profile and locality. The engineering schools will also adopt and adapt global best practice, and where possible collaborate with each other on new curriculum innovations. Together, these changes will represent transformational change to professional engineering degrees. The transformation needs to start now.

Implementation of the transformation will require leadership by the engineering schools and engagement of engineering educators, and strong support of engineering employers and the profession. The detailed evidence presented here shows that engineering academics in Australia are broadly supportive of the directions of curriculum and pedagogy change proposed, and are well able to change their mode of teaching. They will, however, need further support and time to develop their capabilities and industry networks to increase the emphasis on human-social dimensions and engineering practice.

The transformation will not be successful for Australia unless the transformed professional engineering degrees also attract more students, especially women and indigenous students. We believe that increasing the human and social dimensions of the degree will appeal to more school students. However, the work described here also shows that major efforts will be required to explain to schools and the public at large that the ongoing developments in engineering practice and study in an engineering degrees will open up many more opportunities than has been evident in the past.

The Engineering 2035 review has provided the Australian engineering education and related professional communities with new insights. The evidence has consolidated our confidence about the directions for change. It is imperative that academia, industry, government and professional societies now work together to implement the action plan.

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Chapter 3
A New Norm of Learning: Accommodating 21st Century Learners' Needs

Ricky Yuk-Kwan Ng, Robert Wells, and Krissy Yin Lam

Abstract Technologies change behaviours, habits, lives and work patterns. Studies have revealed the vast impact of technologies on learning and teaching. As work competencies change, schools are challenged to grapple with curricula design, within a context of rapid transformations and ever-increasing complexity; whilst educators struggle to produce the style of personalised, online, resources that millennial, tech-savvy, students demand. This paper discusses how educators should respond to the new norm of learning given the rapid advancements in technology and the inter-disciplinary knowledge required in this digital era. It outlines twenty-first century skills, examining how students integrate online information and resources to generate new knowledge and skills to cope with the ever-increasing complexity competencies at work. Through comparison and analysis of curricular, and sharing of learning and teaching practice, it offers insights into, and argues the case for, interdisciplinary curricular that can be delivered cross-institutionally, enabling flexible online learning with self-selected courses to suit individual student's specific needs.

Keywords New norm of learning · Flexible and online learning · 21st Century skills · Cross-institutional curricula · Interdisciplinary learning and teaching

3.1 Introduction

The quest of the 'new' in the education sector has been a perpetual issue. To cope with the contemporary work environment; learning and teaching and school curricula increasingly stress on the 'T-shaped' broad-based knowledge with professional specialisation (Hansen, 2021) to equip students with the key competencies of the twenty-first century skills (McGaw, 2013). The technological enabled 'new

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norm of learning' revolutionised the concepts of institutional education, learning and teaching as well as the forms of knowledge acquisitions. With the increasing acceptance of E-learning over the past decades, teachers, students and stakeholders such as parents, in-services learners, industries practitioners and professional bodies are gradually embracing the changes. Online learning provides open, flexible, self-paced, on-demand and just-in-time learning for the benefit of the stakeholders. The COVID Pandemic proved to be a 'tipping point' that sparked a new norm of learning (Hew et al., 2020), educators are now confronted with the biggest challenge in the history of education. The issues raised from the new norm of learning rest in how to harness and utilise the rapid advancements in technology; and the needs for interdisciplinary knowledge to accommodate the rapid transformations in learning approaches, content, and ever-changing work competencies. In view of the above, this study looks specifically into how technologies, online learning and twenty-first century skills articulate and facilitate interdisciplinary and cross-institutional curriculum design, as well as the new norm of learning and teaching in professional and applied education.

3.2 Higher, Professional and Applied Education

Until recently higher education and professional and applied education co-existed in two systems (academic versus vocational); there was a fine border that may not to be trespassed. Higher education, commonly known as university education, stressed analysis, synthesis, and the generating and advancing of academic knowledge. Technical and vocational education and training (TVET) emphasised good understanding of trade knowledge and the application of profession skills (Harris & Simons, 2006; Bank, 2013; Avis, 2014). With the promulgation of outcome-based teaching and learning (OBTL) during Hong Kong's year 2000 education reform (Education Commission, 2000), universities began to reconsider their student graduate attributes followed by the paradigm shift into student-centered learning and teaching (Biggs & Tang, 2011) which restructured their discipline-based curricula into whole-person curricula, preparing students to become all-rounded life-long learners (Cheung, 2011). Beyond merely emphasising academic knowledge advancement, faculties put application of knowledge and career development in the forefront and focused on talent development and providing human capital for the work market. The replacement of the three-year university curricula with the four-year whole-person curricula aimed to nurture students, offering a range of liberal art, humanities and transferrable skill courses to complement their discipline specific knowledge.

Following the same vision, vocational education and training modified their trade specific and skill-based curricula into vocational and professional education and training (VPET) with the inclusion of whole-person and transferable competencies. Different from the traditional TVET, VPET and applied education aimed to equip graduates with professional qualifications and at the same time provided a broad base of knowledge and pathways that facilitated students' further study and work (Ng et al., 2017). With the increasing demands in contemporary workplaces, resulting from a range of societal and economic factors such as new market demands, short product cycles, continuous obsolescence and the urge for innovation and exploration of the unknowns, a range vast of skills and competencies are required for employees to be effective. For example, to build a production line to manufacture face mask and to market the products; one needs science, technological and engineering knowledge together with finance, legal, logistic, marketing and advertising skills to implement the project. A look into the most current recruitment advertisement for a Marketing Executive reveals that the applicant should possess a university degree; one to two years' work experience in trading or manufacturing companies; experience in consumer electronics; experience in US/EU/overseas markets; familiarity with MS Office, Word and Excel; proficiency in English, Chinese and Mandarin; familiarity with professional services assigned to OEM/ODM clients and orders; orders and projects follow up, from product development through to mass production; coordination with overseas customers and China factories; and last but not least, to monitor order status to meet delivery deadline. Where on one hand we need graduates with strong underpinning discipline knowledge and trade skills, on the other we also need them to possess soft transferable skills such as problem solving, interpersonal, collaboration, coordination, communication as well as language proficiency and digital literacy; how possible is it for educational institutions to prepare their students to accommodate such market needs? Despite implementing whole-person curricula and professional and applied education, the rapidly changing work environment and technological advancements continue to be pressing issues for educators considering their students' future needs.

In view of the above, this paper discusses how educators shall respond to the new norm of learning given the rapid advancements in technology and the interdisciplinary knowledge required in this digital era. Articulating the twenty-first century skills, this paper further examines how students integrate online information and resources, and interdisciplinarity, to generate new knowledge and skills.

3.3 21st Century Skills and Interdisciplinary Learning and Teaching

In most of the educational institutions, the core elements of twenty-first century skills are not well promoted. This is resulted from lack of integration of twenty-first century skills in curriculum and assessment, limited preparation of teachers and the absence of strategies to adopt at scale innovative teaching and learning practices. The need to prepare students with the knowledge, skills and attitudes for living and working in the twenty-first century has been well advocated by academics (EU, 2007; OECD, 2004 and 2005; Voogt et al., 2013; Mishra & Kereluik, 2011). The evolution of TVET into VPET signifies a major mindset change and paradigm shift in higher and tertiary education's learning and teaching approaches and learning environments. Traditional higher education based on lectures, tutorials for theories teaching while TVET focuses on hands on dexterities based on the concept of practice makes perfect. VPET and applied education stresses application of knowledge to solve authentic problems in real-life situations. With changing in learning habits and learning preferences, the procedural and instructional types of training methods are not able to accommodate the millennials' learning styles and the rapid changes at work. Most importantly, the urgent need for educators is to prepare interdisciplinary skilled professionals with the twenty-first century skills.

The twenty-first century skills (de Villiers, 2016) equip students with foundational literacies, competencies and character qualities alongside their professional specialisms in order to become reflective practitioners and lifelong learners who are able to adapt to the work environment and rapidly-changing world. The three new skills (foundational literacies, competencies and character qualities) equip students to apply core skills (literacy, numeracy, scientific, ICT, finance and cultural and civic literacy together problem solving, critical thinking, creativity, communication and collaboration skills; and curiosity, initiative, persistence/grit, adaptability, leadership and social and cultural awareness) to harness the changing environment. The twenty-first century skills are now a hidden curriculum in most educational institutions with the core skills embedded in projects and interdisciplinary collaborations.

Interdisciplinarity has been a prominent topic in education since the 1960s (Huutoniemi et al., 2010, p. 79; Mulder, 2012). There are two central arguments made for embedding interdisciplinarity into higher education programmes; firstly, interdisciplinarity is required to solve key problems in the areas of humanity (food security, global public health, climate change etc.). Complex issues are not in "discipline shaped-blocks" (Kockelmans, 1979, p. 165) and, as a result, solutions require a synthesis of knowledge and skills from multiple disciplines (Condee, 2004; Kockelmans, 1979; Michaelis, 1978). Secondly, interdisciplinarity is required if graduates are to find meaning amid the complexities of the modern world, if we are to have an "informed and knowledgeable public" (Kleinberg, 2008 cited in Jones, 2009, p. 4). In recent years, interdisciplinary learning and teaching had become the most discussed issue in the higher and applied education sector (Repko and Szostak, 2020; Szostak & Buchberger, 2020a, b). There has been a growing body of literature and an increasing number of journals dedicated to the subject; during the decade 2006–2016, 250 books were published on interdisciplinarity alone (Condee, 2016). Normally, university curricula are structured by specific trades or academic disciplines and hence, interactions and collaborations between faculty and students are in scarcity (Clark, 1986; Weingart & Padberg, 2014; Crow & Dabars 2014; Millar, 2016). Rather than pursuing in-depth single discipline knowledge, interdisciplinary curriculum draws knowledge from multiple disciplines to elicit high-order thinking skills and cross-discipline collaborations. Interdisciplinarity provides a wider range of perspectives as it synthesises knowledge from multiple sources. It offers a rounded, comprehensive view of an issue (Repko et al., 2019) and the solutions arising from it thus have a higher probability of success (Wear, 1999). Students share views from their specialisms, integrate and assimilate diverse domains of knowledge to generate multiple perspective aimed at solving complex, real world, problems (Lattuca, 2001;

Kates, 2005a, b; Aslan & Aybek, 2020). Millar (2016) conducted a study on interdisciplinary curricula and how the knowledge taught differed between interdisciplinary and discipline-based curricula. She found that very often, interdisciplinary work was based upon a strong disciplinary foundation with discipline teachers concerned about a lack of depth; interdisciplinarity occurring at the expense of disciplinary expertise. Teachers also asserted that "to teach interdisciplinary subjects in a constructivist manner […] makes the curriculum more open and weakens students' access to specialist discourse and understanding" (p. 481). Although interdisciplinary curricula and interdisciplinary learning and teaching are commonly accepted, there is still strong resistence amongst academics. Nevertheless, interdisciplinarity can also be an approach to integrate curriculum across disciplines, it focuses on process and meaning and the combination of "contents, theories, methodologies and perspectives from two or more disciplines" (UNESCO, 2013, p. 32) to expand studies and apply the blended knowledge in meaningful projects to arouse student interests and to explore career possibilities (UNESCO, 2021). Studies also revealed that interdisciplinary curricula motivate students to exercise high order thinking, problem solving, creativity, cultural awareness and other core twenty-first century skills. It is a new norm of learning that accommodates the millennial, tech-savvy students' learning styles and learning preferences.

3.4 The New Norm of Learning

OECD (2019) asserted that the "new normal" accentuates two ideas: competency-based education and a new learning framework structured by digital technologies. Wan Hassan et al. point out that "online learning skill is one of the key skills in the twenty-first century skills that every person needs to master in order to succeed in this challenging age. These skills require someone who is able to determine what to learn, find information or materials to learn, have self-directed and self-directed learning skills, be motivated, and be able to reflect on their learning through self-assessment or other means" (p. 3300, 2020). Nowadays, learning resources on the internet are delivered in various forms of interactive technology-enhanced learning (TEL) such as online lectures, discussion forums and instruction videos. Wang et al. (2021) also introduced microlearning (ML) as "add-on" complementary online learning resources to allow self-paced, flexible and just-in-time small bursts of training materials for learners to comprehend in a short period of time. Schuck et al. (2017) introduced a 'third space' for learning enabled by mobile technology in addition to the traditional 'first space' (in class learning with activities such as such as lectures tutorials and experiments in laboratories) and the 'second space' (out of school activities such as field trips and site visits). The third space Schuck, Kearney & Burden promote is online learning, which is not bounded by spaces and locations, which can be done during commuting, during breaks between classes or just-in-time learning before examinations or meetings, to name a few. Studies showed that the effectiveness of online learning relied on a range of factors such as subjects, contents, students' attributes, learning styles and preferences, instructional design, innovative pedagogies, learning and teaching strategies, digital learning environment and learning experiences (Peters, 2000; Wignall, 2006; Chau and Cheng, 2013; Ng et al., 2020). Voogt et al., 2013) asserted that "all these developments impose new challenges to us as educators and require fundamental changes in both '*what*' has to be learned and '*how*' this learning is to happen" (p. 403). Mishra and Koehler's Technological Pedagogical Content Knowledge (TPACK) framework focuses on three core components to facilitate digital learning and they are respectively: (1) pedagogical knowledge (PK), (2) content knowledge (CK), and (3) technological knowledge (TK), and four other components formed at their intersections: (1) pedagogical content knowledge (PCK), (2) technological pedagogical knowledge (TPK), (3) technological content knowledge (TCK), and (4) technological pedagogical content knowledge (Mishra & Koehler, 2006; Koehler & Mishra, 2008). Applying the TPACK framework on the new norm of learning would enable students to increase their understanding of complex concepts and encourage interdisciplinary collaborations to prepare teachers and students with the 'new'. Schmid et al. (2020) found that equipping teachers with TPACK requires a good combination of different learning opportunities that exercise the different components of knowledge and emphasise "high-quality technology experience[s]" during their professional development (Pamuk, 2012; Wang et al., 2018). Ng et al. (2021) in their study of students' online learning experiences during the COVID Pandemic further suggest stakeholder in the education sector develop their digital literacy skills to overcome the unpredictable, reconsidering the curriculum, and its mode of delivery, to embrace the new normal of learning and teaching. The above studies laid down insightful directions and conditions for the new norm of learning.

3.5 Case Study

The case study is in two parts. The first part compares the interdisciplinary curricula of three Hong Kong universities, one of Hong Kong's largest VPET and applied education institution, and a performing arts institute. The case study analyses the aims, study framework and programme structure of interdisciplinary curricular across the selected higher education and applied education institutions. The second part looks in detail at the performing arts academy, exploring their implementation of interdisciplinarity and their post Covid-19 engagement with the new norm of online learning and teaching. This case study explores to what extent the performing arts academy utilise technology enabled learning and online resources to accommodate students' learning needs.

3.5.1 The University of Hong Kong

The University of Hong Kong's (HKU) interdisciplinary degree (Bachelor of Arts & Sciences) involves ten faculties "to develop an interdisciplinary mindset and approach to learning, crossing traditional faculty lines and enabling students to work creatively and collaboratively in adopting innovative ways of thinking and problem solving" (HKU, 2020). The six Bachelor of Arts and Science programmes (Interdisciplinary Studies; Applied AI; Design+; FinTech; Global Health and Development and Social Data and Science) provide exchange opportunities with overseas universities and internship opportunities as experiential learning. The BASc (Interdisciplinary Studies) offers students the chance to create their own degree based on personal academic interests. Onto core common programme courses, students can enrol in elective courses for between 90 and 138 credits from the Arts, Science and Social Sciences faculties. In addition, students can pursue any combination of subjects or a second major of their choice (e.g., physics, history, psychology, political studies, marketing or management) to personalise their study.

3.5.2 The Hong Kong University of Science and Technology

The Hong Kong University of Science and Technology (HKUST) offers Interdisciplinary Programmes in their undergraduate studies to "bring together two or more different academic disciplines and offer a brand-new type of educational experience, characterised by (1) Multicultural cohorts with small class sizes of 2–40 students per cohort per program, which allows close and supportive relationships to develop between students, professors and staff; (2) Ambitious curricula across different schools; and (3) Wide-ranging personal and professional enrichment activities and an exclusive team of professional advisors who provide counselling and career advice to students" (HKUST, 2021). Students can apply for programme-based admission when they first apply into the university or apply for school-based admission after their first year of study. The programmes are built on three types of programmes (BEng/BSC, BBA dual degree programme in Technology and Management, BSc in Environment and Technology and Individualised Interdisciplinary Major) where the first two programmes are more structural and the last one is centred on the personalisation of study. Students will take the common university core courses, such as English, Maths and Liberal Arts in their first year of study and work with faculty to devise a personalised study plan for the next 3 years.

3.5.3 The Chinese University of Hong Kong

The Chinese University of Hong Kong (CUHK) started to offer interdisciplinary programs for university students to study in two different fields in year 2000 (Siu, 2000). Interdisciplinary studies in CUHK built upon the concept of double degrees programmes offered between two faculties (for examples, Bachelor of Arts (Translation) and Juris Doctor; Bachelor of Business Administration (Integrated BBA Programme) and Bachelor of Engineering (Biomedical Engineering); Bachelor of Engineering (Financial Technology) and Bachelor of Business Administration (Integrated BBA Programme); Bachelor of Medicine ((MBChB)/Global Physician Leadership Scheme)). The interdisciplinary programmes in CUHK are normally supported by two departments between two faculties. Like HKU and HKUST, students are required to finish the core common courses before they personalise their study into an interdisciplinary study plan.

3.5.4 VPET and Applied Education Institution

In one of the largest VPET and applied education institutions in Hong Kong, a few Higher Diploma Programmes (HD in Design and Event Management, HD in Information Technology and Finance etc.) promote collaboration across trade disciplines to prepare their students as all-rounded work ready graduates. Students need to take the common core courses such as languages and whole person development alongside with the cross-disciplines courses. The institution adopts a project-based learning and teaching approach with interdisciplinary projects used to integrate subject knowledge and twenty-first century skills across different disciplines. Different trade subject teachers conduct co-teaching and co-assessment in project collaboration. Students from different disciplines participate in the lessons to exchange ideas to advance trade-specific or scope-specific knowledge. The project acts as an anchor to facilitate collaborations and the application of subject knowledge from different disciplines and transferable skills to solve problems. Internship and industry attachment are also provided to enrich students' work experiences in different sectors.

3.5.5 The Performing Arts Academy

Because of its distinctive homogenous nature, the performing arts academy applies interdisciplinarity as a pedagogy to promote cross-schools (Dance, Drama, Theatre Arts, Music and Film) collaborations. Using interdisciplinary approaches has been an important area of focus and attention within the academy. As a strategic initiative, the concept of hidden curriculum and a pincer movement of actions focussed on both formal courses and programmes, and activities outside of the formal curriculum are adopted to cultivate students to become twenty-first century performing artists and "Interdisciplinary Collaborators" (one of the academy's graduate attributes). A multi-dimensional approach is adopted to enable all learners at different levels of study to benefit from interdisciplinary studies. At the academy level, a new Academy wide 4-2-4-2-4 timetables provides two-week 'windows' within the timetable for multi-School, interdisciplinary projects. At the programme development and curriculum design level, Schools map aims and outcomes against the Graduate Attributes, ensuring strategic embeddedness of interdisciplinarity in all new programmes. At School level, students from different Schools participate and collaborate in cross-school productions and projects throughout their study years. The elective 'Independent Studies' enables students from different Schools to apply as a group to undertake a project of their own design. Working across Schools is further strengthened by the ability of the academy to strategically implement interdisciplinary practices into courses. General Education's elective courses offered by the Complimentary Studies Unit further enhance interdisciplinarity by creating an environment encouraging students from different Schools to engage in discourse, creating knowledge, skills and values from the perspective of multiple disciplines. The academy has been using online and blended learning since the outbreak of the COVID Pandemic. The Pandemic provided a good opportunity for teachers and students to utilise the technology enabled learning and teaching to make peace with the new norm of learning. The following case study shares one of the authors' teaching Reflective Practice to undergraduate students to accommodate the teaching and learning needs during the Pandemic.

In sum, interdisciplinary curricula are commonly accepted by Hong Kong's higher and VPET and applied education institutions to enable students to tailor for their personal growth as well as to pursuit their own visions and interests. However, it is arguable as to whether the curricula should be regarded as multi-disciplinary or cross-disciplinary rather than interdisciplinary (further reflection on this is in the discussion section). Also, as most of the learning and teaching in universities is still undertaken through lectures and hands-on practices, how do teachers and students utilise online resources, and how are they integrated into the curricula?

3.6 Teaching Reflective Practice to Undergraduate Performing Arts Students Online

The Pandemic has been a force that drives teachers to move away from their daily routines, and challenges teachers to make adaptations to their practices to maintain the effectiveness and quality of teaching when teaching online. The undergraduate course aims at introducing concepts and theories of Reflective Practice in different performing arts practices, providing students with first-hand practical experience in different methods and forms of documenting and reflecting on experiences. Active learning pedagogies were employed to suit the nature of performing arts practices and cater for the learning needs of the students. Interactive activities such as seminars, discussions, workshops and presentations were therefore crucial in providing students with active learning experiences. However, to maximise flexibility and space for technique classes and production projects during the pandemic, the course was delivered online with large proportion of asynchronous learning activities. The course teachers were faced with the challenges of converting the face-to-face active learning experiences to the online mode while maintaining the richness and depth of the learning experience as well as the level of student engagement. With a hope to switch the course to online without sacrificing the quality of teaching and learning, the course structure and content were reviewed, the course formats and learning activities were redesigned, and the notion of student engagement and teacher-student relationship were reconceptualised into the following three stages.

3.6.1 Re-Designing and Re-Structuring

By examining the course intended learning outcomes (CILOs), considering the nature of online teaching environment, students' learning needs, the technology and resources available at the academy for faculty and students, the teacher re-structured the course and re-designed the delivery of course content. Instead of conducting fourteen two-hour lectures or workshops, the course content was re-arranged into smaller units and more digestible active learning activities, resulting in three online workshops, four short video lectures, three online tutorials, six practical exercises and reflective activities conducted at student's own pace which were documented in digital learning portfolio entries, and one online oral presentation. The presentation and discussions taken place within tutorials and the learning portfolio entries acted as formative and continuous assessment tasks, while the oral presentation acted as the summative assessment.

While the course required students to integrate methods and concepts of Reflective Practice learned in the course into their real-life performing arts practices, it was undeniable that online learning took away a large portion of bodily experiences such as touch, smell, instantaneous interactions in the same space. In order to compensate for the lack of the co-presence of bodies in the class, adaptations were made to the delivery of course content in an attempt to maximise student engagement, embodied interaction and embodiment of learning in the online mode. Different forms of materials and activities such as performance recordings, making reflections through drawings or art works, storytelling, interviews and short performative presentations were incorporated in the practical online workshops. Extended practical learning activities were designed for students to carry out with partners or collaborators after the online workshops and to transfer what they had learned in the online platform into their real-life practice. Abstract concepts and theories in literature and journal articles were delivered through short video lectures making use of visual presentations of ideas, storytelling, reflective questions and simple exercises. Feedback and supervision were given continuously throughout the course in the discussion forum of online classroom.

During the process of re-packaging the course content, the teacher's major concerns were (1) students' learning needs, (2) the different types of learning experiences that might be brought to the students, and (3) whether those experiences would bring about desirable learning outcomes. It turned out that students appreciated the active and creative learning activities that they could conduct at their own pace, the short lecture videos that they could watch repeatedly for better understanding, the feedbacks that teacher provided in the discussion forum for learning activities and exercises, and the reflection of the activities that was shared and discussed in synchronous workshops. These adaptations helped students manage their learning more effectively and made them feel that their learning was supported and recognised even when they could not meet the teacher face-to-face.

3.6.2 Re-Imagining and Re-Aligning

Adapting course content and structure for the online mode of delivery was not the only challenge, re-arranging and aligning the materials in both the synchronous and asynchronous modes added extra complexity. Unlike face-to-face classes where teachers can observe students' learning experience and progress closely, asynchronous activities give little clues to teachers about students' learning experience until the assignments are submitted. The teacher of the course had to re-imagine how to apply teaching approaches in different ways that could help students construct desirable learning experiences, and how such learning could be assessed. The sequence of learning activities in the synchronous format and asynchronous format had to be re-aligned, so that each learning experience could build on the previous ones, and the overall learning experiences were connected in a logical and coherent way. The asynchronous self-learning activities needed to be reinforced through synchronous classes in which students were given the opportunity to get together again and share the experience that they gained outside the class. The asynchronous and synchronous activities could therefore drive each other. Such re-imagining and re-aligning process required the teacher to give strong autonomy to the students while carefully structuring the learning experience, so that there was an appropriate balance of guidance and autonomy for the students. Students generally felt that the sequencing of the asynchronous and synchronous activities were logical and easy to follow, however, they still preferred to have more synchronous hours so that more real time interactions, discussions and collaborative learning could take place. The above shows that synchronous classes are indeed very useful and crucial for a course that requires students to apply concepts and skills in their existing practices. The ratio between asynchronous classes and synchronous classes needed to be re-examined, perhaps small group tutorials could be arranged upon students' requests.

As the course placed strong emphasis on developing students' ability to apply Reflective Practice in their development as performing artists as well as their existing performing arts practices, feasible and manageable practical exercises needed to be designed and incorporated into the course. Four major types of practical work: individual creative work, personal reflection, paired interviews and individual Reflective Practice project were included as asynchronous learning activities to let students gain first-hand real-life experiences in conducting Reflective Practice by themselves. However, since those activities were conducted by the students at their own time and space, the teacher was not able to observe the progress. To allow the learning to be witnessed and assessed, assignments in the form of learning portfolio entries were given to the students. Furthermore, to maximise the learning experience and the connection between asynchronous learning activities and the assignments, the assignments took the form of documentation and reflection of the practical activities, so that students got to practice the skills in Reflective Practice while completing the assignments.

3.6.3 Re-Conceptualising

The development of a sense of community and teacher-student relationship happen more easily in face-to-face classroom setting. The online platform, to an extent, does offer alternative opportunity for the teachers to develop a sense of presence and to build relationship with the students. The relationship and rapport building between teachers and students have been reconceptualised in the online world. The teacher for the course adopted the following practices to support students' learning experience while developing teacher's presence and trust with the students. In the beginning of the course, the teacher explained clearly how the course would be delivered online and what the students would be expected to achieve throughout the course. Through interactive online activities and discussions in the introductory seminar, students were given the opportunity to not only introduce themselves, but also to share some of their personal views about performing arts practices. Although students were not able to meet each other physically in a classroom, they got the chance to get to know each other at a deeper and more intellectual level. Throughout the course, students were instructed to create artistic works and share personal reflections, the teacher found it extremely crucial to give students highly specific and timely feedbacks. While time might be a limiting factor for face-to-face class activities, the online platform allowed the space for the teacher to take the time she needed to look at the students' works in great depth, and to give detailed written feedbacks either via individual emails or discussion forums. The lack of live interaction was then compensated using timely written responses. When students received detailed and specific feedbacks from the teacher, they felt that their works and efforts were being recognised, which not only facilitated students' learning but also enhanced the trust that the students had for the teacher.

In order to maintain the students' engagement and social experience throughout the course, synchronous classes were arranged to spread evenly throughout the course. The evenly workshops and tutorials employed active learning teaching approaches which helped enhance the sense of community and students' engagement. The active learning approaches also allowed students to prolong their engagement in the synchronous classes with the teacher and other classmates. The synchronous workshops were followed up with asynchronous discussions around specific topics or questions given by the teacher. Those discussions that took place in the discussion forum in the online classroom continued to promote the exchange of ideas and sharing of experience which also helped develop the sense of community. The three stages of (1) Re-designing and Re-structuring; (2) Re-imagining and Re-aligning; and (3) Re-conceptualising illustrated the key factors of converting face-to-face course into online courses as well as the application of online delivery pedagogy to enhance and enrich students' online learning experience.

3.7 Findings and Discussion

The study on the available information on interdisciplinary curricula and programme structures of Hong Kong's higher and applied education institutions indicated that interdisciplinarity is a well-accepted approach to prepare students for the contemporary work environment. Interdisciplinary programmes in the three universities were developed on a double degree basis, chosen from two (HKUST, CUHK, VPET) or ten (HKU) faculties. Students need to take the university's common core courses before they proceed to the subject-specialised major and self-chosen second major. These programmes are more structural to nurture the 'T-shaped' broad-based knowledge with professional specialisation. Beside this double major model, students can opt for an individualised interdisciplinary major, which is a more personalised form of study, allowing a flexible course selection supported through the guidance of a study supervisor or mentor. In the VPET and applied education institution, the interdisciplinary higher diploma programmes are structured and normally involved collaboration between two trade disciplines. There are no personalisation of study and flexibility on courses selection. Because of the homogenous nature of the performing arts academy, project driven cross-school collaborations and hidden curriculum were adopted to promote interdisciplinarity. Rather than the double degree model, the available programmes merge two or more trade disciplines with the emphasis on project-based learning to drive the interdisciplinarity. A few questions emerge from this study, firstly, is 'interdisciplinary' being used as an umbrella term to include 'intradisciplinary', 'multidisciplinary', 'crossdisciplinary' and 'interdisciplinary'? Secondly, is 'interdisciplinary' an approach for curriculum design and teaching and learning in the above institutions?

Jensenius differentiates the five disciplines and their progression: 'Intradisciplinarity (singular)' occurs when working within a single discipline; 'Multidisciplinarity (juxtaposing)' exists when people from different disciplines working

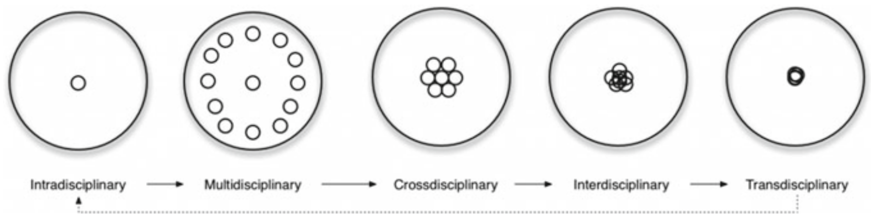

Fig. 1 Jensenius (2012)

together', each person bringing in expertise from their own discipline; for 'Crossdisciplinarity' (borrowing), disciplines borrow from each other, contributing to a single project; 'Interdisciplinarity (synthesing)' happens when disciplines combine, synthesise and integrate; and 'Transdisciplinarity (transcending)' integrates Knowledge from different disciplines combined to create new understandings and approaches, solving and exploring problems (2012) (Fig. 1).

The curricula in the case study indicated that most of the collaborations are basically between two faculties, except the ten faculties involvement in HKU. 'Interdisciplinary' is being used as an umbrella term to include 'intradisciplinary', 'multidisciplinary', 'crossdisciplinary' and 'interdisciplinary'. Making reference to Jensenius (2012), the curricula are more 'multidisciplinary' and 'cross-disciplinary' and yet to be further developed into 'interdisciplinary'; where a range of knowledge, understandings and approaches from difference disciplines combine, synthesise and integrate to develop new knowledge and understandings. This study further revealed that although some of the curricular mentioned academic exchanges, the credits for cross-universities and cross-institution course exchanges are rather limited. Collaborations between universities, institutions and other stakeholders on programmes and courses, including development of mutual credit recognition, will enable a larger scale transdisciplinary exchange; Leavy (2016) asserts that in transdisciplinary work and research there is a need to move beyond in-school academic collaboration and bring in other stakeholders such as practitioners, industry, government and the public for collaboration to investigate a problem.

This study also showed that all of the selected institutions adopt an interdisciplinary teaching and learning approach to prepare their students for the complex work tasks in the twenty-first century workplaces. In view of the above, education institutions may review and advance their 'interdisciplinary' curricular to allow wider collaborations across different faculties and expand their curricula to include other education institutions' courses to broaden students' knowledge base along with their professional specialisation. With the complexities of tasks at work and the need of integrating of knowledge from different domains to solve complex problems; interdisciplinary curricula shall not be bounded within a single academic institution but rather should adopt a 'connectivism', 'reaching out' and 'bringing in' approach (Siemens, 2004) to foster collaborations with other academic institutions and professional bodies on knowledge exchange, course credit transfer and recognition.

The online learning and teaching in the performing arts academy demonstrates a good example of the adjustment to learning and teaching during the pandemic. The practice also reconfirmed the success factors (subjects, contents, students' attributes, learning styles and preferences, instructional design, innovative pedagogies, learning and teaching strategies, digital learning environment and learning experiences) for effective online learning proposed by academics (Peters, 2000; Wignall, 2006; Chau & Cheng, 2013; Ng et al., 2020). The re-packaging and delivery of the online course also reflected the application of the TPACK framework to facilitate online learning. Because of the nature and contents of the course, instead of delivered the lessons solely as online lectures, a series of online and blended learning were adopted to utilise the technology enabled learning and teaching to support and accommodate students' learning needs. The teacher used a three-stages pedagogical approach: (1) Re-designing and Re-structuring; (2) Re-imagining and Re-aligning; and (3) Re-conceptualising to convert the face-to-face course into an online course. Firstly, the course structure and course intended learning outcomes were revisited to ensure the alignment of content, teaching and learning activities followed by the restructuring of course formats and redesigning of learning activities into smaller units, small bursts of knowledge and more digestible active learning activities to allow easy access. As online learning was built on the expanse of sacrificing a large portion of real-life performing arts practices, bodily interactions, tactile and olfactory experiences; a range of activities such as performance recordings, reflective drawings, art works, storytelling, interviews and short performative presentations were incorporated in the practical online workshops while short video lectures were used for theories lessons. In addition, consultation and supervision were provided in the course's online synchronous discussion forum. Those online resources and supports enabled the students to exercise self-paced and flexible learning with significantly effective results. Secondly, re-imagining and re-aligning process were provided to give students autonomy to balance the sequencing of the asynchronous and synchronous activities so that more real time interactions, discussions and collaborative learning could take place. Small group tutorials were arranged on a needs basis between the asynchronous classes and synchronous classes. Learning portfolio were used to maximise the learning experience. The assignments were in the form of documentation to reflect the practical activities. Thirdly, given full online classes were new to the academy; teachers and students' relationship were reconceptualised to build trust and sense of belonging on the online learning platform. Rapport building, sharing, collaboration, personal reflection and timely support were adopted to facilitate learning, to prolong engagement and enhancement of the sense of community. In sum, the teachers had demonstrated the use of pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK) (Mishra & Koehler, 2006; Koehler & Mishra, 2008) to covert the face-to-face course into a full online course to enable the new norm of learning during the pandemic.

Despite the educators' endeavour to develop interdisciplinary curricula and the use of learning and teaching technologies to equip students with the T-shaped' broad-based knowledge with professional specialisation to make peace with the rapid changing and ever-increasing complexity at contemporary workplaces; the personalised learning and online resources that millennial, tech-savvy, students demanded are not to be overlooked. An interdisciplinary curricular that can be delivered cross-institutionally, enabling flexible online learning with self-selected courses to suit individual student's specific needs are the success factors for the new norm of learning. It is asserted that utilising the open educational resources (OER), massive open online courses (MOOC) and the credit and award bearing online learning courses and programmes offered by online learning platforms such as EdX, Coursera and Future Learn to supplement the cross-institutional interdisciplinary curricula would able to provide personalised, self-paced, flexible, and just-in-time online resources and training materials for students to integrate online information and resources to generate new knowledge and skills to cope with the ever-increasing complexity competencies at work.

3.8 Conclusion

This paper first discussed how educators responded to the new norm of learning enabled by rapid advancements in technology and the interdisciplinary knowledge and twenty-first century skills required in the contemporary workplaces. The paper then outlined the urge need of interdisciplinary curricula and the new norm of learning and addressed how students integrate online information and resources to generate new knowledge and skills to cope with the ever-increasing complexity competencies at work. Through comparison and analysis of curricular, and sharing of online learning and teaching practices, the paper offered insights into the design of cross-institutionally interdisciplinary curricular as well as using flexible online learning with self-selected courses to suit individual student's specific needs. The concepts of 'connectivism', 'bringing in' and 'reaching out' were also highlighted to shed lights on cross-institutional curricular. The three stages pedagogical approach to convert face-to-face course to a full online course were also introduced. Implications from this study are (1) a thorough comparison and analysis of the interdisciplinary curricula in terms of programmes structure and delivery methods between the higher education institutions in Hong Kong and those offered by overseas institutions for possible cross-institutional curricula; (2) action research from practitioners to share good practices on the delivery of interdisciplinary curricula; and last but not least, (3) the possibility to utilise online learning resources to complement and supplement interdisciplinary curricula in order to advance the new norm of learning and teaching.

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Chapter 4
The Structure of Domain-Specific Competence in the Occupation of Technicians at Vocational Schools in Germany

Felix Walker and Eberhard Huester

Abstract The present study focusses on the structure of domain-specific competence in the occupation of technicians at vocational schools in Germany. Up to now, in this occupation no such study has been available. Hypotheses: Is the domain-specific competence in the occupation of technicians at vocational schools a multidimensional construct? Sample: According to studies from other occupations we have developed instruments for two dimensions (content-knowledge and problem-solving) of domain-specific competence. The study was conducted by six colleges of the European qualification framework 6 both in a longitudinal control-experimental-group-design (n = 243) and as regular lessons via the digital learning platform Moodle. The data analysis will be made by structural-equation-modeling with the Mplus software. Results: Content knowledge and problem-solving competence are multidimensional. The highest loads related to problem-solving competence are obtained in the multidimensional content knowledge as outlined in the PPIK theory.

Keywords Vocational schools in Germany · Domain-specific competence · Content-knowledge · Problem-solving · Structural-equation-modeling · PPIK-theory

4.1 Introduction and Presentation of the Research Issues

The technical drawing is the central means of communication in conventional order processing. Technical drawings show the spatial component in the necessary views through parallel projection in two dimensions and provide additional manufacturing

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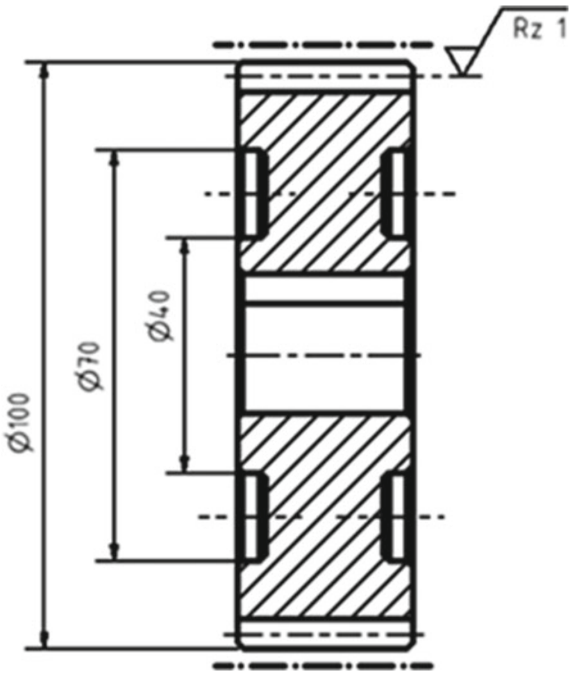

Fig. 4.1 Technical drawing (cf. Labisch & Weber, 2005, p. 156)

information with regard to dimensions, dimensional tolerances, surface information and other additional information relevant to manufacturing (Fritz, 2016, p. 9).

The "staatlich geprüfte Techniker Fachrichtung Maschinenbau " (European qualifications framework 6) is a middle manager who ensures that the technical drawing is complete as well as clearly legible by signing it.

For this reason, the students of the mechanical engineering college have to acquire these competences during their advanced vocational training (Fig. 4.1).

The corresponding framework is realized by module 06 "analyzing and documenting assemblies" in the curriculum of the „Ministerium Rheinland-Pfalz der Fachschule für den staatlich geprüften Techniker Fachrichtung Maschinentechnik "(Ministerium für Bildung, Frauen und Jugend [Hrsg.], 2003, p. 22).

At this point, the importance of an adequate interpretation of technical drawings by future engineers in mechanical engineering appears obvious.

To guarantee this, the technical college has to provide suitable learning arrangements. In order to implement suitable learning arrangements, the teachers in question are asked about the influence of cognitive skills and competencies on the learning process. To avoid arbitrary answers to these questions, it is important to systematically examine them from a scientific perspective, so that learning arrangements can be realized with the help of adequate, scientifically verified models (Abele, 2014, p. 18).

The following issues arise from this study:

- Can the model of vocational competence be represented in a multi-dimensional, reliable and valid way?
- What does a correspondingly valid and reliable measuring instrument for uncovering connections between these constructs look like?
- Does an individual's prior knowledge actually turn out to be a decisive influencing factor on the dimensions of analytical problem-solving competence according to the model of the PPIK-theory?

Despite intensive research of the Eric, FIS, OLC and Google Scholar databases, there is no adequate study to answer these questions, which reveals a research gap in this field.

Accordingly, the following chapter deals with the operationalization of a model with the help of appropriate constructs, which is estimated in the further course through structural equation modeling in Mplus.

4.2 Theoretical Framework, Research Situation and Development of the Questions or Hypotheses

4.2.1 Latest State of Research in the Field of Further Training as a "Staatl. Gepr. T*echniker" (Europe-Qualifications Framework 6)*

Currently, with regard to the domain-specific competence structure concerning the "Staatl. gepr. Techniker", there is one study available in the field of electrical engineering and one in the field of construction technology.

The examination in the field of electrical engineering, conducted in a longitudinal design, is based on the test results of 278 students. In the initial sample, which was carried out longitudinally over three measurement times, a three-dimensional structure of content-knowledge was shown at the beginning and at the end of the study.

The three dimensions of content-knowledge consisted of the fundamentals of electrical engineering, electrical systems as well as systems and control technology, which presumably showed increased integrative processing processes at the end of the advanced training course (Velten et al., 2018, pp. 201–220).

In the cross-sectional examination of students of construction technology, Wyrwal and Zinn report on a three-dimensional structural model for competence measurement, which is spanned by the dimensions of structural engineering/structural theory, building construction/building physics and domain-specific problem-solving competence (Zinn & Wyrwal, 2017, p. 245).

To record the content-knowledge, the outlined study of the electrical engineering college contains, among other things, items which aim at small calculations of, for example, electrical resistance (Velten et al., 2018, pp. 209–220).

In the study of the "Fachschule Bautechnik" (European qualifications framework 6) such tasks, which combine knowledge-based elements with mathematical skills, are used to measure domain-specific competence (Zinn & Wyrwal, 2017, p. 237).

4.2.2 *The Structure of Vocational Competence and PPIK Theory*

Ackerman's theory of intelligence-as-process, personality, interests, and intelligence-as-knowledge (PPIK) aims at intellectual intelligence development in adulthood. In this context, intelligence as knowledge plays an increasingly important role in young adults, while fluid intelligence slowly seems to fade into the background. As a result, the previously acquired knowledge serves as a crucial starting point for any future knowledge acquisition or competency development (Ackerman, 1996, pp. 273–243).

In the context of learning processes related to reading technical drawings and identifying incorrect representations as a real vocational situation of a "staatl. gepr. Techniker" (European qualifications framework 6), the following model, spanned by a two-dimensional basic structure of domain-specific competence, which is realized through content-knowledge and analytical problem-solving competence, appears to be adequate (Nickolaus, 2011, p. 333; Nickolaus & Seeber, 2013, pp. 177–182).

This basic structure of domain-specific competence aims at realizing reliable and valid competence measurements with the help of corresponding sub-dimensions, in contrast to holistically-oriented approaches (Nickolaus, 2011, p. 333; Nickolaus & Seeber, 2013, p. 170) (Fig. 4.2).

Furthermore, this structure is confirmed by empirical findings.

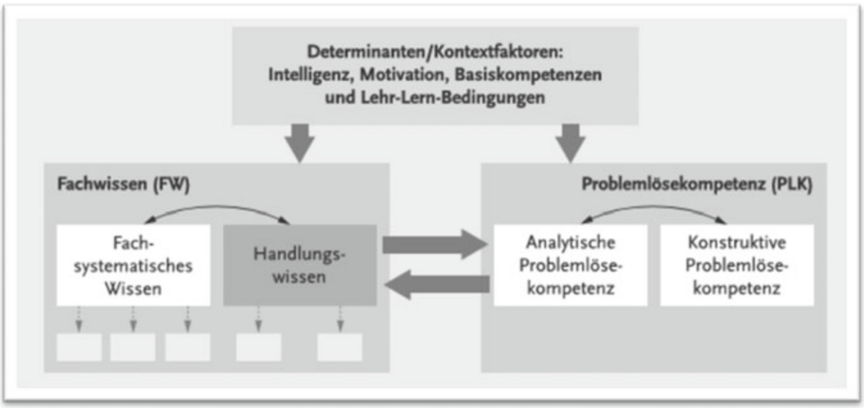

Fig. 4.2 Framework "berufsfachlicher Kompetenz" (Walker et al., 2016, p. 142; Abele et al., 2016, p. 175)

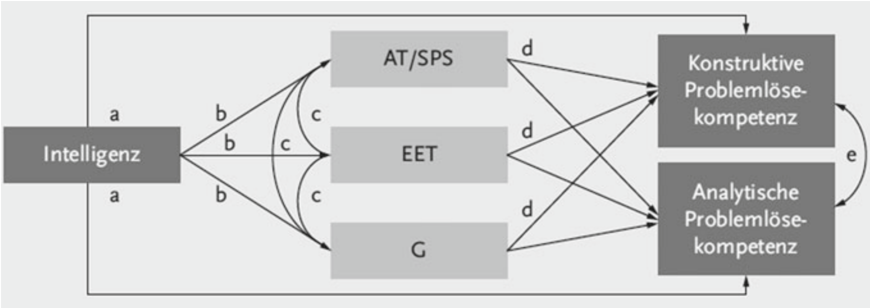

Fig. 4.3 Structural model Electrical engineering (Walker et al., 2016, p. 161)

With this in mind, a multi-dimensional content-knowledge structure has been found in almost all of the apprenticeships examined towards the end of the vocational training (Walker et al., 2016, p. 162; Abele et al., 2016, pp. 177–203; Behrendt et al., 2017, pp. 58–60; Waveren & Nickolaus, 2015, pp. 73–79; Seeber, 2014, pp. 61–64).

Walker et al. (2016) were able to determine the structural equation model in Fig. 4.3. Intelligence had a significant influence on content-knowledge.

In addition, the influence of intelligence, tested via CFT20-R (Weiß & Weiß, 2006), on analytical and constructive problem-solving competences could be demonstrated. However, the greatest overall influence on analytical and constructive problem-solving competences was provided by content-knowledge (Walker et al., 2016, p. 162).

In this context, the importance of prior knowledge regarding the adequate acquisition of competences in adulthood is becoming increasingly apparent. This finding is in line with Ackerman's PPIK theory.

All in all, content-knowledge with three-dimensional sub-dimensions and analytical as well as constructive problem-solving competences were shown as separate dimensions, all of which are embedded in the model of domain-specific competence.

Accordingly, based on this dualistic model of domain-specific competence, an appropriate structure for this study is developed, closely following the structure previously elaborated by Walker et al.

At this point, however, the question arises as to how many dimensions can be shown for content-knowledge or for analytical problem-solving competence so that a valid and reliable measuring instrument can be developed for the appropriate assessment of competence.

Theoretically, for the area specifically tested here—i. e. cross-sectional views in technical drawings—the following six subject areas can be established: cutting sequences, hatching of cut surfaces, lines in sections, sectional designations, sectional types and spatial imagination, each being theory-based with regard to content-knowledge and analytical problem-solving competences.

In the present study, with the help of suitable structural equation models, these six established subject areas are to be estimated regarding the respective sub-dimensions.

In addition, another aim is to determine the influence of fluid intelligence on content-knowledge and on analytical problem-solving competence, as well as the influence of content-knowledge on analytical problem-solving competence. The terms used in this model of domain-specific competence are operationalized below.

4.2.2.1 Berufsfachliche Kompetenz (Domain-Specific Competence)

In general, the concept of competence depends on the respective scientific discipline (Stemmann, 2016, p. 49; Nickolaus, 2011, pp. 332–335; Nickolaus & Seeber, 2013, pp. 167–169).

If the concept of competence is used with reference to a vocational domain, in contrast to classical scientific disciplines such as mathematics, no clear boundaries can be drawn. Ultimately, on the one hand, very specific skills, such as reading a production drawing, and on the other hand, cross-domain skills, such as dealing with legal regulations, are required in a vocational domain (Nickolaus & Seeber, 2013, p. 169).

In addition, throughout the entire training period, merging processes on the one hand and, differentiations of the sub-dimensions on the other hand, can be recorded (Gschwendtner et al., 2010, pp. 264–269; Geißel, 2008, pp. 130–133; Nickolaus, 2011, p. 333; Nickolaus & Seeber, 2013, p. 177; Seeber, 2014, p. 61).

A valid competency diagnosis therefore only appears to be possible if tests for central sub-aspects of competency are developed first. For this reason, in this context, a comprehensive and valid assessment of domain-specific competence has to be dispensed with for the time being. In the field of vocational training, it seems profitable to implement this in the area of domain-specific competence first (Nickolaus et al., 2011, p. 57; Nitzschke et al., 2011, p. 111).

The term “berufsfachliche Kompetenz” (domain-specific competence) is both viewed from and used based on this empirical perspective. In this regard, two basic sub-dimensions of “berufsfachliche Kompetenz” (domain-specific competence) have emerged in numerous cross-domain studies: first, content-knowledge and second, the ability to apply this content-knowledge in problematic situations (Nickolaus & Seeber, 2013, p. 177).

Other non-cross-domain sub-dimensions need to be identified through further empirical research with regard to the respective occupation (Nickolaus & Seeber, 2013, pp. 177–179).

With regards to the present study, on the one hand, a dualistic basic structure of “berufsfachliche Kompetenz” (domain-specific competence) can be assumed. According to Süß, this structure consists of “deklaratives Sachwissen” (content-knowledge/declarative knowledge about facts) as specifically operationalized expertise (see Sect. 4.2.2.3) and of analytical problem-solving competences (see Sect. 4.2.2.2).

On the other hand, another aim is to identify the yet unknown sub-dimensions of this “berufsfachliche Kompetenz” (domain-specific competence).

4.2.2.2 The Term "Analytical Problem-Solving Competence"

Generally speaking, problems arise because organisms do not achieve their set goals directly. The situation itself, however, is not the problem. Instead, the interaction between a given situation, the organism and the goal of the organism can be viewed as a problem (Funke, 2003, p. 18).

The decisive factor here is a barrier that prevents the disruptive initial state from being transformed into the desired final state (Dörner, 1976, pp. 10–12).

With regards to problem-solving, one has to distinguish between simple and complex problem-solving. These terms are misleading since simple problems can also have a high degree of complexity. The differentiation becomes more efficient through the use of the terms "static" and "dynamic" problem-solving (Funke, 2003, p. 107).

While a sliding puzzle can be solved without further prior knowledge, diagnosing a technical drawing after deviations from the DIN EN ISO requires corresponding prior technical content-knowledge, thus making this problem domain-specific.

Contrary to novices who lack the corresponding content-knowledge, the content knowledge acquired in a specific domain enables an expert to develop profitable problem-solving strategies as a result of pattern recognition (chunks) (Chi et al., 1982, p. 17).

Specifically with domain-specific problems, which occur relatively often in a vocational context, domain-specific knowledge (content-knowledge) thus plays a decisive role (Walker et al., 2016, p. 163; Rausch, 2017, p. 178).

The term "analytical problem-solving competence" used here refers to the cognitive resources required for error identification in technical drawings and the according necessary ability to overcome barriers (Walker et al., 2016, pp. 153–154).

4.2.2.3 The Term "deklaratives Sachwissen" (Content Knowledge/Declarative Knowledge About Facts)

According to Süß, merely declarative and merely procedural knowledge represent two extreme poles. Both forms of knowledge, declarative and procedural knowledge, can be converted into one another. Thus, it is conceivable that an action carried out requiring procedural knowledge can nevertheless be expressed verbally with the help of the knowledge component that is also present in the declarative form. Implicit knowledge is to be considered as the part of procedural knowledge that could be unconscious and cannot therefore be verbalized (Süß, 1996, pp. 63–64).

In this context, Süß differentiates between "Sach- und Handlungswissen" (factual and practical knowledge), both of which can exist in the declarative and the procedural form (Table 4.1).

Table 4.1 The term “deklaratives Sachwissen” (content-knowledge/declarative knowledge about facts) (cf. Süß, 1996, p.66)

	Deklaratives Wissen (Verbalizable knowledge)	Prozedurales Wissen (Non-verbalizable knowledge)
Sachwissen (Knowledge about facts)	Deklaratives Sachwissen (for example multiple-choice test on the subject of sectional views or communication between workers)	Prozedurales Sachwissen (for example identification of a half section in a technical drawing)
Handlungswissen (knowledge about strategies)	Deklaratives Handlungswissen (for example description of the procedure for entering a cutting line)	Prozedurales Handlungswissen (for example outlining a cutting line in a technical drawing)

4.2.2.4 The Term “Fluid Intelligence”

In his hierarchical intelligence model of the investment theory, Cattell differentiates between innate fluid intelligence (Gf) and crystalline intelligence acquired from the environment (Gc). Fluid intelligence increasingly includes the areas of inductive reasoning, topologies and matrices, linguistic analogies and numerical tasks (Horn & Cattell, 1967, pp. 108–129).

Horn and Cattell’s theory was confirmed, among other things, by a study on age differences with regard to fluid and crystalline intelligence, according to which fluid intelligence is represented to an increased extent in younger adults, whereas crystalline intelligence is represented to an increased extent in people in subsequent adulthood (Horn & Cattell, 1967, pp. 107–129).

The basic intelligence test CFT is used particularly in the context of school-related issues. The CFT follows this hierarchical intelligence model from Cattell (Funke & Vaterrodt, 2004, p. 47).

4.3 Hypotheses

H1: Using the structural equation models, a confirmatory factor analysis (CFA) can be used to design a suitable instrument for measuring the “berufsfachliche Kompetenz” (domain-specific competence) of technicians on the subject of sectional representations in technical drawings.

(a) There is a multi-dimensional structure for the “deklaratives Sachwissen” (verbalizable knowledge about facts). This basic assumption is established in the study by Walker et al (2016).
(b) A multidimensional model can also be determined for analytical problem-solving competence. This assumption also relates to the previously carried out study from Walker et al (2016).

H2: Similar results can be observed between the sub-dimensions of "berufsfachliche Kompetenz" (domain-specific competence) and fluid intelligence, as shown in the study by Walker et al. in 2016. Here as well, content-knowledge in the form of "deklaratives Sachwissen" (verbalizable knowledge about facts) is expected to show the strongest influence on analytical problem-solving competence.

(a) Fluid intelligence affects the multi-dimensional structure of content-knowledge (deklaratives Sachwissen) with a directed load.
(b) Fluid intelligence affects the multi-dimensional structure of analytical problem-solving competence with a directed load.
(c) The dimensions of content-knowledge have the greatest effect with a directed load on the corresponding dimensions of analytical problem-solving competence.

4.4 Method

4.4.1 Sample

The test subjects are 243 students (9 female and 234 male) from the technical college (Fachschule Technik), specializing in mechanical engineering (with a focus on mechanical engineering in Rhineland-Palatinate) and have an average age of 26.3 years.

The data set is largely collected via the digital learning platform Moodle with the previously designed tests for content-knowledge and analytical problem-solving competence at six vocational schools in Rhineland-Palatinate (Germany).

A so-called "cluster sample" (Klumpenstichprobe) is used for random sampling. In this process, individual groups of a population are completely measured as samples, without the sample resulting from a mixture of the population. This can be done if the so-called clumps as the random sample used largely correspond to the population (Fahrmeir et al., 2007, p. 26).

This study exclusively focusses on classes from the technical college in mechanical engineering (Fachschule Technik). With regard to vocational schools, a specific job-related homogeneity can be assumed for these classes. After all, all of these students have a previously completed vocational training in the metal sector. In addition to this, a respective, at least one-year vocational training is a prerequisite for being admitted to the Fachschule Technik. Moreover, module 06—analyzing and documenting assemblies—is exclusively taught in this form at the technical college (Fachschule Technik), which means that other school types are not considered for this study.

The survey takes place during the regular lessons of module 06—analyzing and documenting assemblies—and is carried out experimentally as conventional lessons.

4.4.2 Developed and Used Instruments

The design and implementation of the study are aimed at a structural equation model of multivariate statistics (SEM) in the subsequent evaluation phase.

Structural equation models of multivariate statistics (SEM) allow for a differentiation between measured (manifest) and non-measured (latent) variables. This results in a so-called measurement (manifest variables) and a structural model (latent variables) in structural equation models. The attenuation-corrected estimation of the measurement model also leads to the evidence of construct validity on the coefficients of the structural model (Brown, 2006, pp. 1–10; Byrne, 2012, pp. 4–5; Reinecke, 2014, pp. 1–2).

Path analyzes in structural equation models are not only limited to direct effects between the variables. Structural equation models also depict indirect effects through so-called mediating variables (Kaplan, 2009, pp. 33–36; Reinecke, 2014, p. 6).

It should be emphasized here that the structural equation model has to be justified in theory. After all, the size of a parameter in a structural equation model is only an indication of causality (Arzheimer, 2016, pp. 41–45; Little, 2013, p. 154; Reinecke, 2014, pp. 11–12).

Both content-knowledge and analytical problem-solving competence are recorded by means of a power test with dichotomous data, for which the students have sufficient processing time (here 40 min) (Bühner, 2011, p. 21).

The test subjects all passed the test for content-knowledge and for analytical problem-solving competence mostly well before the end. This can be seen as a confirmation of the sufficient test time.

Since the result of the CFT20-R is relatively dependent on the test time in terms of fluid intelligence, it is referred to as a “speed test” (Bühner, 2011, p. 21).

4.4.2.1 Development of the Content-Knowledge Test (Deklaratives Sachwissen)

The content-knowledge test is designed to be content-specific on the subject of sectional representations in technical drawings based on DIN EN ISO. A small example is illustrated below for each of the six content areas for a better understanding:

- Cutting sequences: These include, for example, the correct entry of the section of a complex sectional representation according to DIN ISO 128-44 (Fritz, 2016, p. 66).
- Hatching of cut surfaces: The two hatching angles of 45° and 135°, which are used exclusively in general hatchings according to DIN ISO 128-40 and DIN ISO-50, can be listed here as an example (Fritz, 2016, p. 64).
- Lines in sections: These can include hatching lines, for example, which are drawn as narrow continuous lines in accordance with DIN EN ISO 128-20 and which

have a line width of 0.25 mm in the preferred line group 0.5 mm (Fritz, 2016, pp. 23–25).
- Section designations: For example, according to DIN ISO 128-44, half and full sections are not designated in contrast to complex sections (Fritz, 2016, p. 66).
- Types of cuts: The content-knowledge of types of cuts would include, among other things, knowledge of what a half cut is according to DIN ISO 128-40 and DIN ISO-50 (Fritz, 2016, p. 65).
- Spatial imagination: This includes, for example, the knowledge that according to DIN-ISO 128-30 as few views as possible should be implemented (Fritz, 2016, p. 61).

The content-knowledge items are designed as multiple choice tasks on the digital learning platform Moodle. There are five predefined possible answers, only one of which is correct. In addition, the students are asked to refrain from guessing the correct answer using the "don't know" answer option. Thus, the amount of guessed answers is minimized. This way, the 30 items are structured uniformly. Moreover, care is taken to ensure that the available answers appear as plausible as possible for the novice. However, a lack of content-knowledge cannot be compensated for by asking the relevant issues. For the question: "Are parallel cutting planes displayed in the sectional view as if they were in one plane in the case of a complex cutting course?" content-knowledge of complex cuts is inevitable. If the content-knowledge of complex cuts is lacking, a judgement on a correct answer cannot be made.

4.4.2.2 Developing the Test to Measure Analytical Problem-Solving Competence

The test for measuring analytical problem-solving competence is also designed on the basis of DIN EN ISO for specific content on the subject of sectional representations in technical drawings. As with the test for declarative knowledge (see Sect. 4.2.1), a small example is illustrated for each of the six content areas for better understanding.

- Cutting sequences: These include, for example, the incorrect cutting line of the front view according to DIN ISO 128-44 (Fritz, 2016, p. 66).
- Hatching of cut surfaces: The wrong hatching angles of the front view can be cited as an example according to DIN ISO 128-40 and DIN ISO-50 (Fritz, 2016, p. 64).
- Lines in sections: These include, for example, the three boundary lines used for the partial cuts DIN EN ISO 128 (Fritz, 2016, pp. 23–25).
- Section designations: For example, according to DIN ISO 128-44, half and full cuts are not given a designation in contrast to the implementation in the test drawing (Fritz, 2016, p. 66).
- Types of cuts: For example, the error that full components are shown cut in three views (Fritz, 2016, p. 65).

- Spatial imagination: This includes, for instance, the knowledge that according to DIN-ISO 128-30 as few views as possible should be implemented (Fritz, 2016, p. 61).

The analytical problem-solving competence is measured through a digital assignment test via the digital learning platform Moodle. Correspondingly, 36 error terms are assigned to the digital technical drawing view. In addition, the students are provided with a real technical drawing so that the errors can be diagnosed more quickly due to the better clarity. After all, in their later career, the students will also read real technical drawings. Moreover, numerous errors can only be identified with the help of several different views. Thus, the student has to diagnose the error as well as the error location in the technical drawing and assign the corresponding numbers of the error terms digitally with the crosshairs of the drawing view to the exact error location.

4.4.2.3 Intelligence Test CFT 20-R (Part-1)

For the basic intelligence test CFT 20-R, which consists of two parts, only part 1 is chosen. This can be justified with the adult age of the students. In this respect, difficulties in understanding instructions, as would be expected, for example, with other classes in the vocational school system, can be ruled out. In addition, the technician classes exclusively consist of adult students, as the technician training requires a corresponding initial vocational education including an additional one-year as well as relevant vocational experience (Weiß & Weiß, 2006, pp. 14–15).

This first part of the CFT 20-R consists of 56 items which are divided into four subtests.

4.4.3 Analysis and Evaluation

Most of the data obtained via the Moodle digital learning platform is first saved using Excel tables and then transferred to a shared Excel table. This Excel table is transformed into the statistics program SPSS. A KFT-Dat file is then generated from SPSS, which is subsequently imported into the syntax-based statistics program Mplus. The structural equation model can be generated in Mplus as shown in Fig. 4.4 for example.

The variances of the latent variables fluid intelligence, content-knowledge and analytical problem-solving competence are fixed at 1 and the average values at 0. The appropriate model is freely estimated with the statistical software Mplus. To assess the model estimation or model fit, so-called indices are considered with regard to structural equation models. The empirically observed data is compared with the hypothetical model. In this context, absolute fit indices (e.g. the root mean square error of approximation (RMSEA)) can be differentiated from incremental fit indices

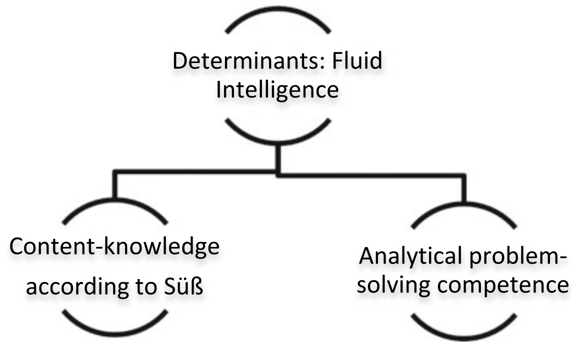

Fig. 4.4 Structure of this investigation

(e.g. the comparative fit index (CFI)) (Brown, 2006, pp. 82–86; Byrne, 2012, pp. 72–73).

In order to determine whether content-knowledge or analytical problem-solving competences are one- or multi-dimensional structural models, the same procedure is used in both cases. This procedure is explained below as an example of content-knowledge.

To analyze the multidimensionality of content-knowledge, the six subject areas are designed as latent variables (VSW1-VSW6) in the SEM (see Fig. 4.5). Moreover, all latent variables are correlated with one another. In other words, a six-dimensional structural model for measuring content-knowledge is hypothetically designed in this way.

The structural model is estimated with the WLSMV estimator, which can be regarded as suitable for categorical (dichotomous) data (Brown, 2006, p. 388; Urban & Mayerl, 2014, pp. 70–71).

Despite the fact that the estimation is obviously normal, Mplus reports a negatively defined covariance matrix (PSI), which may be, among other things, due to a correlation greater than one between the latent variables.

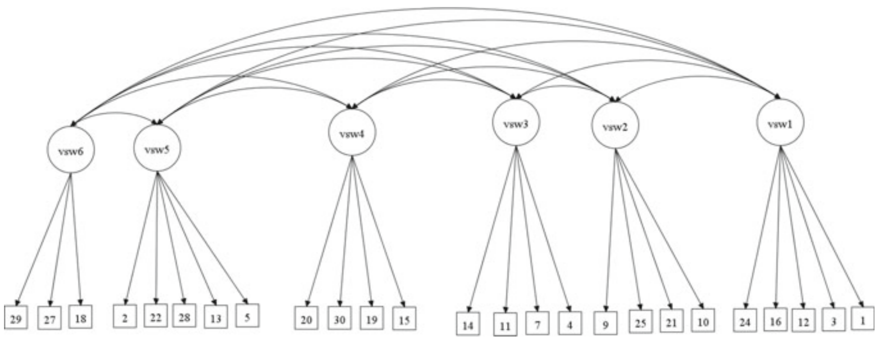

Fig. 4.5 Six dimensions of declarative knowledge (deklaratives Sachwissen)

Taking a closer look at the related correlations between the latent variables in the corresponding output of Mplus, correlations greater than one can actually be determined. At 1.273 the highest correlation is between VSW1 (cutting sequences) and VSW6 (spatial imagination).

The value range of a correlation coefficient is between –1 and +1 (Fahrmeir et al., 2007, p. 352).

For this reason, a correlation cannot take values—($r > 1$). However, since the co-variances and correlations are merely estimated in the present calculations, such results are actually possible (Byrne, 2012, pp. 77–78).

In this case, there are overlapping variances between the latent variables VSW1 (sectional progression) and VSW6 (spatial imagination), which is why they can no longer be reliably distinguished from one another. Both represent the same construct and therefore have to be combined (Byrne, 2012, pp. 265–270).

- Cutting sequences = VSW1
- Hatching of cut surfaces = VSW2
- Lines in sections = VSW3
- Section designations = VSW4
- Types of cuts = VSW5
- Spatial imagination = VSW6

In this case, there are overlapping variances between the latent variables VSW1 (sectional progression) and VSW6 (spatial imagination), which is why they can no longer be reliably distinguished from one another. Both represent the same construct and must therefore be combined (Byrne, 2012, pp. 265–270).

In this way, a model with five dimensions is created from the six-dimensional structural model for measuring declarative knowledge. This includes VSW1 (cutting sequences) and VSW6 (spatial imagination) as one dimension.

In order to compare the six-dimensional model with the five-dimensional one, a chi-square difference test is used (Byrne, 2012, p. 269; Urban & Mayerl, 2014, pp. 217–221; Reinecke, 2014, p. 62; Brown & Moore, 2012, p. 375) (Tables 4.2 and 4.3).

However, when comparing the six- and five-dimensional models using the chi-square difference test, the warning that correlations ($r > 1$) are being estimated reappears. Accordingly, the latent variables with the highest correlations are combined

Table 4.2 Estimated covariance matrix for the latent variables

	VSW1	VSW2	VSW3	VSW4	VSW5	VSW6
VSW1	1.000					
VSW2	0.805	1.000				
VSW3	0.937	1.096	1.000			
VSW4	1.056	0.901	0.953	1.000		
VSW5	0.882	0.769	1.081	0.983	1.000	
VSW6	1.273	0.992	0.981	1.079	1.152	1.000

Table 4.3 Estimated correlation matrix for the latent variables

	VSW1	VSW2	VSW3	VSW4	VSW5	VSW6
VSW1	1.000					
VSW2	0.805	1.000				
VSW3	0.937	1.096	1.000			
VSW4	1.056	0.901	0.953	1.000		
VSW5	0.882	0.769	1.081	0.983	1.000	
VSW6	1.273	0.992	0.981	1.079	1.152	1.000

again. This results in a four-dimensional model which, according to the known scheme, is compared with the previously established five-dimensional model via a chi-square difference test. This procedure is repeated until, first, there are no high correlations, for example ($r < 0.9$) between two latent variables, and, second, the chi-square-rate difference test becomes significant (Byrne, 2012, pp. 265–272; Brown & Moore, 2012, p. 375).

However, through this procedure, a one-dimensional model emerges for content-knowledge. To be sure that content-knowledge is not a multi-dimensional model, not only the latent variables with the highest correlations are combined in an additional test. Instead, the latent variables that show the highest correlation and that can be theoretically grounded are combined.

Using this approach, the latent variables are combined. The chi-square difference test becomes significant during the comparison between the one-dimensional and the two-dimensional model of content-knowledge. This means that content-knowledge is a two-dimensional construct (see Sect. 5.1.1).

The test for the multidimensionality of analytical problem-solving competence is carried out in the same way as for content-knowledge described above. The latent variables with the highest correlation are combined. Applying the chi-square difference test, the resulting model with a smaller number of dimensions is compared with the previous model, which consists of one dimension more.

For the analytical problem-solving competence, in contrast to content-knowledge, a five-dimensional structural model already results during the comparison between the five- and four-dimensional models.

These two multi-dimensional models for measuring content-knowledge and analytical problem-solving skills are then coherently modeled in the structural model including the exogenous variable fluid intelligence.

For an overview, the structural model with the corresponding loads and correlations between the latent variables is illustrated below. The measurement models can be seen in the illustrations shown above.

Thus, the two dimensions of content-knowledge in a directed form influence the analytical problem-solving competence.

Fluid intelligence also has a directed influence on analytical problem-solving competence. In addition, the intelligence affects the declarative knowledge directly, whereby part of the influence of the declarative knowledge on the analytical problem-solving competence can be explained via intelligence.

4.5 Results

H1: Using the structural equation models, a confirmatory factor analysis (CFA) can be used to design a suitable instrument for measuring "berufsfachliche Kompetenz" (domain-specific-competence) of technicians on the subject of sectional representations in technical drawings.

(a) *There is a multi-dimensional structure for "deklaratives Sachwissen" (verbalizable knowledge about facts). This basic assumption is justified in the study by* Walker et al. (2016)

For the empirical verification of H1a, two approaches are carried out so that the assumption of a multi-dimensional structure of content-knowledge can be maintained.

The first procedure always combines the latent variables with the highest correlation, e.g. (r > 0.9).

The resulting model, which is reduced by one dimension, is then compared with the previous model using a chi-square difference test.

This procedure is continued until the chi-square difference test becomes significant and a higher correlation, for instance 0.9, between two latent variables no longer exists (Byrne, 2012, pp. 265–272; see Sect. 4.3).

The chi-square difference test only becomes significant as a result of the comparison between the two-dimensional and the one-dimensional model.

The correlation between the two remaining variables is basically acceptable at 0.756. Eventually, however, one dimension contains five previously combined latent variables, while the other latent variable merely represents -Hatching of cut surfaces-.

Due to this imbalance, no multi-dimensional model can be maintained from a theoretical and empirical perspective.

The situation is different with the second approach. Here, the latent variables with the highest correlations are combined, which can also be theoretically justified (see Sect. 4.3).

In the six-dimensional model, a total of five correlations are above the value 1. A summary that only takes into account the level of correlation can therefore not necessarily be regarded as expedient.

Thus, in the second approach, the latent variables (VSW1) and (VSW4), which, despite not having the absolute highest correlation, still show a value above 1 and can also be theoretically represented, are combined. A two-dimensional structure emerges for content-knowledge.

The correlation at 0.756 between the two latent variables is acceptable and the chi-squared difference test becomes significant.

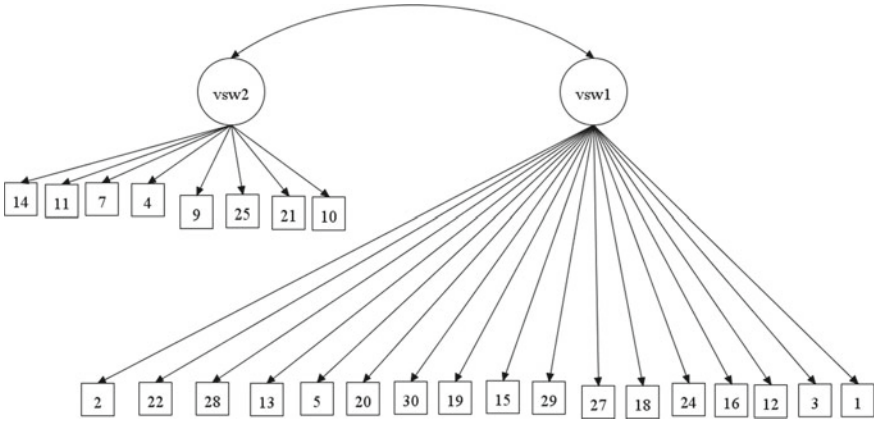

Fig. 4.6 Two-dimensional structure of content-knowledge

The two-dimensional structure is illustrated in Fig. 4.6. The latent variable VSW1 contains the four content areas of cutting sequences, section designations, section types and spatial imagination. The latent variable VSW2 contains the two content areas of hatching of sections and lines in sections. Overall, the first approach does not provide any indications of a multi-dimensional structure of content-knowledge. This approach seems unsuitable for this purpose because of the relatively large imbalance between the latent variables.

If, however, in the second approach, the latent variables—which show the highest correlation and can also be justified theoretically—are combined, the result is a significant two-dimensional structure with regard to content-knowledge.

This confirms the hypothesis H1a: Content-knowledge has a multidimensional structure.

(b) *A multidimensional model can also be determined for analytical-problem solving competence. This assumption as well relates to the previously carried out investigation from* Walker et al. (2016).

Based on the preliminary theoretical considerations outlined in Sect. 4.2.2, the model for analytical problem-solving competence is assumed to have a multi-dimensional structure.

For the empirical verification of H1b, the latent variables with the highest correlation (e.g. $r > 0.9$) are always combined.

The resulting model is then reduced by one dimension and compared with the previous model using a chi-square difference test (see Sect. 4.3).

The highest correlation in the six-dimensional model between the dimensions VPL2 and VPL6 is 1.211.

This is why these two latent variables are merged into one (see Table 4.4). Then, the six-dimensional model is compared with the five-dimensional one using a chi-square difference test.

Table 4.4 Summary of five dimensions

6 dimensions (hypothetical)	5 dimensions (empirical result)
Cutting sequences (VLP1)	Cutting sequences (VLP1)
Hatching of cut surfaces (VLP2)	Hatching of cut surfaces (VLP2) & Spatial imagination (VLP6)
Lines in sections (VLP3)	Lines in sections (VLP3)
Section designations (VLP4)	Section designations (VLP4)
Types of cuts (VLP5)	Types of cuts (VLP5)
Spatial imagination (VLP6)	

> If the chi-square difference test yields significant results, the model with the greater number of parameters to be estimated is retained. If the chi-square difference test appears to be insignificant, the opposite is the case (Urban & Mayerl, 2014, pp. 218–219).

Since the chi-square difference test does not become significant, a test of the five-dimensional with a four-dimensional model appears to be necessary. For the four-dimensional model, the dimensions that result in the highest correlation in the five-dimensional model are combined following the known pattern.

Subsequently, while the testing of the five-dimensional with the four-dimensional model does not result in any comparably high correlations (compare Figs. 4.7 and 4.8), it results in a significant chi-square difference test.

In this model comparison with a significant chi-square difference test, the five-dimensional model contains more parameters to be estimated than the four-dimensional one. So the five-dimensional structure is retained.

The model shows acceptable fit values. Thus, a five-dimensional structure of analytical problem-solving competence emerges, thereby confirming H1b.

Fig. 4.7 Five dimensions of analytical problem-solving competence (n = 243/RMSEA = 0.038/CFI = 0.951/TLI = 0.945/WRMR = 0.989)

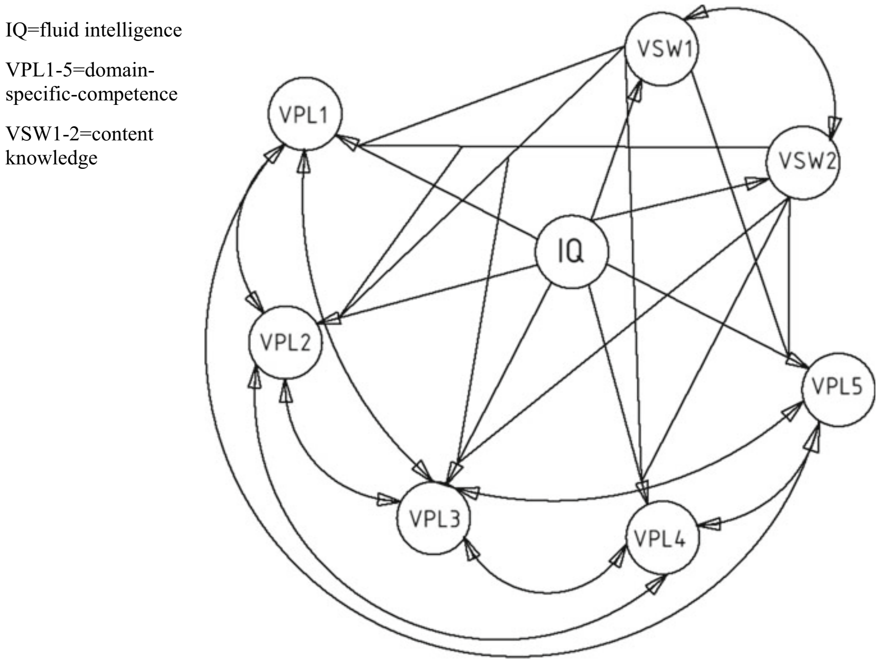

Fig. 4.8 Structure model of this investigation (n = 243/RMSEA = 0.022/WRMR = 0.999/CFI = 0.925/TLI = 0.921)

H2: Similar results can be observed between the sub-dimensions of "berufsfachliche Kompetenz" (domain-specific competence) and fluid intelligence, as shown in the study by Walker* et al. *in 2016. Here as well, the domain-specific knowledge in the form of "deklaratives Sachwissen" (verbalizable knowledge about facts) should show the strongest influence on analytical problem-solving competence. Fluid intelligence affects the multi-dimensional structure of content-knowledge (deklaratives Sachwissen) and analytical problem-solving competence with a directed load.

For an overview, see the structural model below. Some of the loads in the corresponding table become insignificant. The reason for this may be the relatively small sample (n = 243). In a larger sample, these are likely to become significant (Table 4.5).

(a) *Fluid intelligence affects the multi-dimensional structure of analytical problem-solving competence with a directed regression.*

There is a directed influence of fluid intelligence on the two dimensions of declarative knowledge. The standardized regression ($\beta = 0.273$) on the dimension VSW2 becomes statistically significant. Unfortunately, the regression of fluid intelligence affects the dimension VSW1 with ($\beta = 0.132$), but does, however, not become significant ($p = 0.108$).

Table 4.5 Standardized Regression (β) and Correlations (r) Structural Model (n = 243/RMSEA = 0.022/WRMR = 0.999/CFI = 0.925/TLI = 0.921)

Dimension	VPL1	VPL2	VPL3	VPL4	VPL5	IQ	VSW1	VSW2
VPL1								
VPL2	0.108							
VPL3	0.495**	0.753**						
VPL4	0.672**	0.238	0.438**					
VPL5	0.361**	0.312**	0.599**	0.616**				
IQ	0.348**	0.336**	0.244**	0.224**	0.114			
VSW1	0.398	0.326	0.584**	0.686**	−0.007	0.132		
VSW2	−0.005	0.260	0.168	−0.073	0.609**	0.273**	0.794**	

**significance (p = 0.01)

These inferential statistical results provide evidence that can be used to confirm the H2a hypothesis. Thus, fluid intelligence affects declarative knowledge with a directed load.

(b) *Fluid intelligence affects the multi-dimensional structure of analytical problem-solving competence with a directed regression.*

Four out of five standardized regressions of fluid intelligence on analytical problem-solving competence provide significant results (VPL1-VPL4/β = 0.224-0.348).

Only the regression on the dimension VPL5 (β = 0.114) turns out to be insignificant ($p = 0.302$). All in all, the loads of fluid intelligence on the five dimensions of analytical problem-solving competence can be confirmed. H2b can thus be considered valid.

(c) *The dimensions of declarative knowledge have the greatest standardized regression on the corresponding dimensions of analytical problem-solving competence.*

In comparison, the respective dimensions of declarative knowledge have the greatest impact on all five dimensions of analytical problem-solving competence (β = 0.326−0.686). Two dimensions do not yet show a significant load here. However, these are likely to become significant within a larger sample as well.

In this respect, declarative knowledge actually delivers the strongest loads on analytical problem-solving competence, which confirms the H2C hypothesis.

4.6 Conclusion

In summary, evidence of a multidimensional structure using structural equation modeling (Mplus software) via a confirmatory factor analysis (CFA) could be obtained for both content-knowledge and analytical problem-solving competence via experimental and explanatory field studies with the above-mentioned (n = 243) students.

The results are thus in line with the multi-dimensional model for "berufsfachliche Kompetenz" (domain-specific competence) (see Sect. 2.2), in which "deklaratives Sachwissen" (verbalizable knowledge about facts) and analytical problem-solving competence basically represent two separate competence dimensions.

The exogenous variable fluid intelligence and the two latent dimensions of declarative knowledge load onto the five latent dimensions of analytical problem-solving competence. The loads of the two latent dimensions of content-knowledge on the five latent dimensions of analytical problem-solving competence ($\beta = 0.326-0.686$) yield the highest results.

With a value of ($\beta = 0.114-0.348$), fluid intelligence affects the five latent dimensions of analytical problem-solving competence considerably less strongly than the two dimensions of content-knowledge. In addition, loads from fluid intelligence can be recorded regarding the two dimensions of declarative knowledge ($\beta = 0.132-0.273$).

These loads result from an acceptable model fit (n = 243/RMSEA = 0.022/WRMR = 0.999/CFI = 0.925/TLI = 0.921).

The visibly higher loads of the two dimensions of content-knowledge in the structural equation model thus provide evidence for Phillip Ackerman's PPIK theory.

Finally, the learnable prior knowledge of the students concerning the interpretation and error specification of technical drawings according to DIN EN ISO appears to be more important than the comparatively not learnable basic cognitive ability of fluid intelligence.

This result assigns an important role to learnable content-knowledge as prior knowledge, which generates starting points for further knowledge acquisition and competency development. Accordingly, corresponding chunk networks can develop from prior knowledge.

Furthermore, these findings confirm the intellectual development of the participating students analogous to the PPIK theory regarding their average age (of-26.3 years). In this context, the importance of prior knowledge is in line with the adult age of the students.

The results of this study will be followed up as part of a more extensive research project with a larger sample.

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Chapter 5
Futures Literacy: The Concept and Potential Application in Applied Degree Education

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Abstract The term *futures literacy* refers to "the capacity to know how to imagine the future, and why it is necessary" (Larsen et al. in What is "futures literacy" and why is it important? Medium. Retrieved from https://medium.com/copenhagen-institute-for-futures-studies/what-is-futures-literacy-and-why-is-it-important-a27f24b983d8, 2020, para 1). It is argued that being futures literate today is as important as the ability to read was for the First Industrial Revolution (Miller in Foresight, 8(40):13–22, 2006a, Futures 39:341–362, 2007). Being futures literate is not the same as being able to plan the future based on the study of today's reality because that kind of future is necessarily limited by the ideas and conditions of today. Being futures literate assumes becoming aware of our anticipatory assumptions, reframing these assumptions and viewing uncertainty and complexity as valuable resources. This chapter reviews the concept of futures literacy and analyses its applicability to English language curriculum design in the context of tertiary-level applied degree education.

Keywords Applied degree education · Curriculum design · English for Specific Purposes · English language curriculum · Futures literacy · Future of education

5.1 Introduction

This chapter evaluates the applicability of the Futures Literacy framework (Miller, 2006a, b, 2007) to the development of English language curricula in institutions of applied degree education. The key argument is that the approaches currently used for this, i.e. those that are based on the research and developments within English for Specific Purposes (ESP), may no longer be sufficient for preparing students for today's and future workplaces. It is important to explore approaches developed outside of traditional English language teaching frameworks to consider ways of scaffolding the communicative skills and competencies needed in the workplace

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while also addressing students' needs to be "comfortable with ambiguity and the profound uncertainty of the human condition", characteristics of today's learning intensive society (Miller, 2006b, p. 13). The approach presented here is not to replace the existing ones but to complement them by highlighting the strengths of the concept of futures literacy for vocational education and the crucial role that language may play in futures literacy development.

The chapter is organised in four main parts. The first part provides an overview of English for Specific Purposes, a broad term that includes needs-based approaches to English language curriculum development typically implemented in vocational institutes of higher education. The second section deals with the question of what preparing students for the future means. This is followed by the introduction into futures literacy and analysis of its current applications across various educational and geographic contexts. Following this, the possibility of designing and delivering a Futures Literacy Lab as an English language course in institutes of applied degree education is considered and key relevant elements of curriculum design are discussed.

5.2 English for Specific Purposes and Applied Degree Education

At the heart of English for Specific Purposes (ESP) approaches is "sensitivity to the needs of specific language learners in specific contexts with specific current and future target goals" (Belcher, 2017, p. 2). In practice, within tertiary institutions of applied education, this often translates to two distinct types of courses often offered in parallel or one after the other. The first type includes English for Academic Purposes courses which focus on the development of communicative needs required for academic studies. Courses of the second type, English for Occupational Purposes, focus on specialised discourses valued by specific professional communities and on preparing students for joining these said communities. The development of both types of courses relies heavily on some form of needs analysis, and classroom practice incorporates elements of genre-based instruction through the focus on the purposes, communicative functions and lexico-grammatical features of various text types used within professional or academic communities.

At the Technological and Higher Education Institute of Hong Kong, for example, the formal English language curriculum comprises three courses: two courses that aim to help students succeed in their tertiary studies by scaffolding essay writing and presentation/discussion skills and one course that helps students develop job application portfolios and engages them in exploring specific text types and communicative needs of their future chosen professions (more details can be found in Chigaeva-Heddad, 2021). This structure is reflective of the general trend not only within institutes of applied degree studies but also within undergraduate programmes offered by more traditional universities both in and outside of Hong Kong (see, for example, a collection of research articles edited by Sarre and Whyte (2017) on some of the ESP developments and applications in European educational contexts).

To help ESP course developers identify the content that would make the course relevant to learners, some form of needs analysis is typically employed as the first stage of ESP course design. Needs analysis is then used by course developers to define course aims and learning outcomes, develop teaching materials and design assessment tools (Richards, 2001). Traditionally, needs analysis is understood as the process through which ESP course designers or researchers collect, organise and analyse some form of information to identify students' "target needs" (Hutchinson & Waters, 1987). These target needs were presented by early needs analyses in terms of what students needed to read, write, say and listen to upon their hypothetical joining of a target discourse community. In Belcher's (2017, p. 5) words, this was "primarily opportunistic" as ESP professionals tended to rely on published texts they came across and had access to. The resulting analyses typically focused on the lexical and sentence-level grammatical items that students needed to acquire.

Today's needs analyses take the form of smaller-scale in-house studies on the needs of target discourse communities (be it academic or professional) as well as more rigorous published research studies involving large corpora and surveys of numerous established members of target discourse communities. Informed by various genre theories and supported by technological advancements that made corpus linguistics possible, these analyses are more discourse-focused and consider not only the linguistic features of target texts but also the purposes, participants and rhetorical organisations of both spoken and written text types. Overall, though needs analyses focusing on the needs of target discourse communities have been criticised from the early days of ESP for privileging institutional views and ignoring students' own perspectives of needs (e.g., Benesch, 1996), they remain the most prolific and influential in ESP curriculum and materials design.

The main contention of this paper, however, is that the use of target needs analysis, be it small-scale discussions with informants from professional fields or large-scale corpus-based analyses of target discourse patterns, is no longer sufficient for language curriculum design in today's educational contexts. Though they have their own undisputable merits, there are four fundamental reasons for being sceptical about over-relying on needs-based approaches.

1. One constant feature of the ESP literature is the ongoing debate on how specific ESP courses should be (see Basturkmen, 2006; Belcher, 2017). Proponents of the so-called "narrow-angled" (Basturkmen, 2006) ESP courses argue that the content covered should be as specific as possible to ensure students are able to adapt to the communicative practices of their selected fields upon entering their professions (e.g., Hyland, 2002). Meanwhile, those in favour of "wider-angled" (Basturkmen, 2006) ESP courses insist that the focus should be on more general skills that can then be transferred by students to their specific contexts.
2. ESP courses in applied degree education institutions tend to be of the first kind. This is generally welcome by both students and discipline teachers as there is

a clear effort to help students understand professional discourses and eventually join professional conversations. This, however, also raises practical challenges as teachers, who are tasked with developing and teaching ESP courses in contexts where the needs of students from multiple and often diverse academic departments (and therefore professional contexts) need to be met, tend to develop an expertise in a specific course covering a highly specialised syllabus and may be unwilling to teach other courses. This unwillingness may be due to lack of confidence, increased workload, and perceived time investment needed to become acquainted with a new course. In addition to being cost-ineffective, this means that administrators have to find ways to balance teachers' preferences with the practical teaching needs which is a rather challenging task.

3. Moreover, the process of selecting the specific target items to be covered in a language course is rather subjective even if target community informants and multiple data sources are involved. This is due to the finite nature of such courses (in Hong Kong's tertiary institutes these typically last for about 13–14 weeks, three hours per week) and the rather infinite needs that may be deemed to be important. Decisions have to be made as to which items are included into the syllabus and, eventually, teaching and assessment materials, and which items have to be left out. Even if target community members are involved in selecting these items and eventually evaluating the developed materials, it is often the case that these members disagree with each other and/or with course designers regarding what should be taught to students in order to ensure their successful integration into the workforce.
4. Most importantly, however, looking at needs is somewhat akin to looking at trends in that they are "partly in the forever-behind-us past and partly in the currently-out-of-reach future" (Miller, 2006b, p. 10). In 1985, John Swales, the father of ESP, in one of the most influential books about the field *Episodes in ESP*, observed that the ESP practitioners of the time "operate[d] within the 'here and now' of their actual teaching situation" (p. ix). Nearly forty years after the publication of the book, it can still be argued that most of ESP work has remained within the "here and now" as little, if anything, has been done to look into the future, i.e. beyond the current needs of target discourse communities. Today, when we are faced with unprecedented challenges of constant change and instability, identifying these needs may no longer be sufficient as there is a high change these needs will change by the time our students complete their studies.

Future in Applied Degree Education

> In the eighty years or so after 1780 the population of Britain nearly tripled, … the average income of the population more than doubled, the share of farming fell from just under half to just under one-fifth of the nation's output, and the making of textiles and iron moved into steam-driven factories. So strange were these events that before they happened they were not anticipated, and while they were happening they were not comprehended.
>
> (McClosky, 1994, quoted in Miller, 2006b, p. 12)

Today's applied degree education discourse is often referenced to the Fourth Industrial Revolution at the core of which is the use of modern smart technologies to automate manufacturing practices (i.e. Industry 4.0), with consequences being discussed for today's education (i.e. Education 4.0) as well as the future of learning. The Fourth Industrial Revolution, however, may quickly become the talk of the past, especially since the experiences of the last two years have greatly expedited previously unanticipated developments across various industries that rely on the use of new technologies to anticipate and address human needs. Governments and executive bodies across the world are now referring to Industry 5.0 (see, for instance, European Commission, 2021) which was previously predicted to focus on the return of human elements into the industrial framework (Supply Chain Game Changer, 2018), cooperation between human intelligence and machine cognitive computing (Rossi, 2018) and increased attention to sustainability and greening (Berawi, 2019). Regardless of which industrial era we are currently experiencing or about to experience, the questions of whether and how institutions of applied degree education prepare graduates ready for new developments, new technologies, new synergies, new collaboration systems and many other new-s have become particularly pertinent today, when the impact of COVID-19 has clearly signalled the need to adapt faster and be ready for the unknown. To stay relevant, education professionals feel they need to prepare *future-proof* or *future-ready* students and are often attempting to forecast what kinds of new skills and competencies being future-proof would entail.

Two drawbacks of the preoccupation with *future-proofing* our students and equipping them with the skills and competencies anticipated to be useful are worth highlighting. First, though well-intended their uses may be, the terms *future-proof* and *future-ready* can be rather limiting. *Future-proof* suggests that we should be frightened of what may come in the future as it may inflict some kind of pain or damage as bullets do. *Future-proofing* students also presumes passive learners who are equipped with something that will make them protected against the future, against becoming obsolete. *Future-ready*, though it appears to be less common as a term, is too deterministic and suggests one future that we can fully prepare for. On the practical level, both terms appear to be rather vague and it is often difficult to envision their exact operationalisation in practice.

A second, more important, danger is that a preoccupation with the kinds of competencies expected by the future world of work may deflect our attention from the importance of values and assumptions that underpin human practice, as well as the mindsets and leadership qualities that encourage creative thinking. The most recent events, including COVID-19 which was a real-life wildcard event that futurists and planners could only hypothesise about when brainstorming contingency situations and the event with which "the future arrived ahead of schedule" (Parker, 2020), show that characteristics such as being open to change and complexity are particularly important for this and future generations. They show that, more than before, it is important to foster a learning intensive society (Miller, 2006b) which is comfortable with ambiguity and uncertainty and can "respect and empower a greater diversity of 'truths'" (Miller, 2006a, p. 21).

The premise of this chapter is that applied degree education of the future should be concerned with more humanistic aspects of human-technology interactions and focus on helping students develop mindsets that embrace complexity, uncertainty, resilience and adaptability and equipping them with the skills needed to create choices, evaluate them and put them into action. Students need to be able to imagine multiple futures, untangle their assumptions, communicate their imaginings to others and make decisions relevant for their immediate contexts based on these imaginings. The review presented in the next section will show that the term *futures literacies* encapsulates the above abilities.

5.3 Futures Literacy

Associated with the work of Riel Miller and further promoted by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the concept of *futures literacy* (FL) has been applied in programmes across geographic locations within and outside of educational contexts, including tertiary institutes of applied education. Miller (2007) defines it as "the capacity to think about the potential of the present to give rise to the future by developing and interpreting stories about possible, probable and desirable futures" (p. 347). A more recent definition relates futures literacy to "the capacity to know how to imagine the future, and why it is necessary" (Larsen et al., 2020, para 1). At the core of the notion is the idea that this is a capacity, i.e. an individual's potential for "a skill that can be revealed and obtained through learning processes" (Miller, 2018b, p. 6). Such learning processes start with disruptive questions, which in the context of futures literacy development are "What is the future?", "How do we use it?" and "What methods do we use to 'know the future'?" (ibid).

According to Miller and others working within this new paradigm, being futures literate is not the same as being able to predict or plan the future based on the study of today's reality and in an effort to make sense of today's complexity. Planning that kind of future would necessarily be limited by the ideas and conditions of today. Being futures literate is an ability to imagine the future unconstrained by pre-existing images of what the future may look like. Fostering futures literacy assumes training the abilities to anticipate because what is being anticipated may actually impact what happens, i.e. the present. The argument is that, when making decisions and plans regarding the future, it is not sufficient to rely on our understanding of the past and the present. We need to include our anticipations of the future. Fostering futures literacy also assumes training the ability to view uncertainty and complexity as valuable resources rather than something to be overcome or adapted to. The aim is to integrate complexity into plans and choices and perhaps even co-create complexity while seeing uncertainty as an advantage rather than a challenge.

Futures literacy advocates argue that it is a key enabler of an adaptive, networked and responsive learning intensive society characterised by heterogeneity, complexity,

Fig. 5.1 Why is Futures Literacy Important? (Futures Literacy, ©UNESCO, https://en.unesco.org/futuresliteracy/about)

fluidity and spontaneity (Miller, 2007). The UNESCO Futures Literacy website summarises the importance of FL in the following image (Fig. 5.1).

5.3.1 Three Levels of Futures Literacy Development

Miller and others working within the framework of futures literacy argue that futures literacy, like reading, "is a skills that must be learned" (Miller, 2006b, p. 15). Miller's groundbreaking work (2006a, b, 2007) on the development of futures literacy (FL) described three levels of development and these make up the framework that is commonly applied today.

The aims of the first level—Level 1 FL *Awareness*, to use Miller's (2007) terminology—are (1) to enable people to reveal their values and expectations and to move these from tacit forms to more explicit understandings and (2) to increase people's temporal and situational awareness. These aims are achieved through discussion and sharing of stories of what participants expect to happen in the future (i.e., probable future) and what they would like to happen in the future (i.e., hopeful future). Without suggesting causal connections or privileging one imagining over the others, the development of this capacity is supported by the careful specification of storytelling heuristics such as (1) the type or purpose of the story, (2) its temporal or chronological frame, (3) the analytical point of view, (4) main protagonists or ultimate decision makers, and (5) rules that apply to the action (Miller, 2007). Within these pre-set elements, a number of futures are then envisioned and discussed.

Level 2 FL *Discovery* aims to overcome the constraints imposed by present values and expectations and engage participants in a "rigorous imagining" of equally desirable and equally probable futures. This is supported by the complex four-step method for constructing a "possibility space" frame and selecting a few of the resulting scenarios (see Miller, 2007, pp. 352–355, as well as the table below).

Level 3 FL *Choice* compares the values and expectations of Level 1 FL (i.e., today's choices) with those of Level 2 FL imaginings. This level ideally culminates in action or impact on choices and decisions meant to improve the human condition. In Miller's (2006b) words, "a snapshot of the present is compared to the snapshot of a rigorously imagined future" (p. 16) to generate insights into "choices that we are willing to make, not because we can predict what will happen, but because they are consistent with our values and imagination" (ibid.).

The three levels overviewed above are summarised in the Table 5.1. The table additionally specifies the learning processes and support suggested for each phase.

5.3.2 Futures Literacy and Language Education

The review above suggests at least two important, almost immediately visible parallels between futures literacy and language education:

1. Riel Miller has repeatedly compared futures literacy directly to reading and to what he calls "language literacy". When discussing the three levels of futures literacy development, he says that "This is no different than reading. Learning the alphabet is the first step in acquiring the capacity to decipher text, and then being able to read is crucial for beginning to decipher the messages contained in a text to be read" (2007, p. 347). As "the capacity to read a text, in its many senses, can be improved through practice" (p. 347), so can the capacity to become aware of and reframe our assumptions and values, envision and communicate stories about futures and choose the ones that can be acted on. In his multiple texts, he suggests that futures literacy may be as critical a tool for this century and the development of learning intensive societies as the ability to read and write was for the nineteenth and twentieth centuries (e.g., Miller, 2006a, b, 2007). In one of his latest works, he expands the analogy and argues that

> [a]s with reading and writing, FL entails the capacity to decipher and categorize as well as produce (design, conduct and interpret) explicit (volitional and intentional) processes of anticipatory knowledge creation, as a necessary and ordinary skill. FL, like language literacy, involves the acquisition of the know-what, know-how, know-who and know-why—to which we could also add problems of known-when—that are required to deploy anticipatory systems appropriate—i.e. to be fit for purpose.
>
> (Miller et al., 2018, p. 58)

2. At the core of futures literacy development is "the capacity for more imaginative storytelling" (Miller, 2007, p. 343) and ability to develop and interpret "stories about possible, probable and desirable futures" (p. 347). Futures literacy development is a highly discursive process and requires students to reveal, unpack and reflect on their values and assumptions and share these as well as their visions/stories of futures with others. As Miller (2006b) emphasises, "the quality

Table 5.1 Miller's (2007) three levels of futures literacy

Levels of futures literacy	Aims	Processes	Support
Level 1 FL *Awareness*	To develop temporal and situational awareness To shift values and expectations from tacit to explicit	Structured learning processes that help reveal existing values and assumptions Discussions and sharing of stories of what participants expect (probable future) and want from the future (hopeful future)	Careful elaboration of the narrative structure for internally consistent storytelling: • type or purpose of the story • temporal or chronological frame • analytical point-of-view • main protagonists • rules
Level 2 FL *Discovery*	To overcome the limitations imposed by values and expectations To carefully and consistently distinguish between possible, probable, and desirable scenarios	"Rigorous imagining" that helps push the boundaries of what is considered realistic but ensure that what is imagined is intelligible and rigorous Reflective processes of analytical refinement through constructing "a possibility space"	Four-step method for constructing a possibility space frame: 1. selecting a subject 2. developing a model 3. selecting specific scenarios from a great range of possibilities 4. projecting the scenarios back onto the possibility space
Level 3 FL *Choice*	To assess today's choices using the enhanced awareness of values and expectations (Level 1 FL) and the discoveries of "rigorous imagining" (Level 2 FL)	Analysis of Level 2 FL possibility space scenarios in normative terms Identification of similarities and differences between the selected story of the future and present story Consideration of the probability of a decision being made Action on the basis of the insight gained	Four steps that lead to action: 1. strategic goal 2. strategic choices 3. strategic probability 4. action

of our decision making, how well we can exercise our freedom, depends on our capacity to invent and tell stories" (p. 7).

It is the last point, that I feel, is most relevant for language educators who are equipped more than others to scaffold students' abilities to create and communicate stories through various modes, including traditional as well as less explored types of speaking and writing and a combination of creative arts with more reflective discourse types. Futures Literacy Labs incorporating substantial language development and support elements may be used as a form of integrating futures literacy into language curricula.

5.3.3 Futures Literacy Labs (FLLs)

The framework described above has been operationalised in more concrete terms through what is now known as Futures Literacy Labs (FLLs). FLLs present a tool commonly used by FL advocates, including local actors in more than 20 countries working together with UNESCO, to promote FL development. They have been conducted primarily through the format of two-day workshops, with participants ranging from policy makers to researchers to youth representatives. The key aim of FLLs is to engage participants in becoming aware of their anticipatory systems and using this awareness for thinking collectively about the future of a pre-selected topic that carries meaning to them as a group (Miller, 2018b). As such, FLLs are designed to take into account both global concerns and local contexts, and are facilitated by a team of trained professionals. Topics cover a diverse range including cultural heritage conservation, the future of science, transitioning to adulthood in post-war locations, refugee support, policymaking, and UNESCO's Sustainable Development Goals.

FLLs, compared to earlier discussions of FL, give a more central role to anticipatory assumptions, i.e. assumptions that humans use when thinking about the future. In fact, being futures literate, from this perspective, entails "the capacity to identify, design, target and deploy" anticipatory assumptions (Miller, 2018c, p. 24). This is accomplished through experimenting and testing hypotheses, as in a regular laboratory (hence the use of the term *Laboratory*). Reflective of Miller's (2007) three levels of FL, three phases are typically involved in an FLL though the actual names of the phases may differ in different FLL reports (refer to Table 5.2). Careful attention is given to the process as a whole since the phases are tightly linked. The primary outcome expected of an FLL is participants' development of a basic collective understanding of what using the future means. Measures are therefore taken to steer participants away from debating which set of assumptions is better than others or which envisioned futures are better or more desirable than others.

Two large compilations of case studies involving FLLs have formed the basis of the practical discussion that follows: a report from Finland by Raleigh et al. (2018) and fourteen UNESCO-supported FLL-Ns (Futures Literacy Laboratories-Novelty) as described in a 2018 collection of case studies from across the world edited by Miller (2018d). Based on these sources, a typical FLL starts with revealing participants' anticipatory assumptions through small group discussions of probable and hopeful futures. Participants are usually asked to visualise a day in a future life (30–50 years from now) and share these snapshots with others. Visualisation and discussions first focus on a probable future and then move on to a desirable or hopeful future. The next phase engages participants in questioning their previous visions of the future and visualising an alternative future through carefully constructed scenarios or models. The last phase involves a comparisons of the futures imagined in the previous phases

Table 5.2 Three phases of Futures Literacy Laboratories

Phases	Aims	Elements of the learning process
Phase 1: Reveal	To invite participants to appreciate what they know and openly express their expectations, hopes and fears To keep the task of shifting from tacit to explicit understandings manageable and unintimidating To build shared meaning	Small break-out groups Discussion of probable and hopeful futures Differentiation of expectations from hope; distinguishing the probable from the desirable
Phase 2: Reframe	To reframe participants anticipatory assumptions	The same break-out groups Collective intelligence knowledge creation (CIKC)
Phase 3: New questions	To identify and reinforce observations about differences in anticipatory assumptions To develop metacognitive awareness of why and what the future can be used for	The same break-out groups Comparison and contrast between Phases 1 and 2

and development of metacognitive awareness of what being futures literate entails and what the future can be used for. In some cases, the three phases are followed by Phase 4: Choice that focuses on identifying actions based on the experiences of the previous phases.

When implementing the learning process, FLL designers and facilitators may face several challenges. For example, in their report about a summer school that was organised by the Finland Futures Academy on the topic of Complex Futures of Human Settlement 2050, Raleigh et al. (2018) discuss three key design principles of importance to planning and delivering an FLL: (1) keeping the future open, i.e. allowing students to use their own understandings instead of emphasising teachers' views; (2) guiding students to steer their own learning, i.e. deemphasizing lecturing and knowledge transmission while privileging dialogue and discussion; (3) boosting and combining creativity and criticality, i.e. ensuring that these happen together. These and other challenges are presented in the following table that includes specific tools, procedures and techniques that have been used by the previous FLL designers in each phase.

5.4 Language Curriculum Design Considerations

To my knowledge, no attempts relating FL development to a language course have been reported in research literature. Based on the review above, this section therefore attempts to render the somewhat abstract concept of FL more tangible and easier to integrate into a language curriculum by further specifying design characteristics of typical FLLs. At the core of this attempt is the idea that a typical FLL structure can be implemented to develop a course or at least a unit of a course as part of the language curriculum in an institute of applied degree education. The following key elements will need to be considered. These elements are presented below together with specific suggestions on how they can be operationalised in context. These preliminary suggestions need to be treated as such as they are yet to be tested in practice.

Goals: A language course or a unit that takes FL as a key component may aim (1) to extend students' communicative competence by developing their abilities to comprehend and communicate about different types of futures and implications for the present; (2) to enhance their ability to tell stories through various modes including speaking and writing; and (3) to enhance their ability to reflect on and reframe values and assumptions.

Student composition: FLLs have been shown to be highly effective for multi-disciplinary groups (Raleigh et al., 2018; Wilenius & Pouru, 2020). Students from different disciplines should therefore be included in the same class. Furthermore, the composition of discussion groups and panel presentations should also be multidisciplinary.

Mode: this can be flexible based on the situational factors. It is possible, however, to envision a mixed mode combining face-to-face, augmented and virtual learning environments.

Length: Most of the reported labs reviewed in this chapter spanned the duration of two to three days, with activities taking place both in the morning and afternoon. Only few initiatives aimed to scaffold futures literacy have been longer. For example, at Hanze University of Applied Sciences in the Netherlands, one- or two-week courses are usually offered but these are intensive courses with FL activities taking up a major part of each working day during the whole period (Damhof et al., 2020). In the context of tertiary institutions, where learning is traditionally divided into semesters, it is suggested that a semester-wide course focusing on FL development is possible and even preferred. This will allow a deeper engagement with concepts and appropriate scaffolding which is needed for a course of this kind.

Type of course: This could be delivered in collaboration with faculties or as a separate language course. It can also be conducted as a series of ongoing workshops, in line with the original FLL design.

Content: To meet the goals stated above, reading and listening tasks need to be integrated to help students understand what futures literacy entails and what imagining futures involves. To help students communicate their ideas, functions involved in discussions and presentations together with sample linguistic structures used to realise these functions need to be introduced. To support students' development of stories, the five key elements of storytelling as discussed by FL proponents (see Table 5.3) should be introduced and integrated into the teaching and learning activities. Overall, productive and social communication skills should be prioritised.

Sequencing: If this were a course, it can take the form of three units, following the typical structure of FLLs.

Table 5.3 FLL design and implementation

Phases	Design challenges	Tools	Procedures	Specific techniques
Phase 1: Reveal	Guiding participants to: focus on detailed descriptions of day-in-the-life snapshots deemed probable or desirable think long-term which allows more freedom and reduces anxiety of being wrong develop and share meaningful co-constructed narratives	Causal Layered Analysis (CLA) (Inayatullah, 1998, as cited in Miller, 2018a) that involves four levels: litany, systems, protagonists, and metaphor	Participants: 1. individually note down 3–4 points describing their snapshot of expected or desired futures 2. share their notes Facilitator: 3. introduces the four levels of CLA Participants: 4. use these levels to analyse and enrich their initial descriptions of futures	Post-it notes presentations role plays storytelling
Phase 2: Reframe	Inviting and inspiring participants to question their way of using the future Introducing alternative ways Engaging them in "playing with unfamiliar futures in an unfamiliar way" (Miller, 2018a, p. 105)	Learning Intensive Society (LIS) (Miller, 2006a, 2006b)	Facilitator: • introduces the four levels of CLA Participants: • use these levels to analyse and enrich their initial descriptions of futures	Written reports snapshots presented through role plays, storytelling and other creative media such as sculptures
Phase 3: Rethink	Stimulating reflective thinking and development of metacognitive awareness	Reflective questions		Individual spoken testimonies plenary sessions

Assessments: If offered as part of a credit-bearing course, care should be taken not to over-assess students as the focus should be on the process of FL development rather than any of the resulting products. In line with the FL framework, care should also be taken to avoid at all costs focusing on evaluating the proposed futures in terms of "best" scenarios or comparisons with other futures. Based on the highly reflective nature of the three FL levels and the focus on the process, it is suggested that portfolio assessment integrating reflective pieces should be considered.

Approach: FL integration presumes student-led enquiry with an active learning approach which would mean minimised role of lectures and increased focus on co-creation and collaboration.

Role of the teacher: The teacher or teachers should be facilitators rather than experts in the field. This requires careful training without which the success of FL integration may be diminished (Raleigh et al., 2018). This may also prove to be the biggest challenge for the development of FL-focused courses.

Themes/Topics: These can be anything ranging from global concerns to localised topics as everything has a future. One strategy is to use a pre-selected topic that may be of interest to the class as a whole while an alternative strategy is to let students choose a topic that carries meaning to them.

5.5 Conclusion

This chapter presented a case for integrating futures literacy into language curricula of institutions of applied degree education, not to diminish the value of the current ESP-based approaches but to supplement them. The reviewed literature shows that futures literacy scaffolding is a promising way for helping students become more open, reflective, and creative—capabilities which have always been important for education but which are becoming even more significant in the face of the unknown that characterises today's world. The approach presented in this chapter may prove to be useful not just for language professionals but for anybody working in vocational education, including those who are interested in up-skilling and re-skilling the current workforce as well as preparing new generations of graduates who are ready to face the world of the unknown.

Institutions of applied degree education, to stay relevant, should not only aim to equip students with the capabilities that fit the projected trends of the unknown future but, more importantly, prepare students who can open up to unexpected possibilities, "appreciate, even cultivate complexity" (Miller, 2018b, p. 9), and create new futures. As Damhof and her colleagues (2020) put it, "we are currently working in an environment that often teaches for the future—i.e. preparing students for jobs and for futures that we deem to be predictable" (p. 170). This may no longer be enough as what is predictable is not necessarily desirable and what students need is not necessarily to be future-ready or future-proof but to be able to participate in co-creating futures, i.e. to be futures literate.

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Chapter 6
Creativity Under COVID-19: How Technology Has Enhanced and Promoted Student Engagement Online

Katrine K. Wong and Michael Zihao Li

Abstract In 2020, the sudden outburst of COVID-19 changed teaching and learning drastically. Teachers and students worldwide had to adapt to hybrid teaching and learning within an extremely short period of time. This study focuses on how the sudden and involuntary changes in pedagogies brought about by the onset of COVID-19 impacted students' class engagement in a general education (GE) course delivered online. The study also examines how features such as chatrooms and share-screen in the selected video-conferencing tool enhanced the hybrid mode of teaching and learning in the GE course in question. This study is one of the few studies with a focus on teaching and learning at the tertiary level in the context of creativity during COVID-19, and it aims to demonstrate how technology has facilitated and enhanced online student engagement in the said context.

Keywords Creativity · Online teaching and learning · eLearning · COVID-19 · Video-conferencing · Student engagement

6.1 Introduction

The COVID-19 outbreak at the beginning of 2020 disrupted and then rapidly changed the ecology of teaching and learning worldwide. One by one, major cities such as Beijing, Milan, Dubai, and Toronto shut down. In the education sector, schools of all levels were shut and all campus classes were cancelled. As early as late January 2020, students in China, from kindergarteners to doctoral candidates, were instructed

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The original version of this chapter was revised: In the reference Polkinghorne, D. E. (1995) on page 136, page range has been updated. The correction to this chapter is available at https://doi.org/10.1007/978-981-16-9812-5_31

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to stay home and continue their studies online; among them were 30 million tertiary-level students at 3,000 institutions, who were pushed into adapting to mandatory online classes. In the United States alone, there were "more than 50 million children being shut out of school for months because of the coronavirus pandemic" (The New York Times). Accordingly to the World Health Organization, there were more than 86 million confirmed COVID-19 cases, and 1.8 million died because of the virus (World Health Organization, as of 15 January, 2021). Notwithstanding, the COVID-19 pandemic creates opportunities for teachers and students to see and experience education differently, and it forces everyone involved to explore alternative spaces, which can lead to the formation of new resources and pedagogies to support future education (Tortorelli et al., 2021).

6.2 Background

"Creativity for the 21st Century" is a General Education course open to all undergraduate students at a comprehensive university in Southern China. The course grew from *Creativity*, Macao's first MOOC, which was launched in September 2018.[1] The instructors met the 390 students of "Creativity for the 21st Century" ("the course" hereafter) twice in January 2020, before the COVID-19 pandemic started. In February, all classes at this University were suspended. Online teaching became mandatory. Some support, such as online workshops, was provided to help academic staff equip themselves one way or another for online teaching; however, there was a prevalent sense of uncertainty as there were no clear instructions on how any one course was going to be managed. The sudden change in the mode and domain of teaching and learning made teachers and students feel rather disconnected. While most felt that there was a general absence of clear, timely, and supportive communication within the institution, the instructors of this 390-student-course took action and implemented a few strategies to boost learning engagement and facilitate students' achievement of learning outcomes.

This study looks at how the sudden and unexpected changes in teaching and learning brought about by the onset of COVID-19 affected students' engagement. With that in mind, the researchers in this article raise a tripartite research question that investigates whether or not student engagement was stunted by:

1. the sudden change in class management (class attendance became a non-issue, and students could opt for Pass/No-Pass instead of receiving a letter grade as per usual practice);
2. the sudden change in learning environment (teaching and learning moved from a physical classroom to a virtual space); and

[1] The course, recognized in 2020 by the Ministry of Education of China as a national first-class undergraduate course, is run twice a year on XuetangX and has thus far attracted 26,000+ students across the globe. See https://www.xuetangx.com/course/UMX08091000590/4233612.

3. the sudden change in assignment format (in-class discussions and presentations became online discussions and digital submissions).

6.3 Literature Review

6.3.1 Student Engagement and Constructionism

This study is largely informed by theories surrounding student engagement, fundamental components of which include behaviours, emotions, and cognitive engagement (Woo & Reeves, 2007; Wang, 2008; Hew, 2016). Cognitive engagement entails the notion that students see course content as both relevant and important (Buelow et al., 2018). The ability to engage with course content is predicated by the ability to be present with and to interact with course content, which can be understood as cognitive presence. Cognitive presence enables learning through sustained meaning construction (Garrison et al., 2001), which is dialogic with constructionism.

Studies of student engagement tell us that learning engagement comprises physical and mental capacities and is dependent on a variety of situational factors (Astin, 1985). To assess student engagement means to evaluate "students' psychological investment in and effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote" (Newman et al., 1992, p. 12), which is supported by studies that correlate student engagement with student involvement with subject content, instructors, and peers (Astin, 1993; Feldman, 1994). The social construct of learning engagement is manifested as interactive "presences" in the context of online learning. At the turn of this century, Garrison, Anderson, and Archer identified in their Community of Inquiry (CoI) model of learning engagement social presence, teaching presence, and cognitive presence as the three presences for effective student engagement in online learning (Garrison et al., 2001). Social presence refers to learners' ability to project themselves as individuals and to connect and identify with fellow learners; teaching presence includes the provision of learning material for students to achieve desired learning outcomes; cognitive presence embodies construction of meaning through sustained interaction with learning material. Cognitive presence and cognitive development are recognized and affirmed as crucial ingredients that lead to learning engagement and student success in an online context (Banna et al., 2015; Britt et al., 2015). Online learning requires a substantial amount of effort and stamina of meaning construction among students.

Active meaning construction and idea creation form the basis of the theory of constructionism. The theory of constructionism (1991) is built upon the theory of constructivism (1980). The differences between constructionism and constructivism lie in the ways through which knowledge is constructed and disseminated (Ackermann, 2001). Constructionism complements the constructivist viewpoint in that the learner is an active, participatory builder of knowledge. It goes beyond constructivism and it further emphasizes a learner's social interaction with others in meaning making. In return, it contributes to knowledge construction through the learner's iteration of understanding about the process and product. Constructivism and constructionism are differentiated as such: "Constructionism—the N word as opposed to the V word—shares constructivism's connotation of learning as 'Building knowledge structures' irrespective of the circumstances of the learning. It then adds the idea that this happens especially felicitous in a context where the learner is consciously engaged in constructing a public entity [.]" (Papert & Harel, 1991, p. 1). In this study, students' discussion in chatrooms and their digital submissions (textual and visual) are artefacts that testify to their cognitive presence and engagement with the course material, as well as their synthetic construction and representation of knowledge acquired from the course.

6.3.2 Technology and Student Learning

Digital technology has become a central feature in educational experience, and hence the role that technology plays in student engagement has garnered much interest (Selwyn, 2016; Henderson et al., 2017; Li et al., 2018). The extent to which educational technology has enhanced student engagement is well recognized (Wong & Li, 2020). A positive relationship between the use of technology and student engagement has been identified (Chen et al., 2010; Henrie et al., 2015; Webb et al., 2017). Researchers have demonstrated repeatedly the positive impact technology brings about in educational settings and for academic and professional collaborations (Bates & Poole, 2003; Vries & Mottier, 2006; Martin & Ertzberger, 2013; Bernard et al., 2014).

Much attention has been paid to technology-enhanced teaching and learning in the landscape of higher education in developed and developing countries and regions. Pedagogies punctuated with portable devices for teaching and learning purposes have received extensive studies (Gikas & Grant, 2013; Viberg & Grönlund, 2013; Tabuenca et al., 2015; Li et al., 2018). Recent years have seen teaching and learning in higher education undergo rapid adaptation and transformation in a global ecology characterized with an ever-increasing usage of smart phones, together with frequent new appearances and updates of modes of communication seen in social media and video-conferencing (Al-Emran et al., 2016; Li, 2020).

Social media applications can activate and stimulate interactive communication between instructors and learners (Prescott et al., 2013; Rambe & Bere, 2013; Barhoumi, 2015; Naidoo & Kopung, 2016; So, 2016; Sobaih et al., 2016). The incorporation of mobile instant messaging (MIM) applications in education has never been more natural and spontaneous. The synchronicity inherent in MIM applications allows instructors and learners worldwide to enhance accuracy and efficiency of exchange of content knowledge and course information. MIM applications, surpassing all geographical and temporal boundaries, promotes self-paced (Shi et al., Ciampa, 2014; Dold, 2016; 2017), personalized (Crescente & Lee, 2011), lightweight (Stošić & Bogdanović, 2013), and affordable learning. Various mobile applications complement different learning styles of learners of the twenty-first century (Sarkar et al., 2017). Pedagogical purposes and significance afforded by mobile applications expand from enhancement of language acquisition and language exchange (Tang & Hew, 2017), to delivery of subject-specific skills and knowledge (Charalambous, 2016; Eid & Al-Jabri, 2016), and to enhancement of learning engagement in classroom of theatrical arts (Li et al., 2018).

Synchronicity in online teaching is the result of a combination of video-conferencing, online instruction, and student participation. By allowing instructors to reach multiple students at once, video-conferencing increases instructor presence in an online classroom. It allows instructors and students to interact in real time, not dissimilar to the interactions typically present in a physical classroom. Instructors can conduct personalized, real-time conversations with students regarding course content, which allows students to have a stronger perception of teacher presence in their education, which is essential for students in online courses (Rodriguez-Keyes et al., 2013). Besides, it has been shown that learners who have participated in video-conferencing tend to feel more motivated to participate, prepare, and use technology in their studies (Rudd & Rudd, 2014). Synchronous elements in a classroom, be it physical or virtual, have been proven to promote levels of student engagement (Acosta-Tello, 2015; Li, 2020).

Interacting with students is central to learning engagement (Wong & Li, 2020) and student success (Foronda & Lippincott, 2014). Sense of community and instructor presence would be rendered non-existent without a synchronous component, such as video-conferencing (Tunks, 2012). Video-conferencing affords instructors an opportunity to create an environment in which learners can build relationships with both the instructor and their peer learners anywhere in the world (Ellingson & Notbohm, 2012). It allows students to be actively engaged in their learning by communicating and collaborating with others, rather than passively absorbing content knowledge, which is often the case in an online setting (Tunks, 2012). Learning via video-conferencing also helps students familiarize themselves with technological tools that they can use in learning other subjects or in their careers later on in their lives (Ellingson & Notbohm, 2012; Rudd & Rudd, 2014).

6.4 Methodology

To better monitor and assess learning engagement, this study utilizes mixed methods. The combination of qualitative and quantitative methods is practised widely (Pluye et al., 2009; Harrison et al., 2020). Methodological pluralism provides stronger evidence than methodological monism (Eisner, 1981): "Looking through one eye never did provide much depth of field" (ibid., p. 73). Mixed methods garner the strengths from both qualitative and quantitative research methods and reduce their limitations (Twinn, 2003). One can triangulate the data sets by employing both methods to minimize biases that exist within either set of meanings and implications (Creamer, 2017).

The current study includes surveys, interviews with focus groups, chat records, students' work samples, as well as documentation of changes in university policy that took place during the pandemic. The researchers have collected data from multiple sources to investigate whether or not student engagement is stunted by the sudden onset of changes in teaching and learning environment, classroom management, and assignment format. Researchers have employed an additional two-pronged analysis of qualitative data in order to synergize ideas and perspectives and to foreground the role played by technology in learning engagement. One is qualitative content analysis that aims to assess patterns within the content (White & Marsh, 2006). Qualitative content analysis in this study includes the number of similar technical issues participants raised (frequency), multimedia sources shared (variety), and the feedback from interviewees during the interview (emotion). The other one is narrative analysis (Polkinghorne 1995); its goal is to comprehend meanings behind stories (Polkinghorne 1995) and to seek broader understandings from these online learners. Stories from students without interruptions have enabled researchers to unpack how students learn during the COVID-19 period. All interviews are transcribed and coded into different categories. Such data are further labelled and tabulated by themes. To avoid missing subtle yet important details during the interviews, researchers have examined the entire interview transcripts in between coding and cross tabulation.

6.4.1 Sample Selection

For this study, a convenience sampling technique is used; it involves students at a public university in Southern China, which is a comprehensive and research-based institution with approximately 10,000 students at various degree levels. Students from an undergraduate course, "Creativity in the 21st Century", were invited to participate in this study without any reward or incentive. Prior to the study, the researchers followed all policies and procedures, including informing all participants of the research purpose and procedure of the study. All participants were informed that they could withdraw from the study at any time, that their identities would be protected, and that there would be no impact on their final grade. An online questionnaire was then distributed to participating students via Moodle (a Learning Management System).

Of the 390 participants (undergraduate students from years 1 to 4), 16 students who failed to complete both the pre-test and the post-test were excluded. In total, 377 students provided complete data for both tests. Three outliers were detected and removed from the dataset, which led to a final sample of 374 participants. Students were from different disciplines ranging from engineering to literature, from history to hospitality. The majority of them were Macao residents while others were from Korea, different parts of Africa and different provinces of China. Everyone took the course online during campus class suspension under COVID-19.

6.4.2 Surveys

Two anonymous online surveys were conducted during the study to ensure accuracy and to allow comparison of findings over a period of time. The first survey, conducted in the third week of the semester, was designed to collect students' initial response before they started the experience of online learning. The second survey, executed towards the end of the semester, was designed to collect students' feedback after they had experienced a period of online learning. Results of both surveys were coded, organized, and cross-checked for data analysis.

6.4.3 Focus-group Interviews and Chat Record

In the middle of the semester, an email message was sent to all students in the course, inviting them to participate in a focus-group study. Of those who responded, 38, which was approximately 10 percent of the class, were randomly selected for interviews. Participants were informed clearly that they had a choice to accept or refuse to participate without any consequences to their grades. All interviews with the focus group were conducted online towards the end of the semester at the participants' convenience. These interviews were later transcribed, coded, and analyzed. Questions were designed to gather students' views about the pros and cons of online learning, tools instructors utilized, and various learning activities. Three participants later declined to be involved in the focus-group interview. In total, 35 students participated in the semi-structured interviews. Researchers were able to investigate patterns and meanings behind stories from interviewees through qualitative content analysis and narrative analysis.

In addition, class chat-logs from the chatroom embedded in the video-conferencing tool, documenting interaction among students and between students and instructors on various in-class activities, were generated, coded, and analyzed. All students in the class were informed that all identifiable names or student numbers would be erased.

6.4.4 Changes Within Institution

The institution where this study took place announced in mid-February that all teaching would be conducted online. A month later, senior management of the institution further announced that mandatory attendance would be a non-issue and that students would be allowed to opt for Pass/No-Pass instead of receiving letter grades. Such initiative proved to be effective as some students could not attend live-streamed sessions owing to various reasons such as low bandwidth at home; such students could view recorded live-streamed class sessions. Workshops on online teaching

Fig. 6.1 Some of the better-known video-conferencing tools (as of March, 2020)

were provided for all teaching staff at the institution. The instructors tested more than ten video-conferencing tools (Fig. 6.1) in order to locate one suitable for online class adaptation.

6.4.5 Documentation

Low-stakes and high-stakes assignments were set and collected digitally at various stages to monitor student progress in the course. Some assignments were in-class tasks while others were after-class tasks. "What is a story?" and "What do you see?" were in-class tasks that required students to transform their thoughts into words creatively. "Innovation & Creativity", another in-class activity, was slower-paced than the former two and it prompted students to conduct activities in their minds and verbalize their thoughts during that particular class meeting. "Creative Frame", on the other hand, was an after-class project, in which students were to capture an image with their mobile device whilst working under a set of requirements. These tasks will be documented and discussed in greater detail later.

6.4.6 Tools for Online Teaching and Learning

For effective class interaction and engagement, eleven video-conferencing tools had been tested before the instructors chose their desired tool. Given the nature of the course as well as the teaching and learning needs, the instructors looked into three major factors, namely, participant capacity, clarity of audio and video, and availability of a text-based discussion space, when testing the limited number of tools. Skype is well-known, yet the image quality is not entirely clear and it does not provide share-screen function. Adobe offers diverse features, but it is not user-friendly in the specific teaching context. Google hangout and Messenger carry nice designs and yet they pose territorial constraints (Mainland China blocks the use of Google and Facebook). Having considered the pros and cons afforded by various tools, the instructors decided to use Zoom to conduct their online teaching. Figure 6.1, indicative of what the instructors were looking for when testing and evaluating the limited video-conferencing tools, shows a few of the popular video-conferencing tools in use during our time of study, mostly free with conditions.

Zoom is a cloud-based video communication application and is compatible with most operating systems and devices. Zoom carries pedagogical advantages as it enables and facilitates virtual video- and audio-conferencing, webinars, live chats, screen-sharing, and other collaborative capabilities (Antonelli, 2020). During class meetings of the course, the functions of live chat and video- and audio- conferencing, share screen, breakout room, and polls were frequently utilized. Interaction with students is key to student success (Foronda & Lippincott, 2014), and a Zoom-enabled virtual classroom facilitates and promotes a sense of community wherein instructors' presence is established and reinforced (Tunks, 2012).

6.5 Findings and Discussion

Students in this course were actively engaged in class activities. Details of findings and policy changes are discussed in connection with the three components in our tripartite research question, with relevant signposting when necessary and appropriate. Researchers will examine the virtual learning space of the course and students' preference of features in the conference tool used in the course, which will help shed light on how online student engagement in this course was enhanced through collaborative learning facilitated by technology. Specifically, selected online assignments as well as the use of chatroom and mobile device will be examined in connection with students' learning engagement and meaning construction.

6.5.1 Class(room) Management

The delivery of the course changed from face-to-face to fully online, and the learning space moved from a physical classroom to an online space. Notwithstanding the drastic changes, a low rate of absenteeism was documented throughout the semester; specifically, only 3–5 percent of the entire student population of the course failed to show up for online class meetings in the first part of the semester. The rate of absenteeism increased by about 5 percent as soon as the university changed its policy on class attendance (which stated that a student's final grade would not be affected by his or her attendance record) and allowed students the options of pass/fail. In the online learning space, most students turned up for each virtual class meeting, and students were able to engage with technology in creative ways in their assignments.

6.5.2 Learning Space—Zoom and Its Features

Video-conferencing using Zoom helped instructors build a safe virtual space in which all participants built relationships with both instructors and peer learners from various locations (Ellingson & Notbohm, 2012). This virtual space enabled interaction to take place: students stayed active in their learning by sharing and collaborating with others (Tunks, 2012; Li et al., 2018). In addition, by using multiple devices in virtual classes, students had to experience a variety of technological tools, which they then effectively used to complete tasks and assignments throughout the semester. Such technological skills students learnt during class will likely be used for other learning activities or in their future careers (Ellingson & Notbohm, 2012; Rudd & Rudd, 2014).

Data show that features of Zoom that students found most useful were teacher-student interactions, screen-sharing, and chatroom (Table 6.1); students were allowed to select more than one feature. Synchronous interaction between teachers and students increased learning engagement (Acosta-Tello, 2015). The chatroom function in Zoom worked in similar ways as social media applications would in that it shortened distance between instructors and learners (Prescott et al., 2013; Rambe & Bere, 2013; Barhoumi, 2015; Naidoo & Kopung, 2016; So, 2016; Sobaih et al., 2016). The instructors of this course maintained effective communication to enhance learning, an approach much recommended by Rodriguez-Keyes et al. (2013).

In terms of students' response towards the sudden change in learning environment (from a physical classroom to a virtual space), the researchers observed a drastic change in students' perception towards learning on Zoom during the length of the course. The same set of questions were asked twice, three months apart in between. In early February, almost half of the class disagreed or strongly disagreed with taking class on Zoom, and 39 percent felt neutral towards taking class on Zoom. Only 14

Table 6.1 Students' preference of Zoom features

#	Feature	Count
1	Teacher-student interactions during class meetings	350
2	Screen sharing	301
3	Chatroom	211
4	Screen recording	169
5	Reaction buttons	162
6	Breakout room	120
7	Poll	89

percent of the students agreed or strongly agreed with the use of Zoom (Fig. 6.2); they indicated that they would like to see other teachers use Zoom.

In late April, researchers found that students' negative perception towards taking class on Zoom dropped to a mere 15 percent while nearly 50 percent agreed or strongly agreed with using this cloud-based application in learning. Neutrality stood at 37 percent, which suggested that there were still mixed feelings towards learning in a virtual space (Fig. 6.3).

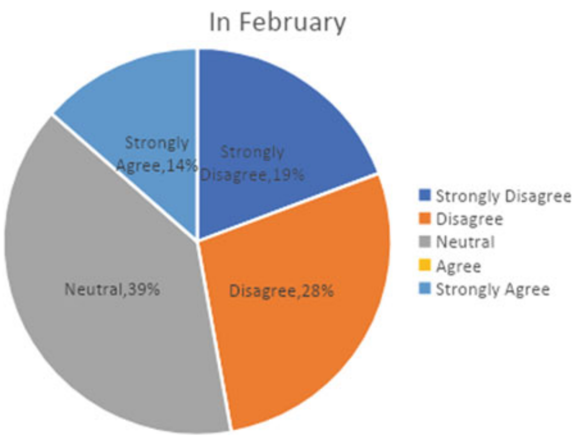


Fig. 6.2 Students' perception towards taking class on Zoom teaching (early February)

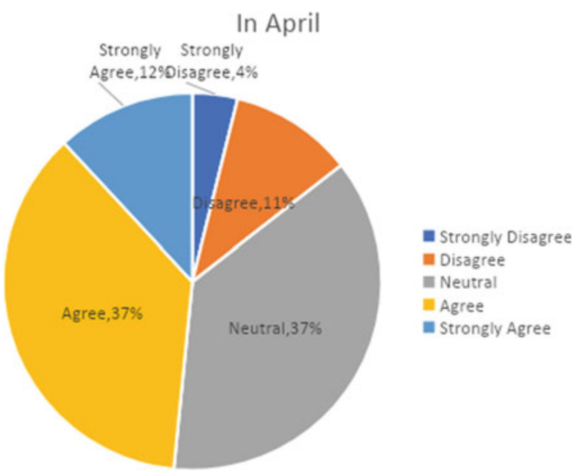


Fig. 6.3 Students' perception towards taking class on Zoom teaching (late April)

6.5.3 Learning Space—Collaborative Online Learning

The abrupt change of learning space surprised many, if not all, students. Undoubtedly, students encountered changes in their learning experience. Researchers asked students whether or not they were able to, in this course, work with other students to set goals and make plans for the group, and whether or not they were able to finish the learning tasks with partners and group-mates. Again, the same set of questions were asked twice, three months apart in between. In early February, researchers found that a whopping 94 percent of students neither agreed nor disagreed with the fact that working on collaborative online learning tasks (setting goals, making plans, and finishing tasks set for pair work and group work alike) was possible. Only 5 percent agreed or strongly agreed that online collaboration with peers was possible (Fig. 6.4). Most of the students at this stage did not know each other and more than 300 were present in any one single Zoom session. However, researchers found a drastic change two months later. In late April, nearly 50 percent of the students agreed or strongly agreed with the fact that working on collaborative online learning tasks was possible; at the same time 47 percent of the students still remained neutral towards collaborative online learning tasks (Fig. 6.5). This might be related to the university's policy change on attendance policy, which will be discussed later.

Interviews with the focus group (35 interviewees) further strengthened the data above: students in general welcomed the opportunities of conducting collaborative online learning tasks. A good handful of students in the focus group preferred the online model. Through collaborating online with their peers, students enjoyed and partook in interactive presences identified in the CoI model of learning engagement, in particular, social presence, which is crucial to enabling individual students to connect and identify with their peers (Garrison et al., 2001). The majority of students spoke positively about "working together with classmates online." Many of them used the phrase "sense of belonging" or the word "comfortable" when speaking

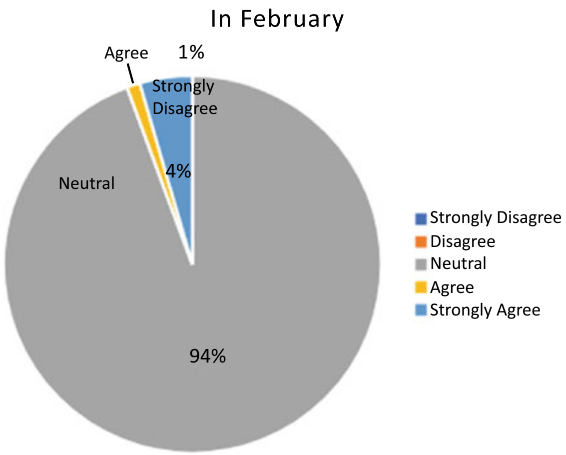


Fig. 6.4 Students' attitude towards the feasibility of collaborative online learning tasks (early February)

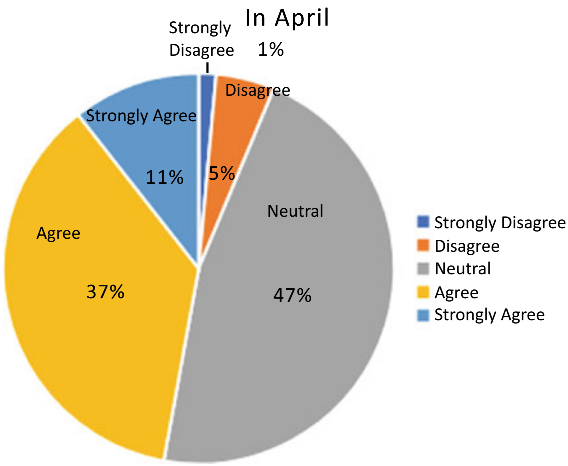


Fig. 6.5 Students' attitude towards the feasibility of collaborative online learning tasks (late April)

about learning with their peers online. Only very few indicated that they missed in-class and face-to-face interactions with peers and instructors. Students expressed that they could adapt to online learning quickly. When asked about difficulties they had encountered during online class, many students reported very few problems or no problem. Others claimed that they had problems which they were able to solve on their own; for example, talking with their peers, contacting teaching assistants, looking for answers online, watching DIY videos on YouTube. One student asserted that "some theory-based classes should be made available online at all times. Then, we can access them whenever we want and repeat the parts we do not understand" [*sic*]. One further observation from the focus group was that all participants agreed that practice-based courses, such as laboratory work and physical education, should be conducted in person, for obvious reasons.

6.5.4 Chatroom—Learning Engagement and Meaning Making

The use of chatroom in the chosen video-conferencing tool indicated a positive relationship between technology and student engagement (Chen et al., 2010; Henrie et al., 2015; Webb et al., 2017; Li et. al., 2018). During class meetings, communication simultaneously took place in the chatroom when questions were posed at various points by the instructors. For instance, in the early weeks of this course, short stories were read and fundamentals of creative writing were discussed. Figure 6.6 shows students' chat log (of a mere 25-s window) in response to a short class task: "What is a story?".

In this activity, the chatroom function in the video-conferencing tool was utilized to promote active learning among the students (Bates & Poole, 2003; Vries & Mottier

16:07:02 From [redacted] The story has beginning and ending, plot and characters
16:07:02 From [redacted] : A story is the expression of some things or events
16:07:03 From [redacted] : own by yourself
16:07:05 From [redacted] : the events as described by him
16:07:05 From [redacted] : mush have magical elements
16:07:05 From [redacted] : story can real or fake
16:07:06 From [redacted] : a story must has a person or people and his feeling
16:07:06 From [redacted] : A story is about imaganation
16:07:06 From [redacted] : Have miningful
16:07:07 From [redacted] : story is something that can tell others what you going through
16:07:07 From [redacted] : talking about something that meaningful
16:07:07 From [redacted] story required characters, events and the main theme.
16:07:07 From [redacted] a story is a experience
16:07:08 From [redacted] : Someone's life
16:07:08 From [redacted] : is about someone or something
16:07:09 From [redacted] something happened, a process....
16:07:10 From [redacted] : experience place character
16:07:10 From [redacted] : story is a voice to say people's ideas
16:07:10 From [redacted] : A story should be meaningful.
16:07:10 From [redacted] : A story is about beinging process ending
16:07:10 From [redacted] s. Mallard was afflicted with a heart trouble, and told
16:07:11 From [redacted] : the meaning of story is talking about someone experience or something happen
16:07:11 From [redacted] : a story including the character and what you want to tell
16:07:11 From [redacted] someone affect myself
16:07:11 From [redacted] : it's something
16:07:12 From [redacted] : something happened, a process
16:07:12 From [redacted] : something happened
16:07:14 From [redacted] : a sad story.
16:07:14 From [redacted] : description, either true or imagined of an event
16:07:15 From [redacted] : a story is expressing something happened
16:07:15 From [redacted] : beginning middle part ending
16:07:15 From [redacted] : An imagination with characters and some scenarios
16:07:15 From [redacted] : The story is about the experience
16:07:15 From [redacted] story is a piece of creativity thing
16:07:16 From [redacted] : Fake or real
16:07:18 From [redacted] : beginning process and the end
16:07:18 From [redacted] : An experience of happiness
16:07:19 From [redacted] : The combination of imagination and recording.
16:07:19 From [redacted] : This story makes sense
16:07:19 From [redacted] ry is an experience.
16:07:19 From [redacted] : something
16:07:19 From [redacted] ion or non-fiction of an event for entertainment.
16:07:20 From [redacted] : strory is a script to tell everyonr what is your experience, it can be un real or happen in the reality
16:07:20 From [redacted] : a story contains a setting, people, something happened like a conflict
16:07:22 From [redacted] : a story is a creative thing based on reality.
16:07:22 From [redacted] : a story of experience
16:07:22 From [redacted] story of love
16:07:22 From [redacted] : Story is a script that fake or real
16:07:23 From [redacted] : a story is about a part of life
16:07:24 From [redacted] : A story has ups and downs.
16:07:25 From [redacted] : maybe someone experience
16:07:25 From [redacted] : A story is about an experience of someone or something, it can be imaginary or real.
16:07:25 From [redacted] : a statement of a experience or a memory
16:07:25 From [redacted] story life
16:07:25 From [redacted] : story is telling an even, experience.
16:07:25 From [redacted] : A description , either true or imagined
16:07:26 From [redacted] : a description of a connected series of events
16:07:26 From [redacted] Someone's experience or live
16:07:26 From [redacted] ing, conflict, ending
16:07:26 From [redacted] : A story is a message that tells particular of an act or occurrence of events
16:07:27 From [redacted] story is imagination or fact you told others
16:07:27 From [redacted] : Meaning for someone
16:07:27 From [redacted] : the message about Kate

Fig. 6.6 An excerpt from the chat log from in-class activity "What is a story?"

2006; Martin & Ertzberger, 2013; Bernard et al., 2014), who showed active participation and enthusiasm. Figure 6.6 shows the diversity of responses and the uniqueness therein, from tentative attempts to giving simple definitions to budding ventures to relate to one's personal experience. Student responses indicate that the activity participants were willing and ready to carry out their own independent learning process. Technology enabled all participating students to "speak" at the same time by sending in their responses without having to "wait in line" as they would have done if they were participating in discussions in a physical classroom. This finding affirmed the role of chat during video-conferencing (Bates & Poole, 2003; Martin & Ertzberger, 2013). By referring to chat logs automatically generated, the instructors could monitor students' understanding and students could view and review their peers' responses.

From "what is a story" to "what makes a story a story," one of the instructors introduced the concept of how characters, perspective, and interpretation—key elements of a short story—contributed to the construction of a story with a twist (Kate Chopin's 'The Story of an Hour', in this case). To better prepare students in their understanding of the concept "perspective," the instructor designed a simple activity. She held a water bottle in her right hand and asked students what they saw (Fig. 6.7). Responses

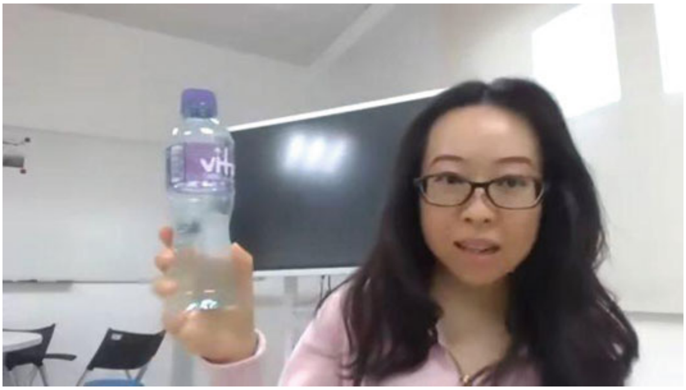


Fig. 6.7 Instructor holding a water bottle

containing straight-up facts and anthropomorphic expressions of the water bottle and beyond poured in within seconds (Figs. 6.8 and 6.9).

When the instructor asked the question "What do you see", responses poured into the chatroom instantaneously and simultaneously. The volume of chat messages was so substantial that it went on for a few minutes. This high level of engagement reflects students' perception of teacher presence in their education, which is essential for students' active participation in online courses (Garrison et al., 2001; Rodriguez-Keyes et al., 2013). Interviews with students also generated similar responses. One student said:

> I love the instant chat room because I got to see all others' thoughts. Some are really interesting and I have never thought about it. This gives everyone an equal opportunity to express themselves. [sic]

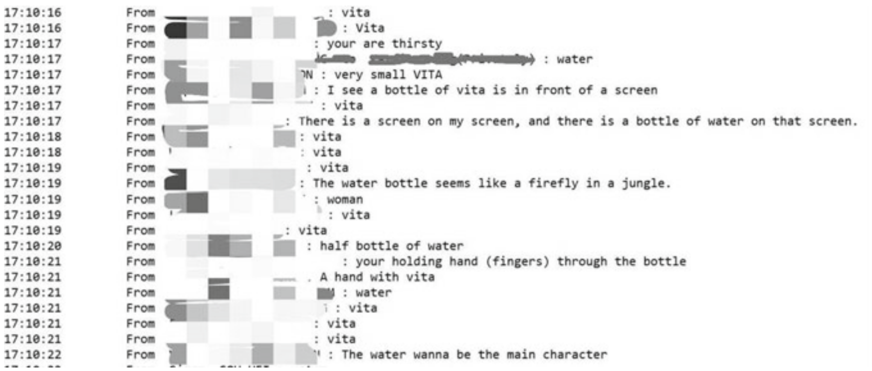
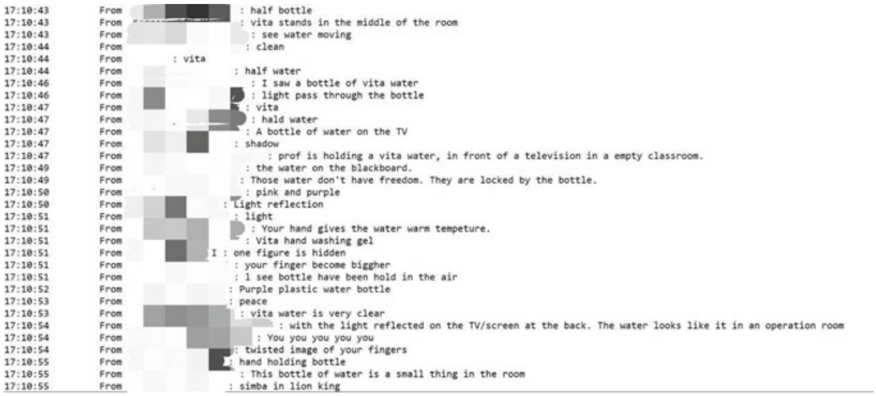

17:10:16 From [redacted] : vita
17:10:16 From [redacted] : Vita
17:10:17 From [redacted] : your are thirsty
17:10:17 From [redacted] : water
17:10:17 From [redacted] : very small VITA
17:10:17 From [redacted] : I see a bottle of vita is in front of a screen
17:10:17 From [redacted] : vita
17:10:17 From [redacted] : There is a screen on my screen, and there is a bottle of water on that screen.
17:10:18 From [redacted] : vita
17:10:18 From [redacted] : vita
17:10:19 From [redacted] : vita
17:10:19 From [redacted] : The water bottle seems like a firefly in a jungle.
17:10:19 From [redacted] : woman
17:10:19 From [redacted] : vita
17:10:19 From [redacted] : vita
17:10:20 From [redacted] : half bottle of water
17:10:21 From [redacted] : your holding hand (fingers) through the bottle
17:10:21 From [redacted] . A hand with vita
17:10:21 From [redacted] : water
17:10:21 From [redacted] : vita
17:10:21 From [redacted] : vita
17:10:21 From [redacted] : vita
17:10:22 From [redacted] : The water wanna be the main character

Fig. 6.8 An excerpt from the chat log from in-class activity involving a water bottle held by the instructor



17:10:43 From [redacted] : half bottle
17:10:43 From [redacted] : vita stands in the middle of the room
17:10:43 From [redacted] : see water moving
17:10:44 From [redacted] : clean
17:10:44 From [redacted] : vita
17:10:44 From [redacted] : half water
17:10:46 From [redacted] : I saw a bottle of vita water
17:10:46 From [redacted] : light pass through the bottle
17:10:47 From [redacted] : vita
17:10:47 From [redacted] : hald water
17:10:47 From [redacted] : A bottle of water on the TV
17:10:47 From [redacted] : shadow
17:10:47 From [redacted] : prof is holding a vita water, in front of a television in a empty classroom.
17:10:49 From [redacted] : the water on the blackboard.
17:10:49 From [redacted] : Those water don't have freedom. They are locked by the bottle.
17:10:50 From [redacted] : pink and purple
17:10:50 From [redacted] : light reflection
17:10:51 From [redacted] : light
17:10:51 From [redacted] : Your hand gives the water warm tempeture.
17:10:51 From [redacted] : Vita hand washing gel
17:10:51 From [redacted] I : one figure is hidden
17:10:51 From [redacted] : your finger become bigger
17:10:51 From [redacted] : 1 see bottle have been hold in the air
17:10:52 From [redacted] : Purple plastic water bottle
17:10:53 From [redacted] : peace
17:10:53 From [redacted] : vita water is very clear
17:10:54 From [redacted] : with the light reflected on the TV/screen at the back. The water looks like it in an operation room
17:10:54 From [redacted] : You you you you you
17:10:54 From [redacted] : twisted image of your fingers
17:10:55 From [redacted] : hand holding bottle
17:10:55 From [redacted] : This bottle of water is a small thing in the room
17:10:55 From [redacted] : simba in lion king

Fig. 6.9 Another excerpt from the chat log from in-class activity involving a water bottle held by the instructor

Another student added:

> It's fun to get my words out. The chatroom pages flip so fast as if we were in games. So many were in the game and we were on. I even compete with others on many different thoughts we could put in. It makes me think harder. [sic]

"What do you see?", an activity that introduced students to perspective, was followed by an activity "joy that kills", an activity that prompted students to exercise their interpretation of the story in question, "The Story of an Hour." Figs. 6.10 and 6.11 show that students actively participated in an activity in which they were asked to evaluate the last three words of "The Story of an Hour"—"joy that kills"—and to relate the three words to Mrs. Mallard, the main character of the story. The full sentence in which the three words are situated reads as such: "When the doctors came they said she had died of heart disease—of joy that kills." While many simply took the final sentence of the story on face value (granted, the majority of the class did not have proper training in literary studies), some managed to produce synthetic responses by looking at the whole psychological journey of Mrs. Mallard. To facilitate readers' appreciation of this activity and the data presented in Figs. 6.10 and 6.11, here is a summary of what happens to Mrs. Mallard in the story: the story starts with Mrs. Mallard's grief at the news of her husband's death, and it then narrates her newfound desire for freedom as a widow and her ecstatic realization of her newly-acquired freedom that awaits her now that she is a widow, and, eventually, the story concludes with her utter disappointment and subsequent death on seeing her husband coming home, alive and unharmed. Story comprehension, instructor-student interaction, and student chats all took place at the same time. These synchronous elements in this virtual classroom promoted levels of student engagement (Acosta-Tello, 2015). The student comment, "panic and surprise," sent at 16:34:48, is indicative of that particular student's comprehension and interaction with the learning material. Many comments sent prior to this one contain simply "heart disease," which was not an apt response to the question posed, but these comments did not make this particular student deviate

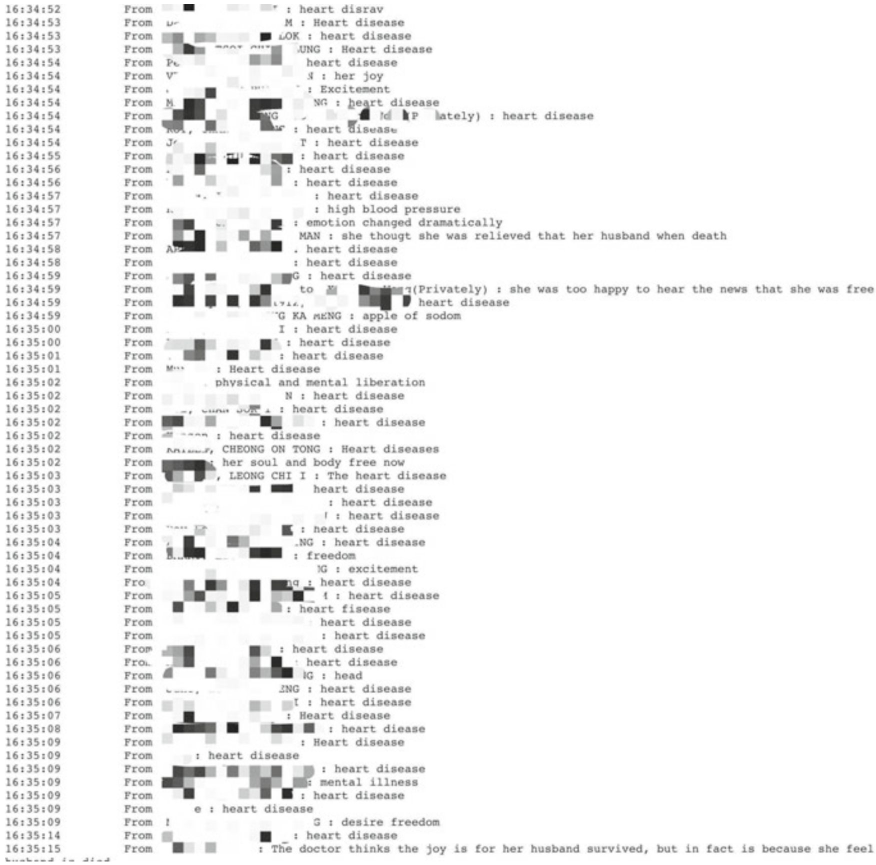
16:34:44	From [redacted]	: surprising reality
16:34:44	From [redacted]	: neart disease
16:34:44	From [redacted]	: heart disease
16:34:45	From [redacted]	: Very excited so heart attack
16:34:45	From [redacted]	: the heart
16:34:45	From [redacted]	: heart disease
16:34:46	From [redacted]	: heart disease
16:34:46	From [redacted]	: future MAYBE
16:34:46	From [redacted]	: heart disease
16:34:46	From [redacted]	: Heart disease
16:34:47	From [redacted]	: neart disease
16:34:47	From [redacted]	: Heart disease
16:34:47	From [redacted]	: heart disease
16:34:48	From [redacted]	: heart disease
16:34:48	From [redacted]	heart fisease
16:34:48	From [redacted]	Heart disease
16:34:48	From [redacted]	
16:34:48	From [redacted]	panic and surprise
16:34:48	From [redacted]	: heart disease
16:34:49	From [redacted]	: heart attack caused by the enormous joy of freedom
16:34:49	From [redacted]	: heart disease
16:34:49	From [redacted]	: heart disease
16:34:49	From [redacted]	: heart disease
16:34:50	From [redacted]	: The war and wanting for the democratic
16:34:50	From [redacted]	: heart disease
16:34:50	From [redacted]	: heart disease
16:34:51	From [redacted]	e
16:34:51	From [redacted]	: heart disease
16:34:51	From [redacted]	: heart disease
16:34:51	From [redacted]	: heart disease
16:34:51	From [redacted]	: Heart disease
16:34:51	From [redacted]	: Heart disease
16:34:52	From [redacted]	. Very excited so heart attack
16:34:52	From [redacted]	heart disease

Fig. 6.10 An excerpt from the chat log from in-class activity regarding "joy that kills."

from his or her own interpretation of the story. Similarly, one of the lines sent at 16:34:57 reads "emotion changed dramatically," showing that the respondent carried out their own independent learning process, unfazed and unswayed.

6.5.5 Learning Engagement and Constructionism

Other in-class activities, including discussions and debates, were designed to engage students in active meaning construction, a critical component in helping students succeed in online learning (Banna et al., 2015; Britt et al., 2015). "Innovation & Creativity" can demonstrate how meaning construction took place. In one online class meeting, students were asked to read selected narratives of three international corporations (Walmart, Starbucks, and Apple). Based on the concepts of innovation and creativity introduced by the instructors, students had to engage in active meaning construction and idea creation, a process through which students developed new understandings of the concepts of innovation and creativity and gained further insights on how these international corporates succeed in their business models. The activity generated a high level of engagement, as can be seen from student responses. Here are two sample responses.



```
16:34:52 From [redacted] : heart disrav
16:34:53 From [redacted] : Heart disease
16:34:53 From [redacted] : heart disease
16:34:53 From [redacted] : Heart disease
16:34:54 From [redacted] heart disease
16:34:54 From [redacted] : her joy
16:34:54 From [redacted] : Excitement
16:34:54 From [redacted] : heart disease
16:34:54 From [redacted] ately) : heart disease
16:34:54 From [redacted] : heart disease
16:34:54 From [redacted] : heart disease
16:34:55 From [redacted] : heart disease
16:34:56 From [redacted] : heart disease
16:34:56 From [redacted] : heart disease
16:34:57 From [redacted] : heart disease
16:34:57 From [redacted] : high blood pressure
16:34:57 From [redacted] : emotion changed dramatically
16:34:57 From [redacted] : she thougt she was relieved that her husband when death
16:34:58 From [redacted] . heart disease
16:34:58 From [redacted] : heart disease
16:34:59 From [redacted] : heart disease
16:34:59 From [redacted] to [redacted] (Privately) : she was too happy to hear the news that she was free
16:34:59 From [redacted] heart disease
16:34:59 From [redacted] : apple of sodom
16:35:00 From [redacted] : heart disease
16:35:00 From [redacted] : heart disease
16:35:01 From [redacted] : heart disease
16:35:01 From [redacted] : Heart disease
16:35:02 From [redacted] physical and mental liberation
16:35:02 From [redacted] : heart disease
16:35:02 From [redacted] : heart disease
16:35:02 From [redacted] : heart disease
16:35:02 From [redacted] : heart disease
16:35:02 From [redacted] : Heart diseases
16:35:02 From [redacted] her soul and body free now
16:35:03 From [redacted] : The heart disease
16:35:03 From [redacted] heart disease
16:35:03 From [redacted] : heart disease
16:35:03 From [redacted] : heart disease
16:35:03 From [redacted] : neart disease
16:35:04 From [redacted] : heart disease
16:35:04 From [redacted] : freedom
16:35:04 From [redacted] : excitement
16:35:04 From [redacted] : heart disease
16:35:05 From [redacted] : heart disease
16:35:05 From [redacted] : heart fisease
16:35:05 From [redacted] heart disease
16:35:05 From [redacted] : heart disease
16:35:06 From [redacted] : heart disease
16:35:06 From [redacted] heart disease
16:35:06 From [redacted] : head
16:35:06 From [redacted] : heart disease
16:35:06 From [redacted] : heart disease
16:35:07 From [redacted] : Heart disease
16:35:08 From [redacted] : heart diease
16:35:09 From [redacted] : Heart disease
16:35:09 From [redacted] : heart disease
16:35:09 From [redacted] : heart disease
16:35:09 From [redacted] : mental illness
16:35:09 From [redacted] : heart disease
16:35:09 From [redacted] : heart disease
16:35:09 From [redacted] : desire freedom
16:35:14 From [redacted] : heart disease
16:35:15 From [redacted] : The doctor thinks the joy is for her husband survived, but in fact is because she feel
```

Fig. 6.11 Another excerpt from the chat log from in-class activity regarding "joy that kills."

Student A's response:

> Apple belongs to both creativity and innovation. Apple is not only making products such as hardware and software for people, but also reform and add new things such as function and converge many ideas to one whole product that lead to "innovation" that can be implemented. Walmart belongs to "creativity" because of its strategies on pricing for consumers by developing cost structures, using advanced inventory technology, and managing supply chains. Starbucks belongs to "creativity" because there are many coffee stores. Yet, Starbucks creates an upper-scale cultural atmosphere that makes people happy and comfortable. [sic]

Student B's response:

> Apple is an example of both creativity and innovation. The iPhone combines Books, music, phone, etc. Steven Jobs is able to combine existing tools together to make something new and great. That also applies to his creation of the Macintosh personal computer and IOS operating system later on. (MITS Altair 8800). Walmart is also an example of both creativity and innovation. It is not the first supermarket in the world, but it has improved and upgraded

> the old model of the supermarket. It creates the model of Best Price Modern Wholesale. And now, it transformed itself to compete with Amazon (online stores). Starbucks is creative because it changes the buying habit of people. Starbucks makes their customers feel like they are not buying a cup of coffee but a lifestyle or a social status. People will not come to Starbucks if they just want a cup of coffee. [sic]

Student B's response was similarly situated as Student A's, yet it went further than Student A's evaluation and offered further observation and conjecture which showed that Student B had acquired a broader understanding of the concepts of "innovation" and "creativity." This online, synchronous learning space stimulated and enabled participants to discover nuances, synthesize different observations, and thus create further, more complex ideas. Through sharing and discussing online, students ventured beyond boundaries of their critical thinking and creative imagination. It was observed that once students became interested in a topic, their curiosity was activated, and so was their level of engagement. Some students finished and submitted their response in class while others did so after class, testifying to active engagement in both synchronous (in-class online debate and chatroom) and asynchronous (project submitted after the class) activities (Acosta-Tello, 2015). Meanwhile, in the process of reading (understanding), chatting (understanding and explaining), and writing (evaluating and synthesizing), students were engaged in exercising both their lower-order and higher-order thinking skills, and they were able to construct meanings and verbalize the ideas thus created in their own process of meaning making (Papert & Harel, 1991).

6.5.6 Learning Engagement and Mobile Device

In the assignment "Creative Frame," students were asked to capture an image with their mobile device. More than half of the focus group students commented that it was a brand new experience for them since the instructors specifically asked them to complete assignments with mobile devices. Students reported to have willingly spent time on taking various photographs with ideas and skills related to creativity imparted during the course. In this assignment, students were encouraged to realign or reassemble items and adjust the angle, space, or time setting to convey new meanings in a creative manner; they were, however, not allowed to use automatic filters or special effects in the process. Students worked with existing materials, deconstructed meaning components therein, and then re-compiled, re-constructed, and created new meanings for their newly assembled images. Such active processes enabled students to develop new understanding of the concepts of innovation and creativity and gain further insights on how seemingly unrelated items could generate new meanings. One student said:

> "It was really fun taking pictures with my photo. Even my photographer teacher did not let us do so. Why not? It's with us and in our lives" [sic]. Another student commented similarly: "When I heard that Prof. told us to take photos and submit them for marks, I could not believe it. First time I got such a request! My friend and I spent so much time trying to

capture creative moments. It was cool but we spent way too much time. Definitely more than I expected" [sic].

Mobile devices enhanced students' learning experiences in this assignment of "Creative Frame", which testified to the findings of Henderson et al. (2017). Mobile devices boosted student learning engagement through online collaboration, be it through chats or submissions of group work (Li et al., 2018). Researchers in this study also observed that with mobile devices, students were engaged in the construction of something meaningful for and shareable with their peers (Papert & Harel, 1991). The use of technology and student engagement were inseparable as various studies have concluded (Chen et al., 2010; Henrie et al., 2015; Webb et al., 2017). To further its positive impact on learning, multiple mobile devices applications were utilized simultaneously to encourage more collaborations (Bates & Poole, 2003; Vries & Mottier, 2006; Martin & Ertzberger, 2013; Bernard et al., 2014). Students were prompted to become creative when they became engaged in this hands-on task. Students shared their works with the whole class via share-screen function, which allowed everyone in the course to witness and experience various ways to frame an image creatively. The researchers detected excitement on the students' faces and in their exclamatory texts in the chatroom, prompted by their interaction with various products from this assignment. In other words, newly-constructed meanings were resulted from what was seen, heard, and shared. Figures 6.12, 6.13 and 6.14 are

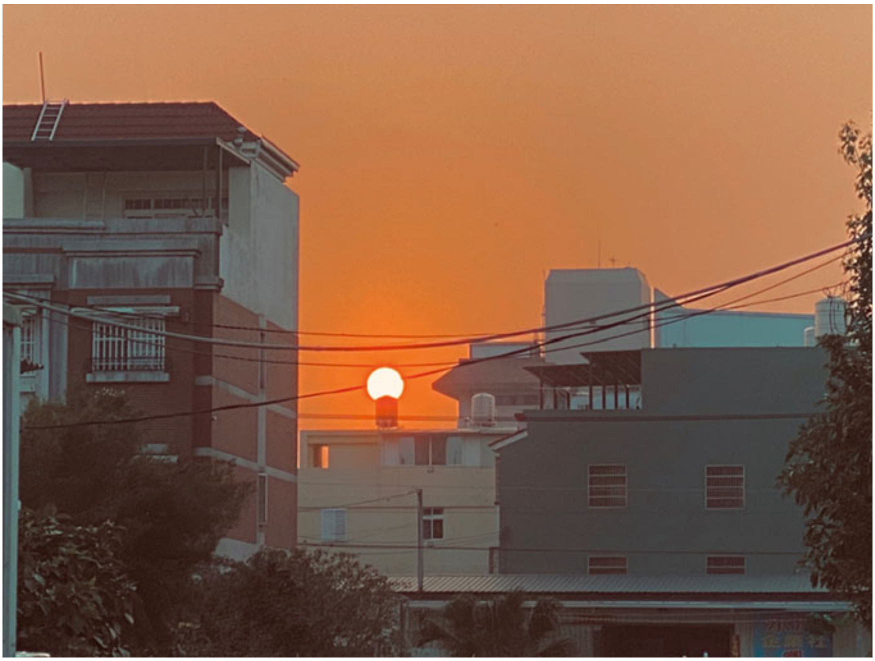


Fig. 6.12 Sunset light bulb

Fig. 6.13 Smile

Fig. 6.14 Leap into the birthday present

some of the "Creative Frame" products students shared during class meetings (titles of the images are kept unedited).

6.6 Limitation and Conclusion

This study has several limitations. The sample size is relatively small (374 participants). The types of technology used and discussed are limited. The period of study is short (15 weeks). There was no control group as the period of study coincided with the first time that the course was offered as a General Education course at the institution. Owing to these limitations, readers should interpret the results presented with caution because results may have limited generalizability and applicability in different settings and contexts. Nonetheless, this study shares insights and new understandings on learning engagement in the context of student creativity facilitated by the use of technology during COVID-19 pandemic. It shows that within virtual classroom environments, the chosen technology afford various interactive functions which enhance learning engagement and subsequently students' active meaning construction. Students are willing to explore new technologies and they are ready for such learning models. The authors echo that quick transitions from face-to-face to the online model of teaching and learning can prove to be effective and it can be applied in the future (Basilaia & Kvavadze, 2020). Learning engagement in technology-present and technology-enhanced teaching and learning depends on how technologies are used in the classroom (virtual or face-to-face); how projects and activities are carried out; and whether or not these tasks are relevant to the students. Findings of this study contribute to the existing literature on learning engagement, collaborative learning in online education, and teaching and learning innovation.

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Chapter 7
Competency-Based Workplace Learning and Assessment: A Framework and Models for Future Research

Benson K. H. Hung, Jacky F. Wen, Catter C. N. To, and Jimmy S. M. Tang

Abstract Workplace Learning and Assessment (WLA) is broadly linked to the wider assessment for learning movement and is simply an effective use of educational measures. From this perspective, this assessment method may have enabled a better engagement with knowledge and demonstrated competency. However, there is a lack of research on workplace assessment due to insufficient recognition of workplace learning. This paper presents a review of research on development and strategies for competency-based WLA in the education context of the workplace setting. More importantly, we present a framework and models for the assessment of workplace learning by empirical method based on research and upon experiences of vocational training in WLA implementation. The framework and models are the starting point for a set of propositions regarding how the discontinuity in assessment between schools-based and workplaces can be connected. The propositions provide the impetus for a research agenda that identifies critical issues in learning and assessment in workplace.

Keywords Workplace learning · Workplace assessment · Competence · Framework · Models

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7.1 A Revolution in Assessment Principles

The pandemic has dramatically accelerated a growing shift to coursework-based assessments in which we decry the leniency of grades is socially unproductive. Grade inflation is most likely even worse due to COVID-19. Traditional tests and exams provide a rigorous form of assessment that remain deeply ingrained in higher education of assessment for learning. Time-limited, unseen test and exams are a narrow and formulaic engagement with knowledge.

From this perspective, a different assessment method may have enabled a better engagement with knowledge. The fundamental assessment principles have to be rethought and the workplace is a learning site should be recognized. Workplace Learning and Assessment (WLA) is broadly linked to the wider assessment for learning movement and is simply an effective use of educational resources. A reform of WLA has become popular and is often touted as the way ahead for relevant and robust assessment. WLA seeks to ensure that the ways we assess students focuses on future relevance and the ways they will need to apply the knowledge learned.

The purpose of this article is to propose an integrated framework that enables adaptive curricula with a suitable integration of workplace learning and workplace assessment. It examines WLA structures with local and oversea experiences in the context of understanding the roles and purposes of assessment and workplace learning. The framework and propositions provide the impetus for a research agenda that identifies critical issues in WLA.

7.2 Literature Review

WLA comes at a time when higher education institutes are urged to cope with changing demands from our emerging knowledge societies. Despite assessment being an important part of learning process, there is limited literature on workplace assessment due to a lack of recognition of learning that takes place in the workplace (Vaughan, 2009). In particular, there is very little international and New Zealand research on learning and assessment in on the job settings.

Hager (2004a) suggests that learning is inherently contextual and the main outcome of learning is the creation of a new set of relations in an environment. Concepts include Learning as Acquisition, Learning as Participation (Sfard, 1998), Learning as Co-construction (Felstead et al., 2009), and Learning as Action (Tynjälä, 2008) feature practice-based and authentic learning that are often collaborative. Workplace learning is described as a process which is informal, incidental and practice-bound, based on experience, shaped by the work tasks and context in which the learning takes place, and is shared with internal and external work teams and communities (Collin, 2006; Virtanen et al., 2009). Figure 7.1 highlights the forms of learning following the Organization for Economic Cooperation and Development definitions (Doyle et al., 2009; Misko, 2008). Formal learning is learning in courses

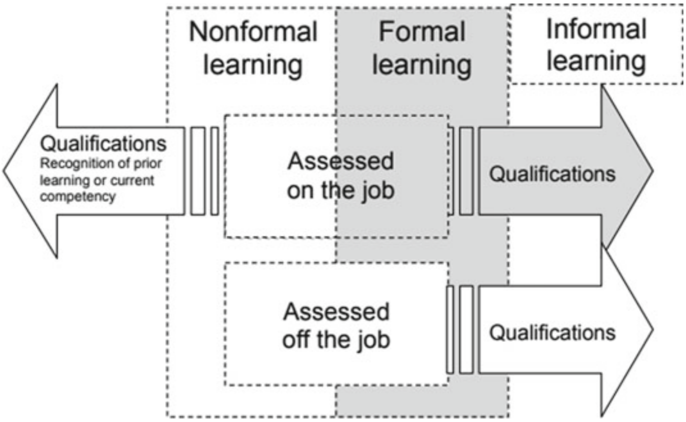

Fig. 7.1 Pathways for workplace-related learning and assessment

or programmes leading to nationally and internationally recognized qualifications; nonformal learning is learning that occurs in structured programmes but does not lead to accredited final qualifications; and informal learning—learning acquired through everyday work and life.

There are different models of workplace learning assessment used around the world, and among all, Industry Training Organizations (ITOs) in New Zealand are set up by industry but recognized by government. They coordinate training on behalf of those industries, but also involve many other parties, including education and training providers, funders and government. The Associate Minister of Education (Tertiary Education) under the Industry Training Act 1992 recognizes ITOs and ITOs can assist in gaining qualifications listed on the New Zealand Qualifications Framework. In New Zealand, workplace assessors may be ITO-based, business staff members accredited to assess their own staff, or trainers/tutors. Individual New Zealand workplace assessors have different affiliations and may or may not combine assessment with training. Figure 7.2 illustrates the role and affiliation combinations in New Zealand.

In Hong Kong, the Vocational Training Council (VTC) introduced the concept of WLA in 2018 to enhance learning and training outcomes. WLA aims at integrating learning and practice to gauge the practical skills of students and their ability to utilize professional knowledge. Employers could provide trainees with constructive feedback to enhance their work performance and professionalism. Figure 7.3 provides details on the roles and functions of different parties in WLA of VTC.

Workplace assessment involves the collection and evaluation of evidence about a trainee's performance. The assessment activities translate the requirements of the unit standard into action that can be assessed. Evidence is data that collectively proves a trainee can (or cannot) be judged competent in a unit standard. The supporting evidence may include verified documents, verified photographs and/or videos, and other types of supporting evidence to show demonstrated knowledge relating to

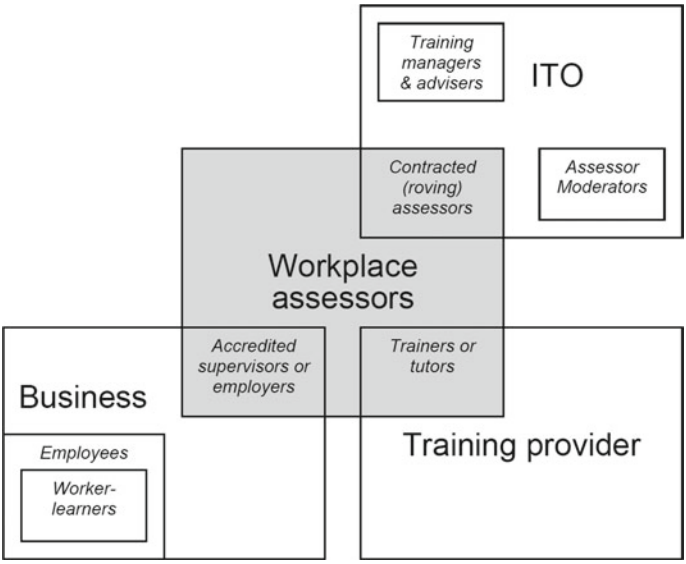

Fig. 7.2 Workplace assessor affiliations and roles in New Zealand

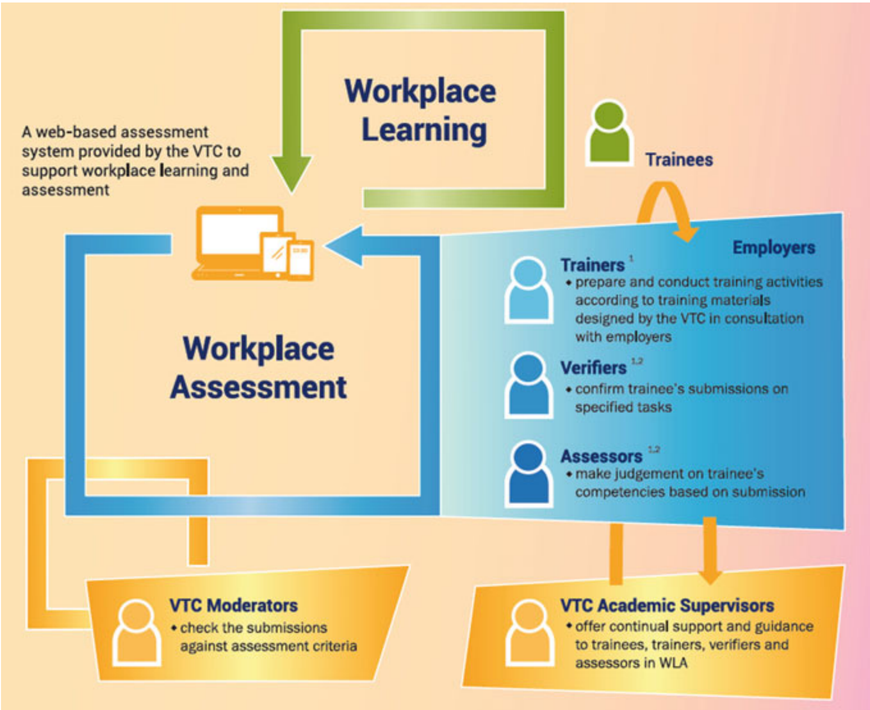

Fig. 7.3 Workplace learning and assessment with roles and functions in VTC, Hong Kong

assessment. Competence is not only about completing a task, but also doing it "to an appropriate standard" (Gonczi, 1999) or "to the expected standards" (Eraut, 2003). This relationship between work and competence has been acknowledged by the national competency-based training systems in Australia and the United Kingdom. National Quality Council (2010) states that competency is the consistent application of knowledge and skill to the standard of performance required in the workplace. Carroll and Boutall (2011) also mention that people need skills to be competent, but competence is about applying skills and knowledge to achieve a work function.

7.3 Delivery of Assessment in the Workplace

Vocational and Professional Education and Training (VPET) in Hong Kong plays a pivotal role in the education system by providing multiple and flexible pathways for young people with diverse aspirations and abilities. The development of WLA in VTC programmes includes both school-based learning and workplace learning. While school-based learning is characterized by formal structures and guided by aims in the curricula, workplace learning is often informal, incidental and directed by the daily work-tasks. In this sense, WLA explores student perceptions of a wide range of learning and assessment experiences. Apart from school-based learning in the forms of workshops, seminars and relevant activities arranged by academic supervisor, workplace training and workplace assessment play key roles in the WLA delivery by providing workplace coaching, meeting and relevant activities arranged by workplace mentor and verification/assessments by workplace mentor.

Assessment in workplace learning is mainly formative and different stakeholders including trainees, academic supervisors and workplace instructors are involved in the assessment. A close cooperation between all stakeholders is essential in order to enhance trainees' capabilities and enable them to become more work-ready with the professional knowledge and industry-relevant skills required by the employers. VTC WLA integrates structured classroom learning with on-the-job training, providing young people with a clear career progression pathway and preparing them to join those trades and industries with great manpower demand. WLA is flexibly designed to cater for specific needs of industries through an all-round apprenticeship training. In addition to classroom learning, participants will also receive on-the-job training from their employers. Graduates can also opt to pursue further studies to acquire higher academic qualifications, making progress both in their career and in studies.

7.4 Models of Assessment for Workplace Learning

Delivery of workplace assessment involves a complete process of assessing skills, knowledge and attributes of a trainee on the job in an authentic workplace. Real-time, authentic, reliable and valid evidence should be collected and recorded to demonstrate trainees' competences according to unit standards. The process is a form of competency-based assessment for trainees to provide evidence that tasks are completed as set in the standards in a consistent manner. Figure 7.4 shows the WLA framework and the corresponding responsibility of various stakeholders.

New Zealand has launched workplace assessment, which is jointly implemented by the government, recognised professional organisations and various industry training organisations, for years. The WLA system in New Zealand adopts a "70:20:10 model" to ensure a suitable balance between workplace and classroom-based delivery and assessment. In which, 70% on-the-job learning is acquired via

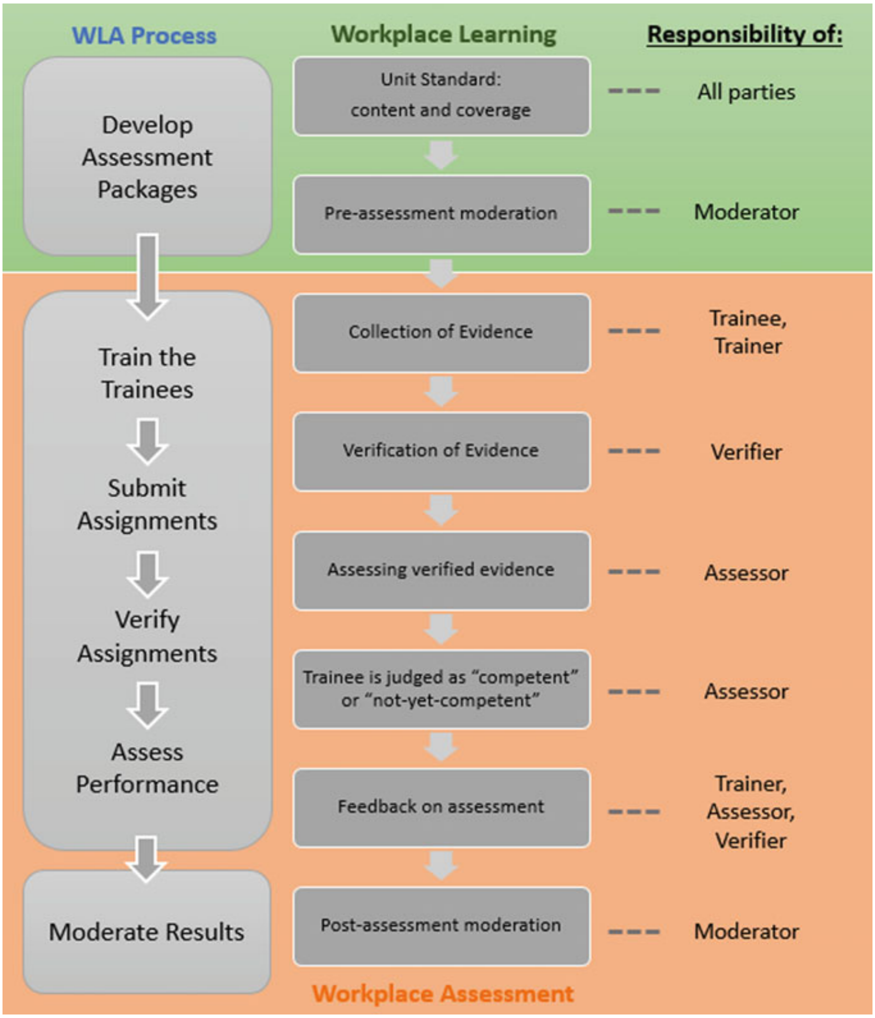

Fig. 7.4 Workplace learning and assessment framework and responsibility of stakeholders

learning by working through experience, experiment and reflection. 20% of social learning is achieved through learning by collaborating and working with others, while the remaining 10% is formal learning by formal interventions and planned learning solutions.

On the other hand, under the VTC's strategic plan, WLA was implemented in the programme, starting from 2019. The WLA development team has consulted the teaching staff on the appropriateness of QF Level, alignment to Module Intended Learning Outcomes, assessment standards and appropriateness of the workplace setting of the unit standards. Moreover, the unit standards are also supported by the employers concerned. Using engineering programmes as an example, the current WLA model adopts a contribution of not less than 5% of the total contact hours for the vocational modules of the programme. An incensement of percentage contribution is expected in the near future after years of successful implementation and positive feedbacks received from different stakeholders.

Derived from the WLA framework described, there are different models for the assessment of work placements such as employers' ranking of competencies (Coll et al., 2002) and negotiated placement objectives (Zegwaard et al., 2003). In the first model (Table 7.1 refers), competencies are provided in the form of a template and employers are asked to rank student performance part way through the placement and at the end of the placement. A key feature of this model is that it is based on negotiation of the meaning of 'very competent', 'competent', 'limited' and 'deficient' in their education context of the workplace setting. In the second model (Table7.2 refers), sample placement objectives specific to the workplace are negotiated at the beginning of the placement between the trainees and employers. Both trainees and employers have a shared meaning for the terms 'very competent' 'competent', 'limited' and 'deficient' in the education context of the workplace setting. The programme team moderated these placement objectives and agreed levels of competency were in effect negotiated by the three parties.

Under our implementation experience, WLA in VPET engineering programmes has adopted an integrated model based on negotiated evidence with employers' ranking (Table 7.3 refers). The trainee must collect supporting evidence as far as

Table 7.1 A sample model for WLA (Employers' ranking of competencies)

Employers' ranking of competencies				
	Very competent	Competent	Limited	Deficient
Ability and willingness to learn				
Teamwork and cooperation				
Initiative				
Analytical thinking				
Computer literacy				
Concern for order, quality and accuracy				
Written communication				

Table 7.2 A sample model for WLA (Negotiated placement objectives)

Negotiated placement objectives				
Technical objectives	Very competent	Competent	Limited	Deficient
Instrument familiarity				
Instrument operation				
Instrument competence				
Non-Technical objectives				
Interpersonal communication				
Interactions with other people				

Table 7.3 A sample model for WLA (Negotiated evidence with employers' ranking)

Negotiated evidence with employers' ranking		
Technical evidence	Competent	Not-yet-competent
Able to apply engineering knowledge and skills with sound judgement when handling engineering tasks		
Able to handle problems and apply the regulatory framework requirements and the organization's accepted procedures and methodologies wherever appropriate		
Able to manage engineering tasks in accordance with good practice		
Able to acquire new knowledge and skills from the workplace		
Non-Technical Evidence		
Able to work independently		
Able to apply engineering knowledge and skills proficiently		
Able to solve problems without too much guidance		

possible on how he/she has demonstrated and applied professional competence in the engineering industries. Negotiated evidence with employers' ranking helps the assessor to decide whether the trainee has met the requirements of the assessment under our observation. Assessor should make sure that all required evidence is current, valid, authentic, equitable and sufficient and judgement is made based on the requirements of the unit standard. And more, the assessor should also provide timely and direct feedback to trainees on their performance and/or requirements for further evidence, and record the result and feedback written format.

7.5 Propositions for Future Research

The learning potential of WLA, in its broadest sense, is to enable our students to involve genuine intellectual challenge and to nurture both individual and social well-being this can bring. The advantage of viewing learning as a process is that it incorporates important social, cultural and political dimensions (Hager, 2004b). Morley (2018) admires the cost benefit has been found to be beneficial in work-based assessment and mentorship, while an apprenticeship requires determination, perseverance of the student/employee and resource and time investment for the employer. Despite these challenges, the principles of WLA are worth pursuing and are increasingly important in knowledge societies that are potentially a good match with learning in workplaces.

The next level for improving WLA practice in Hong Kong lies with the industry training system itself. It is about the authenticity of the student as a person, not simply a particular task. It will require creative and flexible minds able to engage with complex problems and offer inclusive solutions. A deeper understanding and a balanced distribution of responsibilities are key to address the differences between WLA and school-based learning. Issues such as job-matching, follow up the training progress of the apprentices and render support to the participating organizations should not be overlooked as well. In addition to encouraging more employers to implement WLA, consideration could be given to developing industry-recognised trade tests as a certification of the trainees' competence after completing training. This would also be conducive to providing valued exit points for trainees for immediate employment as well as enhancing the recognition and attractiveness of the training.

7.6 Conclusion

WLA is instrumental in ensuring the successful integration of classroom study and workplace learning involving trainees, trainers and employers. Referencing best practice and successful experience in overseas countries, the VTC has introduced a web-based WLA platform to facilitate the acquisition of professional skills and recognition of qualifications. Through the online assessment platform, students' performance and skills will be assessed real-time. While students' performance and skills at work could be formally recognised, employers can also make reference to the assessment results for identifying suitable candidates for their companies. The initiative has already been implemented in engineering, applied science, hospitality and interdisciplinary programmes.

Upon experiences of vocational training in WLA implementation, the three identified major challenges are (1) finding a right balance between workplace and classroom-based delivery and assessment, (2) getting buy-in from industry stakeholders especially agreement in training plans and training periods (3) learners' recognition of workplace as a learning place. To overcome, it is suggested that an integrated approach with continuous improvement cycle should be adopted to allow good practices. In term of competence and performance, statements which capture what the trainee will know, understand and be able to do when they achieve competence should be defined to ensure constructive alignment. Appropriate assessment methods that will measure against the competence and performance should be first established. Guidance on appropriate teaching and learning approaches would be given to assess competence using a clear marking rubric or guide that specifies requirements. As one of the most important phases, it is essential to evaluate and refine the programme as part of on-going continuous improvement.

The success of VPET highly relies on the integrated learning and job attachment which requires participation of students, trainers and employers. Workplace assessment marries learning with practice in its assessment standard to gauge the practical skills of students and their ability to utilise professional knowledge, which will raise the quality of applied degree education and the future of learning.

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Chapter 8
Embedding Uncertainty in the Learning Process—An Evaluation Case-Study of VUCA Model in Education

Meiju Keinänen and Maria Välivirta Havia

Abstract We live in a VUCA environment: Volatile, Uncertain, Complex, Ambiguous, where tolerance for uncertainty has become the standard. Without embedding uncertainty in the learning processes of professional and personal development, coping in the VUCA environment can lead to stress, anxiety, and vulnerability. In this article, we evaluate how the principles of VUCA can be applied in education in learning environments presenting cases from five European countries and examine, by applying thematic analysis, educators' perceptions on how VUCA is shown in such environments from the perspective of four design elements (epistemic, instrumental & spatial, social, and temporal). The results show that principles of VUCA model can be applied in educational context and all the four design elements have important role in the framework. Although there can be found different key characters of design elements, they are strongly interconnected and forming a coherent whole for learning environment design of uncertainty.

Keywords Uncertainty · VUCA model · Learning environment · Design element · Higher education · Case study

8.1 Introduction

The world is rapidly changing with and without Covid-19, with most areas of society facing a turning point. Thus, it can be said that we live in a VUCA environment. The VUCA acronym is standing for Volatility, Uncertainty, Complexity, and Ambiguity that describes a turbulent environment, where tolerance for uncertainty has become the standard.

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VUCA is often referred in the context of leadership theories (Pasmore & O'Shea, 2010; Horney, Pasmore, & O'Shea, 2010), although according to Hänti et al. (2021), originally the acronym was coined decades earlier by the social scientists at a military school in the U.S. attempting to characterize the future environment in which the students would need to operate. After that, VUCA term has been generalized as a term in the discussions in numerous topics in geopolitics, organizations, business, and leadership as well as in working life in general (Hänti et al., 2021).

The VUCA world has been characterized by many interconnected parts and variables. Although information can be available, it is typical for the VUCA environment that the amount of information is too overwhelming as well as it is difficult to process (Fadel & Groff, 2019). Additionally, the causal relationships are nor clear and this is leading to complexity and even situations of "unknown unknowns" (Bennet & Lemoine, 2014). This makes the problem unstable and possible solution actions unclear and uncertain. High mobility of people and goods and services have broadened the sphere of activities and the global trends and megatrends are widely spread at a fast pace. Reconfiguration at a mental, technological, and physical level and evolving technological interconnectivity (Codreanu, 2016) form an ongoing process that changes the ways people are acting in their private and working life. This all makes the insights of the future working life unstable, obscure, unpredictable, fuzzy, and even chaotic (see also Hänti et al., 2021).

To survive in VUCA world handling uncertainty in a positive, generative, and productive manner is a key ability. According to Bollinger and van Rooijen (2021), uncertainty can be classified as positive (activating, eustress) and negative (inactivating, distress) experience having also mental and physiological effects (Bigdeli, 2010). Viewed form the negative perspective, uncertainty can be experienced as a source of threat, anxiety, and fear (Majerek, 2018 referred in Bollinger & van Rooijen, 2021) with the result that it can decrease creativity, weaken performance, and make people resort to safe work practices or methods (Savijärvi, 2016). Instead, from a positive side uncertainty can be interpreted as a growth factor, a driver for creativity and innovation. As a professional skill, it is powerful and productive to be able to view uncertainty as a rich source of opportunities, as it can offer the possibility to create new forms of thinking and acting (Joosten, 2021, referred in Bollinger & van Roojien, 2021). Positive uncertainty opens new possibilities for action and thus implies a goodbye to dogma's and limitative normative frames (Jacobs, 2010, referred in Bollinger & van Rooijen, 2021). It is also a prerequisite for developing the ability to deal with open-ended problems in the future (Muukkonen & Lakkala, 2009). Overall, uncertainty can be an essential dimension of future professional competences (Attard, 2008; Lane & Maxfield, 2005).

The competences needed in coping with the turbulence and with the increasingly frequent change as well as the uncertainty it causes, is also facing us, pedagogies, both in the way we approach the designing of the learning environments and how we teach in this environment. However, compared to an educational setting, learning is often well planned, phased, and structured, although being conflicted in the real VUCA world where we are living and working. To response the needs of VUCA world and the requirements of future-professional competences, it is necessary to prepare our students to handle uncertainty in a positive, generative, and productive manner, without being stressed. All this requires versatile experiences and learning situation intensively during their study path. To achieve this, it requires from pedagogies carefully designed learning environments, wherein students can experience and train acting in VUCA world but in a safe and supportive manner.

However, although the concept of VUCA seems to be a suitable framework to reflect uncertainty competence, there seem to be still a lack of research of VUCA in the educational context, albeit some publications applying experimental learning pedagogy to prepare the students to cope with a VUCA work environment can be found (Hänti et al., 2021). To response to this cap, the aim of this article is to show how VUCA world can be simulated in authentic educational situations and examine educators' perceptions on how VUCA is shown in a hybrid learning environments from the perspective of four design elements. In this article, first, we present shortly the theoretical principles of hybrid learning environment and design elements, and then, describe the data and methods representing cases from five European higher education institutions, and share the key results of the study. Finally, we conclude our experiences according to the results.

8.2 Theoretical Background

8.2.1 VUCA in Educational Context as Part of Learning-Environment Design

The educators are also facing the competences needed in dealing with the turbulence and the increasingly frequent change as well as the uncertainty, both in the way we approach the designing of the learning environments and the way we work with the environment. In an educational positioning, learning is often well planned and structured which is conflicted in the real VUCA world where we are living and working. Therefore, it is crucial to prepare students to tolerate a sense of uncertainty, as well as to solve and apply professional problems in a productive manner without being stressed already during their daily pedagogical settings. Innovatively but carefully designed learning environments can be used as a safe platform for students to experience and train acting in the VUCA world (Hänti et al., 2021).

A learning environment can be understood in a wide perspective as a socio-cultural continuity and discontinuity between the daily academic practices and the challenges of the VUCA world. A learning environment is most frequently understood as physical (e.g., a classroom or campus) or virtual premises and spaces (e.g., learning systems or platforms), meant and built for learning purposes, wherein we share the description, contents, and goals of the study unit. Some authors have been included psychological and physical perspectives, e.g., the psychological comfort with space as well as the motivational and inspirational effects of space, in learning environment definition. However, the concept of a social learning environment is frequently neglected in this discussion (Räsänen et al., 2013), although in the VUCA word problems are solved and innovations are created in groups and networks. Solving wicked problems requires people from many different disciplines who are expected to work effectively together, and knowledge and skills which do not belong to the scope of one discipline only.

In this article, following the work of Hänti et al. (2021), a learning environment is defined to indicate educational arrangements or systems that are designed and managed. Additionally, learning environment is both the socio-cultural and the physical or digital settings where learners perform their tasks, wherein connectivity plays a key role by referring to the relationship between work experience, learning and knowledge. Learning across contexts implies that learners interact with, move across, or participate in different practices and thus cross boundaries between these practices (Hänti et al., 2021). In this article these kind of learning environments are called as hybrid environments simulating real working-life, wherein the elements for work practice are incorporated into education.

8.2.2 Design Elements of Learning Environments

To prepare students for the working life in the VUCA world, the curricula and the learning environments necessitate intentionally designed environments and learning processes for recognizing and thus understanding VUCA in a motivational educational context. This renders to turn professional uncertainty in to something positive and productive. All this requires specific designable elements for different types of learning environments (Hänti et al., 2021).

The design characteristics of learning environments are expected to be broadened beyond the higher education institutions towards working life, e.g., by creating dynamic learning systems (Laukkonen, Biddel & Gallagher 2019). In other words, the learning and working process can be merged, and learners can not only simultaneously learn and work, but also grow into community practice. These kind of intentionally designed hybrid learning-environments at the boundary of higher education and working-life facilitate communication between both contexts. They also include authentic goal-directed work activities or centrality of real-life work tasks. Additionally, physical settings, in which learners can practice and be guided by experts from occupational practice and the variety of roles that actors fulfil in a learning environment, are key elements as well (Bouw, Ziller & de Bruijin, 2020).

According to the Bouw et al. (2020) these components can be designed in more concrete level by applying epistemic, spatial and instrumental, social, and temporal elements in design:

Epistemic elements of a learning environment design are the task characteristics and the task arrangement. These elements are based on the needed competence that is seen as meaningful in the relevant domain. Supporting students to learn a vocation, epistemic elements are related to the occupation for which learners are being prepared; how people engage in work practice and what they can learn from the practices, what kind of tasks learners are supposed to engage in, and what kind of information they need to perform those tasks.

Spatial and instrumental elements consist of physical features. Spatial elements are the location (university, work or third location), spaces (analogue or digital) and how these spaces are furnished (e.g., as professional workspaces or as traditional classroom spaces). Instrumental features include all tools and artefacts needed to perform relevant tasks.

Social elements consist of all actors present in a learning environment, the roles that they fulfil, such as educational roles (e.g., coach, learner, assessor) and roles related to the profession (e.g., junior or senior colleague, or managerial roles), how actors might interact, how they are grouped and how tasks are appointed to and divided between different actors (i.e., the division of labour).

Temporal elements illuminate the importance of considering affordances related to timespan and intensity of the programme, nature of the schedule, work pace (including the amount of time pressure), and work interruptions to slow down, accelerate or pause the work process for educational purposes.

8.3 Methodology

8.3.1 Data and Methods

This study utilizes practice-oriented and evaluation research strategies. Practice-oriented research is a research strategy in which the goal of study is coming from the professional practice and in which the knowledge created in the study contributes directly to this practice (Hermans & Schoeman, 2015). Similarly, in the core of the evaluation study, the aim is also to provide means to judge actions and activities in terms of values, criteria and standards for a given situation, like in this case the VUCA framework in specific educational contexts. Evaluation research is aiming to produce for the drawing up of the justifiable conclusions and developing recommendations a sufficient amount of information which is of high-quality enough to support management and decision making. Thus, it also forms a mirror of practices to concrete actors (Anttila, 2007; Jokinen, 2017).

The VUCA model was used as framework to recognize the hybrid learning environments where in the uncertainty is present (Hänti et al., 2021). The data were collected by inquiring educators from five European higher-education institutions during the spring semester in 2021 as part of the PUNC (Professional UNcertainty Competence) project 2021–2023. The aim of the project is to professionalize educators to enable learners to develop their uncertainty competence in their professional performance to find a way through this increasingly uncertain, changeable, and ambiguous world. The project consortium contains partners from Poland, Finland, Netherlands, Denmark, and Spain. All the selected educators (N = 177) were from the courses that applied constructivist and student-centered approaches to learning with activity-based teaching methods following the hybrid learning environment categorisation presented previously. As such, it was presupposed that these educators, based on their pedagogical understanding and experience, can reflect their experiences. Altogether, the data represents 13 different hybrid learning environments.

The used inquiry included some background questions, four clusters of Likert-scale questions related to designing elements (epistemic, spatial & institutional, social, and temporal elements) and six open answer parts. In the Liker-scale questions, educators were asked to evaluate importance of each item related to four design elements. Instead, in the open answer parts, educators had possibilities to describe more specifically their perceptions and opinions of important elements in enabling students' learning in a hybrid learning environments. In this article we focus only on open answers parts (n = 150). The qualitative data of open answers was analysed by applying a thematic analysis, in which four design elements (Bouw et al., 2020) formed the chosen themes of uncertainty in learning process. The research questions of this case-study are following:

(1) Can the principles of VUCA be applied in educational context in cases of hybrid learning environments?
(2) What are the educators' authentic perceptions on how VUCA is shown in such environments from the perspective of four design elements?

8.4 Results

First of all, this evaluation case-study shows that the principles of VUCA model can also be applied in educational context, particularly in hybrid learning environments, wherein the uncertainty is embedded in the learning process. The study demonstrates that theoretical model can be used as an suitable evaluation tool for pedagogical practices in many ways, not only to improve curricula designing, recognizing specific learning environments and their special characteristics but also to reach actors authentic experiences and supporting their pedagogical reflections better. The article also presents how the VUCA concept acts as a framework when reflecting learning environments more concrete level from the perspective of *epistemic, spatial and instrumental, social, and temporal* elements.

Second, the results showed that, according to the educators, VUCA is shown in many ways in hybrid learning environments in education. When using VUCA as a framework, several different key characters of four design elements from the perspective of educators were found.

For example, from the epistemic elements, educators highlighted following topics:

- *balancing in instructions and guidance*
- *learning by doing*
- *not knowing*
- *creativity.*

From the instrumental and spatial elements educators raised up:

– *connection of learning environment and motivation*
– *safeness in learning environment*
– *simulation of professional environment.*

What comes to social elements most reflected topics by educators were:

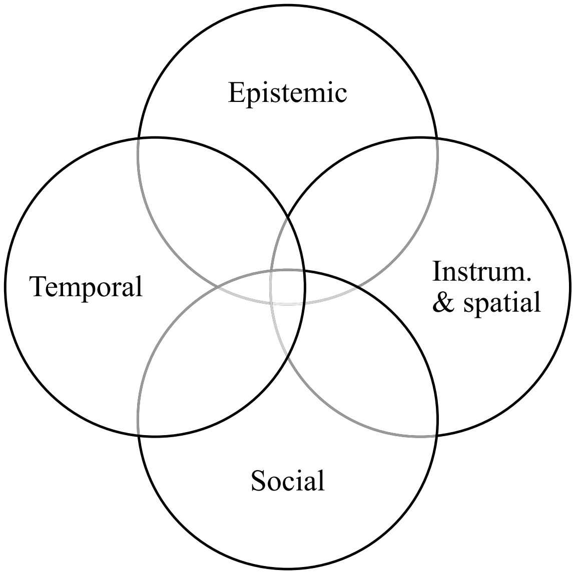
– *role of facilitator and advisor*
– *avoiding teacher centricity*
– *team work methods.*

As a last and fourth design element, two themes of temporal elements were emphasized:

– *balancing structure and schedules*
– *simulating pressure of working life.*

However, although the results of this study showed that there are different specific topics or characters in different design elements, overall, there can be also recognize lot of similarities and connections between these four design elements and founded key characters. The key characters of four design elements were not clear-bordered and they even appeared in all design element categories but having different angles. Therefore, when examining how VUCA is shown in hybrid learning environments from the perspective of educators, it seems that all the four design elements have important role in a in the framework, they are strongly interconnected, and thus, forming a coherent whole for learning environment design of uncertainty. Next characters of four design elements will be described more detailed (Fig. 8.1).

Fig. 8.1 Connection of four design elements in VUCA hybrid learning environments



8.4.1 Epistemic Elements

Based on the thematic analysis of epistemic design elements, educators often reflect the suitable balance in giving guidance and instructions when working in VUCA learning environments. What is the right balance between over instructing and giving freedom to students to organize, solve problems and arrange the tasks? Naturally, some learning environments are fundamentally designed for exploration and trial and error type of learning where more freedom and less guidance are given to the students. On the other hand, other learning environments may require clearer tasks, solid structure, and well-defined goals for desired outcomes to actualize, otherwise the learning process may end up being too fuzzy and chaotic. For educators, finding a right balance between the control and freedom is not always an easy task to solve.

> "As a teacher it is important to find a balance in steering, guiding, letting go and trust (---)" (Educator 128)

> "To learn away from teaching and pouring information is difficult (---)" (Educator 79)

> "It is sometimes difficult to keep the balance between being a moderator but also an educator during a course (---)" (Educator 114)

Reflection of epistemic questions, many educators also shared an opinion that learning by doing is the best practice to enhance the skills that are needed in VUCA world. The students who learn to ask why, when, and how and can use creativeness, flexibility and adaptiveness skills are the ones who do well in a real world too. A learning environment that offers possibilities to practice problem-solving skills and working in versatile teams, creates important skills for working life and makes students better in terms of their future jobs. Overall, todays' working life and its requirements are something what educators are thinking quite much—how to equip the students for future. Furthermore, it was seen that education aiming at personal and professional growth in knowledge and skills can be stimulated by professional surroundings.

> "The students have to learn by themselves not by teacher. They need to solve the challenges and experience all kinds of phases, because that is the real life too. Learning by doing!" (Educator 19)
>
> "One can learn theory by reading books, but the practical learning comes by doing." (Educator 91)
>
> "I create circumstances in a safe space where the students can feel uncertain to develop professional and personal." (Educator 41)

Moreover, according to the results, not-knowing is the very important aspect of the learning process. Therefore, educators should encourage and explain to students that learning is about exploring knowledge. Educators see that their role is to be a facilitator of this process and support students when things are too difficult, and they are stuck but otherwise, students must be very active themselves in problem solving and to try out how to manage tasks themselves. In this way, the students can make mistakes and learn from those but still get results. A facilitator should give enough room and flexibility to students. When students can make their own decisions, it will enhance their creativity and increase knowledge. Mistakes and uncertainty of how things should be made are usually more acceptable in learning environment than in actual work situation. Therefore, educators pointed out that it is essential to make mistakes and learn how to deal and solve those first in safe learning environments.

> "In project work uncertainty is usual and you need to get used to it. Mistakes must be allowed, because you can learn from those." (Educator 33)
>
> "Mistakes and uncertainty of how things should be done are usually more acceptable in learning environment than in actual work situation." (Educator 36)
>
> "To encourage students not to be afraid of mistakes, not-knowing etc. on the other hand is important to enhance their creativity and experimenting to find their own answers and ways to work." (Educator 92)

On the other hand, many educators emphasized that creativity and creative thinking are the engines of a learning development and students can be very creative in constructing their knowledge. An educator should encourage creativity and creative thinking and support students' reflection processes. For a creative process to be successful, students should have freedom to move in different directions. Albeit the process might be controlled, but the way to move, is better to keep relatively free.

> "They come from other schools and often are closed minds. They were taught that ´better is not to ask' or 'if we don't ask, I will not talk more (---)" (Educator 122)
>
> "Unexpected situations encourage creativity in students (---)" (Educator 154)
>
> "Best outcome comes if you hold on to obligatory deadlines but give chances to creativity and flexibility to situations (---)" (Educator 40)

8.4.2 Spatial & Instrumental Elements

Based on the data, many educators pointed out that learning space, environment and circumstances are important factors to stimulate and inspire students to learn. Educators also commented that is good if the environment is as close to the practice as possible. A simulated professional like environment encourages learning also in a sense that students identify more professionally and will therefore exhibit the required professional behaviour. Physical workplace in school premises cannot usually mirror fully professional settings but recognize structures, tools and equipment is a must for fast assimilation to a professional workplace. Real simulations of working life and practising those during studies is good preparation for the future. Professional surroundings are important for both personal and professional growth in knowledge and in skills wise. Furthermore, professional environment was seen as a motivational tool for student's learning experience.

The open answers also demonstrate that, according to the educators, students need to come out of their comfort zone to make an essential leap in learning. Therefore, from educators' point of view uncertainty is an element which is a necessary factor for learning purposes. However, students also need enough safeness, like structures, encouragement, and skills to face the uncertainty. Feeling safe was mentioned several times in educators' answers. An educator should take care of a safe environment, where students feel free to be themselves, they can communicate openly, experiment and gradually develop professional skills. Safeness and safe frames can be constructed from different elements e.g., psychological, and environmental feel of safety, support provided by an educator, students getting to know each other, via discussions, and reflections between students and with an educator.

> "Students forced to look for solutions to problems are more confident and bold in solving problems in real life. As a result, they are more creative and more effective." (Educator 106)

Similarly, educators highlighted that skills of tolerating uncertainty are not important just in learning contexts but also in context of life as uncertainty is part of daily life, both personal and professional wise. In learning environments some VUCA components emerge as a surprise in the process of working and while students learn to work in a changing and somewhat chaotic setting, this prepares them to manage with real life.

> "Uncertainty and unexpected things also take place in the professional field, so experience with them is a good preparation for real life". (Educator 88)

8.4.3 Social Elements

When working as an educator in a hybrid learning environment, the educators described their role as being more like a setter of a right learning direction, providing support and guidance during the work process. Their role is more like an advisor and facilitator, than a director. One part of educators' role is to inspire and stimulate the students as well as show good practices. An educator is the one who keep an eye on that learning goes in a productive direction.

> "In my opinion, it is important to find the right balance between being a partner and a 'manager' for students." (Educator 134)

According to educators, it was also noted that too much detailed instructions and teacher-centricity can lead to the passiveness of the students. Although educator may have educator may have a clear vision and expectation of the outcomes, it is good to keep in mind that an outcome can be much less creative than what it could have been. Over preparing from educators' side may lead to too "teacher desirable outcome". In other words, learning, exploring, and doing together is much more effective than someone telling exactly what to do. Naturally is good to remember that opposite things don't necessarily contradict each other, therefore allowing mistakes, and encouragement for creativity doesn't mean that clear instructions should not be given.

> "By preparing everything you get 'teacher desirable behaviour' and it is suggested that there is only one correct answer (---)" (Educator 128)

> "(---) there should be a safe place for students to experiment, to think of own questions and activities they want to answer or experience, to try things out, to use their creativity, to see what are the results for themselves and others, to learn and grow by experimenting." (Educator 59)

One way to broadening the vision of the learner is diversity in learning teams. Working in diverse teams enables students to learn from each other, construct knowledge and discover new things together, but also make mistakes and find a way to correct those and make progress in learning. Working with others provides possibility for encounter uncertainty, especially when team members are unfamiliar with each other. Often students are quite shy at the beginning of the course and they need some time to start working together. Working together and being responsible for the results teach students to trust themselves and other team members. Teamwork enables students to develop communication skills, being an active agent of their own learning, and as well as developing self-management and leading skills.

> "(---) the students need to learn and rely on themselves and other teammates. This way they can bring out their ideas and chose the best one themselves." (Educator 62)

> "To deal with uncertainty students need to work in groups / with other people and feel responsible for results (---)" (Educator 136)

> "Multisectorality is a challenge as well as a motivator. It keeps mind fresh, when there are groups which are working with subjects that are out of your personal comfort zone. On the other hand, it challenges your know-how." (Educator 31)

> "Create together; to strengthen each other; create a win–win situation (---)" (Educator 150)

> "By doing so the students are able to manage in a real working life where you have to be able to work with different kind of people without the boss saying what to do." (Educator 19)

8.4.4 Temporal Elements

Regarding temporal design elements, educators commented a student related challenges especially in following deadlines. Giving freedom to students to plan their own schedules may lead to the delays or procrastination of assignments if students do not have time management skills and feeling being responsible for their own work. In that sense, given deadlines and rules were seen helpful. It was also noted that students agreeing schedules together may become somewhat problematic in teamwork if there are many participants i.e., hard to find common free times. Especially educators from project-based learning environment kept set milestones and deadlines important for a project to proceed and important deliverables be ready in time. However, flexibility was seen important because in project it is common to work with many items at the same time and unexpected changes actions may occur in time wise. If learning environment includes 3rd parties like clients, it brings pressure especially to timing and getting ready concrete results. External parties were seen very good because this element provide opportunities for students to negotiate and communicate with a customer about schedules, project proceeding and other important things.

> "The students sometimes have challenges following the rules, deadlines etc. if you give them freedom to decide their own schedules (which may become a problem when there are other stakeholders involved). This can be used as an opportunity to learn to take the responsibility that inevitably comes with freedom." (Educator 92)

> "In this learning environment it is important that student learn to negotiate with customers regarding schedules and communicate to client if there are hick-ups." (Educator 97)

Additionally, educators emphasized that schedules and timetables are needed in working life. In real life such as VUCA world, as they often referred, many issues must be solved simultaneously. Thus, students should learn effective coordination skills and handling of different activities efficiently.

> "The schedules and timetables are needed in the working life too. Many issues need to be solved at the same time, but the teams need to be able to coordinate the activities efficiently." (Educator 95)

8.5 Conclusion and Discussion

The aim of this article was to approach the discussion of today's education and present how these new requirements of education simulating VUCA world can be reached. This article brings new insight on the limited research topic of VUCA in the educational context not only by showing how VUCA can be simulated in authentic educational situations but also by sharing the educators' authentic perceptions on hybrid learning environments from the perspective of four design elements.

Firstly, the results of this study show that principles of VUCA model can be applied in educational context and all the four design elements seem to have important role in the framework. Secondly, based on educators' authentic perceptions on how VUCA and its fours design elements are shown in different learning environments, this study presents that educators are acknowledging the importance on VUCA in education and developing skills to tolerate uncertainty, especially for demanding working life and its requirements. Furthermore, similar themes can be found in their answers which were presented in results sections. However, although the results of this study showed that there can be recognize different specific topics or characters in different design elements, overall, there can be also identify lot of similarities and connections between these four design elements and the founded key characters of the elements. The characters are strongly interconnected and forming a coherent whole for learning environment design of uncertainty.

However, applying VUCA in educational context requires from pedagogies carefully designed learning environments, wherein students can experience and train acting in VUCA world but in a safe and supportive manner. VUCA learning environments are not only safe platforms for students to learn and develop their working life skills but also environments to handle uncertainty in a positive, generative, and productive manner. According to Bollinger and van Rooijen (2021), positive uncertainty opens new possibilities for action, and it is also a prerequisite for developing the ability to deal with open-ended problems in the future. When uncertainty can be an essential dimension of future professional competences, VUCA learning environments seem to offer lot of possibilities for students to be creative and use their potential in there.

In addition to the new results on the research subject, this study also demonstrates how a theoretical model can be used as an evaluation tool for pedagogical practices. Hopefully, this kind of study strategies can be a push for further strategical evaluations, practice-oriented interventions, and pedagogical development projects, or provide results for decision making or strategical development in educational institutions. However, although this research shows inspiring results, there are limitations to the generalizability of the findings because of case-study setting. Moreover, a deeper thematic or other qualitative analysis might be beneficial. On the other hand, those limitations serve as points of consideration for future research. This preliminary evidence encores and inspires to research not only educators' but also students' perceptions and experiences to understand better learning environments' role in the development process of uncertainty competence. Thus, this article not only brings new insight to the topic of uncertainty in learning but also can serve as an example to pedagogic development when educating future professionals.

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Part II
Innovative Pedagogies in Applied Degree Learning and Training

Chapter 9
Remote Teaching and Learning in Applied Engineering: A Post-pandemic Perspective

Mouhamed Abdulla and Weijing Ma

Abstract The COVID-19 pandemic significantly disrupted the educational sector. Faced with this life-threatening pandemic, educators had to swiftly pivot to an alternate form of course delivery without severely impacting the quality of the educational experience. Following the transition to online learning, educators had to grapple with a host of challenges. With interrupted face-to-face delivery, limited access to state-of-the-art labs, barriers with educational technologies, challenges of academic integrity, and obstacles with remote teamwork and student participation, creative solutions were urgently needed. In this chapter, we provide a rationale for a variety of course delivery models at different stages of the pandemic and highlight the approaches we took to overcome some of the pressing challenges of remote education. We also discuss how we ensured that hands-on learning remains an integral part of engineering curricula, and we argue that some of the applied changes during the pandemic will likely serve as a catalyst for modernizing education.

Keywords Remote education · Online education · Hybrid learning · Experiential learning · Engineering education · COVID-19

9.1 Introduction

The COVID-19 pandemic has had a devastating impact across the world, and overall, various sectors of society were impacted by this event. The educational sector was considerably affected by the pandemic as strict lockdown measures were imposed. Immediately, instructors and students were asked to proceed remotely with their teaching and learning. Despite this disruption, various disciplines that greatly depend

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on active hands-on learning had to find new and creative means to continue teaching in online mode.

Sheridan's engineering is one of these disciplines with program curricula that are contingent on learning-by-doing, system design, prototyping, and troubleshooting. These programs are designed with the objective of training students in the full lifecycle of real-world engineering based on conceptualization, design, implementation, and operation (CDIO) guidelines (Abdulla, Motamedi, & Majeed, 2019). At Sheridan, this educational CDIO framework is applied by particularly focusing on skills-based learning with experiential education, project-based education, work-integrated learning, and applied research (Abdulla, Troop, & Majeed, 2020).

Unfortunately, with the reality of the pandemic, assembling, testing, and measuring engineering systems for hand-on CDIO learning and proof-of-concept was no longer a viable possibility. Lacking access to specialized laboratory facilities on-campus, faculty members and support staff had to promptly find solutions that would surmount this challenge while guaranteeing a steady migration from face-to-face (F2F) to online delivery mode. Sheridan's course leaders in the different disciplines of electrical engineering (i.e., electronics, telecommunications, control systems, computer systems, and power engineering) had to determine feasible workarounds and redraft related hands-on content for each of their respective courses.

While being cognizant that the impact and response to the global pandemic on education were unique in various parts of the world, in this chapter, we find it insightful to document and analyze pivotal events that impacted the higher education sector in Canada, and particularly within the province of Ontario. We also outline disruptions encountered because of the prolonged shutdown of public spaces in the Greater Toronto Area, which is home to Sheridan's three campuses located in the municipalities of Mississauga, Brampton, and Oakville. The data suggest that Toronto is considered to have the longest continuous societal restrictions of any major city in the world (Levinson-King, 2021). Understanding these strict decisions taken throughout the pandemic will help us better comprehend the rationale behind these rulings. We will also be able to identify any gaps in the evolving response from higher education to protect its learning community, while still ensuring quality education.

In this work, we also feature some of the effective and creative practices applied at Sheridan to overcome pressing educational obstacles as we pivoted to online and hybrid delivery. This includes, among others, topics related to interrupted F2F delivery, limited laboratory access, barriers with educational technologies, challenges of academic integrity, travel restrictions of international students, and obstacles with remote teamwork and classroom participation. By way of example, we also discuss how we swiftly adapted engineering courses for online education and explain the techniques used to support experiential learning with no or limited access to on-campus facilities. We reflect on the lessons learned and underscore the silver lining of the pandemic that catalyzed the gain of novel skillsets in virtual technology and educational innovation. Finally, we describe how these abilities are valuable for a post-pandemic future in transforming and modernizing the teaching of applied engineering.

9.2 Impact of the Pandemic on Education

The response of the educational sector to the COVID-19 pandemic is generally related to regional trends. While Canada is the second-largest country in the world, 87% of its 38 million inhabitants live in only the four major provinces of Ontario, Québec, British Columbia, and Alberta (Statistics Canada, 2021). Furthermore, in each of these provinces, most people cluster in and around the major cities of Toronto, Montréal, Vancouver, and Calgary. As such, the overall Canadian experience with the pandemic was unique with such geographically distant regions and cities scattered across the enormity of the Canadian land. Moreover, since healthcare is administered and managed at the provincial level, the individual response to the pandemic varied from one province to another. Due to unique regionality and jurisdictional responsibility, the impact of the pandemic on higher education varied accordingly.

To better understand the impact of the pandemic, consider the 7-day moving average of the daily trend of new positive cases and fatalities of COVID-19 for the province of Ontario depicted in Fig. 9.1 using data from Public Health Agency of Canada (2021). This trendline is interesting to analyze not only because our campuses are in Ontario, but because it is the most inhabited province of the country with a share of roughly 39% of the population (Statistics Canada, 2021). Because of this size, it is no surprise that the shape of the normalized trendline for the pandemic in Ontario greatly resembles that of the country. Therefore, understanding the trend in Ontario can also give some indication of how the country is doing regarding this health crisis.

In Fig. 9.1, the trend of new cases (shown in black) is plotted alongside the number of fatalities from the pandemic (shown in red). In hindsight, the coupling of these

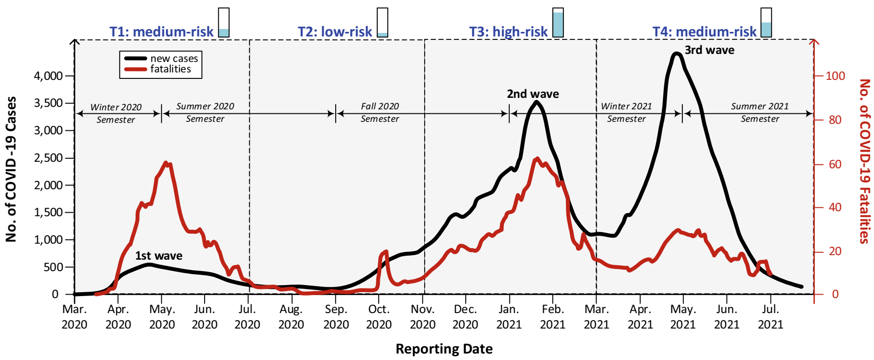

Fig. 9.1 Daily trend of COVID-19 cases for the province of Ontario, Canada

Table 9.1 Risk matrix of COVID-19 pandemic on higher education in Ontario, Canada

Risk = Prob. × Impact	High Impact	Low Impact
Low Probability	Period: Mar. → Jul. 2020 T1 Semesters: Winter/Summer 2020 Risk Level: Medium Implemented Mode: Remote Education	Period: Jul. → Nov. 2020 T2 Semesters: Summer/Fall 2020 Risk Level: Low Implemented Mode: Hybrid/Remote Education
High Probability	Period: Nov. 2020 → Mar. 2021 T3 Semesters: Fall 2020/Winter 2021 Risk Level: High Implemented Mode: Hybrid/Remote Education	Period: Mar. → Jul. 2021 T4 Semesters: Winter/Summer 2021 Risk Level: Medium Implemented Mode: Hybrid/Remote Education

two plots will help us analyze the risk level over different duration intervals. We are looking at the impact of COVID-19 over the past 16 months of recorded data since the onset of the pandemic in March of 2020, and until the time of this writing in July of 2021. We can split the span of measurable data into four equally sized timeframes of four months each, which we denote respectively as T1, T2, T3, and T4 in Fig. 9.1. For context to the educational sector's response, we also overlay in this figure the five semesters (i.e., Winter 2020, Summer 2020, Fall 2020, Winter 2021, and Summer 2021) that were impacted since the start of the pandemic and until now.

With this arrangement, we can assess the risk level at each interval of four months by multiplying the likelihood of an event (i.e., low, or high probability of positive COVID-19 cases) with the severity of the event (i.e., low, or high consequences of the coronavirus, where low impact is associated with recovery and high impact with fatality). As shown in Fig. 9.1, the pandemic trendline in Ontario (also in Canada) indicates three obvious waves of COVID-19 cases, where the first wave occurred in T1, the second wave in T3, and the third wave in T4.

As presented in Table 9.1, this information paired with the fatalities curve results in a coherent and simple two-by-two risk matrix for the different time intervals. As shown, a rough estimate of the risk suggests a low-risk event in T2, a medium-risk event in T1 and T4, and a high-risk event in T3. Due to an incredible amount of uncertainty, erring on the side of safety and taking "extraordinary measure in an abundance of caution" (Clay, 2020) at the start of the pandemic by Sheridan was understandable. However, in retrospect, it could be argued that a data-driven approach for risk assessment could have perhaps yielded a more proportionate response by the provincial government and the educational sector for general operations. This could have lessened the complexity of migration by giving more time for online transition.

Certainly, amid a life-threatening pandemic, it is generally impossible to predict the extent of an infectious disease wave and assess, *a priori*, its risk level with high accuracy and precision. This is an example of a known-unknown event, as we know the existence of the pandemic, but lack full information and understanding of the risk level at different stages and time intervals. Experts on pandemics could use mathematical models to forecast the spread of infectious diseases. But the fact remains that these are likelihood predictions based on available data and input assumptions, which sometimes result in over-or under-estimation of the risk. As the statistician George Box is attributed to have said, "all models are wrong, but some are useful". Nonetheless, the situation is gradually changing as infectious disease models are improving in sophistication and accuracy (Strain, 2020).

9.3 Adaptive Course Delivery Models

As the prediction capability of infectious diseases improves, government agencies could for instance assess the risk using highly reliable and advanced analytical tools and offer recommendations and guidelines to the educational sector for a calculated and adequate response for permissible operations. For example, depending on the estimated risk level, a specific course delivery mode can be selected from the spectrum of available choices outlined in Fig. 9.2. On one end of the spectrum, under a high-risk situation with curfews and maximum restrictions, the course delivery should exclusively be in a virtual mode with no F2F component. On the other end of the educational spectrum, when no imminent risk exists or is known, traditional on-campus education is naturally applied with the option of including some virtual delivery component (e.g., implemented with a flipped classroom model). Between these two extremities, a flexible or hybrid education mode can be considered where the former can be applied for low-risk, and the latter for a medium-risk event.

To be precise, in the flexible education model, students are given the choice to either attend classroom activities or be present remotely using educational platforms and learning management systems (LMS). This model can also be compatible with the flipped classroom approach (Bishop & Verleger, 2013), where the learning and content dissemination is achieved outside class time, say through pre-recorded video lectures, and the application and practice are done in F2F fashion on-campus and/or synchronously with live streaming sessions. This approach effectively uses class time for skills-based learning, learning-by-doing, experiential learning, problem-solving strategies, interactive discussions, and brainstorming sessions for major deliverables. Indeed, in comparison to traditional lecturing, the flipped classroom model provides greater opportunities for collaborative learning during class time (Jdaitawi, 2019).

On the other hand, the hybrid education model is different from flexible learning as students are not given the choice to attend campus for F2F delivery or join class

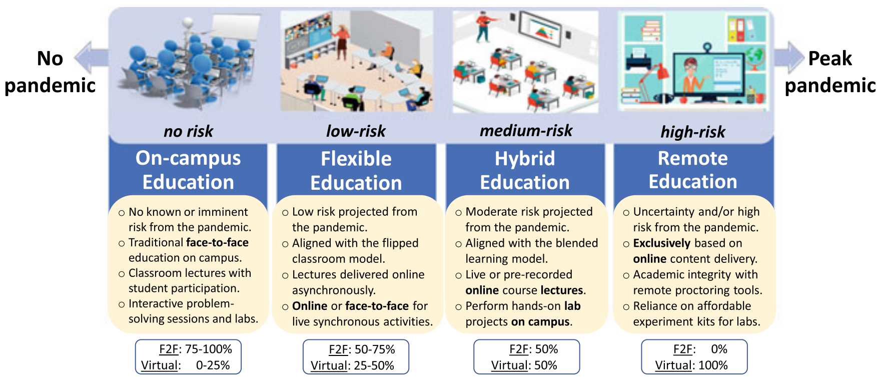

Fig. 9.2 Variety of course delivery models at different stages of the pandemic with recommended split between F2F and virtual delivery mode for each option

virtually. For applied learning disciplines such as engineering, the hybrid model can be used primarily to accommodate hands-on labs that are impossible or impractical to conduct off-campus through simulations, augmented and virtual reality (AR/VR), affordable off-the-shelf equipment, or using development kits. Under this special circumstance, authorized students are permitted campus entry, provided they follow personal protective equipment guidelines from the school, the local authority, and the Ministry of Health. For the coronavirus pandemic, this means that students, support staff, and faculty should all wear medical facemasks, safety glasses, use hand sanitizer upon entry to the lab, and maintain physical distancing of at least two meters.

To further minimize the risk of spreading the pandemic under the hybrid model, lectures are exclusively delivered online. By pre-established school guidelines, the instructor can be given the choice to either deliver content through pre-recorded videos or present a lecture in real-time streaming using LMS applications or teleconferencing software. It is worth noting that there are unique advantages with both synchronous and asynchronous course delivery. In a live session, teaching and learning are more interactive and engaging as students' questions, clarifications, and instructor feedback can all be done immediately in real-time. Meanwhile, in a recorded lecture, students have greater flexibility to move at their own pace and bypass mastered topics through video timestamps, they can learn at any day and time of their choice and the learning can revolve around their daily schedule. Yet, asynchronous teaching is often more time-consuming than synchronous delivery. In essence, it is a form of rehearsed performance with multiple iterations to ensure a final recorded content that is technically accurate, professionally produced, and of high quality.

Informed by various classroom feedback, many of our engineering students preferred synchronous delivery as a motivator to their scholastic success. Moreover, during various COVID-19 lockdowns, where stay-at-home orders were enforced, any possibility of social connectivity, albeit remotely, brought a degree of contentment and a sense of togetherness with the students, their peers, and the class instructor. As indicated by Pietrabissa and Simpson (2020), isolation associated with this pandemic has resulted in various psychological consequences, such as loneliness, depression, and anxiety. Recognizing that some students may have felt isolated, it was important to show compassion, consideration, and a sense of community during this difficult period.

Moreover, in addition to the live online classes, many students expressed their interest in obtaining access to the recording of synchronous sessions for review before exams. With different LMS applications (e.g., Brightspace or Blackboard), it is generally possible and easy to automatically record the live sessions and publish them for students' access. Meanwhile, other learners favored a more curated pre-recorded video lectures that only focused on the content without the excess of in-class interactions (i.e., without questions, comments, classroom interruptions, etc.). Accommodating the different learning preferences of all students certainly increases the instructor's workload beyond what is expected. Judgment should be made to proceed with the best course of action for one's specific classroom.

Alternatively, an instructor can apply a blended learning approach (Hill, 2012). For example, the course can be designed with a mixture of pre-recorded video lectures for content delivery (e.g., virtual/asynchronous: 25%); live online streaming for learning-by-doing exercises, problem-solving strategies, and interactive discussions (e.g., virtual/synchronous: 25%); and on-campus access for hands-on labs (e.g., F2F: 50%). Of course, any other derivatives of this setup that is compatible with the learning outcomes of a course are possible to apply for the hybrid educational model with blended learning.

At present, we can circle back to Fig. 9.2 and observe the recommended split proposed between F2F and virtual delivery for the different educational models. Notice that the importance of online delivery increases as the risk varies from low to high, and as we move from F2F to remote education. Conversely, as the risk level subsides with time, the role of on-campus learning increases. The COVID-19 pandemic showed us that although being physically present on-campus is important on so many levels (e.g., connectedness and access), if done well, remote education can function quite effectively. Therefore, in a post-pandemic world, when we return to a *new normal*, the convenience of virtual delivery with hybrid or flexible modes will likely still be part of several courses and programs. Irrespective of risk levels, the use of blended and flipped classroom approaches with a combination of on-campus, synchronous, and asynchronous delivery can provide greater variety in learning. Moreover, these approaches will make the educational sector more accessible for students who work, have family obligations, health and mobility concerns, transportation challenges, etc.

9.4 Pedagogical Challenges

Over the past year and a half of teaching under the risk of COVID-19, we faced various educational hurdles. We compiled a list of the most prominent challenges in our teaching practice in Table 9.2. As outlined, some of these difficulties are more generic for education, while others are discipline-specific. The table is also organized as a function of the different stakeholders in education that are most impacted by each obstacle (i.e., students, faculty members, technical and support staff, and school administrators). Below, we briefly explain some of our responses to these challenges:

- *Interrupted F2F delivery*: To overcome this challenge, we had to redesign and digitize all pertinent components of engineering courses, including, lectures, labs, project deliverables, assignments, quizzes, and exams. Overall, this was a very laborious task, especially in the early days of the pandemic while instructors were gaining new skillsets with diverse LMS tools for online delivery.
- *Laboratory access*: Experiential engineering learning was accomplished using different approaches over remote delivery. Course leaders and faculty members had to redraft experimental setups and handouts by amending labs with major reliance on laboratory equipment on-campus. Quite often, new labs were designed

Table 9.2 Key educational challenges faced during the COVID-19 pandemic

Main challenges	Stakeholders in education			
	Students	Faculty	Staff	Admin.
Interrupted F2F Delivery: Redesign course curricula and digitize all pertinent learning contents and evaluations for remote delivery.		✓	✓	
Limited Laboratory Access: Creatively think of new experiential hands-on exercises with limited or no access to on-campus equipment.		✓	✓	✓
Barriers with educational technologies: Train instructors the full capacity of e-learning platforms for virtual classroom delivery.		✓		
Concerns with Academic Integrity: Uphold academic integrity and safeguard against plagiarism using anti-cheating tools and strategies.		✓		✓
Travel Restrictions: Inability of international students to travel for synchronous learning with F2F or hybrid course delivery mode.	✓	✓	✓	✓
Truncated semesters: Regular semesters were shorten by a week, where the extra time was allocated for additional course preparation.	✓	✓	✓	
Obstacles with Remote participation: Hesitation of some students to actively participate (Chat, audio, and video) in synchronous remote delivery.	✓	✓		

to fit the reality of remote education. These lab exercises focused more on circuit- and system-level simulations, computer programming, AR/VR platforms, IoT-based development kits, circuit components, and off-the-shelf measurement equipment.

- *Technological barriers*: Faculty members had to be trained and retrained with LMS tools that are exclusively necessary for remote education, including, features for synchronous and asynchronous teaching, online examinations, and remote teamwork. The role of Sheridan's Centre for Teaching and Learning was instrumental in assisting faculty members to improve proficiency with new skillsets for online education.
- *Academic integrity*: Students were advised at the start of each semester that we will use remote e-proctoring software with live monitoring of audio, video, and screen activity to uphold academic integrity. We also used tools that automatically detect and rate the likelihood of cheating behavior using facial detection technology. For written deliverables, we used Turnitin, an online plagiarism detection service applied to verify the originality of students' work.
- *Travel restrictions*: Roughly 20% of Sheridan's students are international with over 100 countries represented. Some of our international students were restricted from entering the country. Due to time zone differences, live streaming of lectures and synchronous examination was always a challenge. Teaching was bifurcated

between domestic and international students as deadlines were usually extended for international students due to time zone differences, delays in accessing remote lab equipment, intercontinental travel, and mandatory quarantine requirements.

- *Truncated semesters*: Since the onset of the pandemic, five consecutive semesters operated with 13 weeks rather than the usual 14 weeks. The shortened week in each semester was given to instructors to help them in migrating content from F2F to remote delivery. Despite the gain in preparation time, course leaders had to redesign class plans to accommodate all learning objectives being met within the readjusted period.
- *Remote participation*: Although students had the option to use chat, microphone, and camera features for real-time interactions during remote sessions, yet, some learners were still reluctant to participate with questions and comments. To encourage active online participation, we modified the evaluation plan of the third-year wireless communication courses by allocating a 10% project component. For the deliverable of this component, students had to synchronously present to the entire classroom their research findings in an oral camera presentation with slides. In the weeks following this learning activity, we observed a noticeable improvement in remote participation.

9.5 Implemented Practices

Throughout the pandemic, we implemented different educational practices. Upon reflection, we can attribute some of our engineering schools' accomplishments to the following key factors.

9.5.1 Curriculum Transition in Phases

When the entire province of Ontario went into lockdown, the Winter 2020 semester was well underway with only four weeks of teaching remaining. By that time, most students have gained hands-on skills and equitable knowledge of lab equipment. This know-how assisted students' comprehension of new and advanced materials covered virtually during the remaining parts of the semester. As the duration of the pandemic extended, and subsequent semesters were switched to online or hybrid mode, returning students during these semesters benefited significantly from the experience gained in the initial transition. This unintentional phased approach has been an important contributor to the successful delivery of our programs.

9.5.2 Ready-to-Deploy Hardware and Software Tools

To serve the different learning needs and styles of our students, we embraced the concept of universal design (UD) with our teaching and learning practices (Smith, 2012). The UD approach provides a list of principles in developing course instructions and materials (Burgstahler, 2009). For instance, we used a suite of pedagogical tools to teach engineering and technology concepts with hands-on exercises. This included the use of LMS applications, software packages, simulation techniques, and hardware equipment. Meanwhile, we also ensure that we had the necessary number of licenses for the various lab applications. This allowed our students to begin their remote learning without excess delays.

Besides, online platforms for the organization of course materials were employed by instructors and learners. Even before the pandemic, LMS applications have been around and widely utilized in higher education (Katz, 2013; Kuran et al., 2017). Platforms such as Brightspace, Blackboard, Canvas, and Moodle are some of the widely used virtual learning environments in Canada (Peters, 2021). Our school has been consistently using LMS applications to organize and curate course materials. During the initial transition from F2F to online delivery, LMS features that were previously underutilized were proven extremely helpful.

Throughout the pandemic, our virtual learning environment provider regularly updated the new online examination tools to include different features for students, including among others, identification and verification, online invigilation, library access, course-based chatrooms and forums, video homework, and project spaces. These updated features have significantly expanded the capacity of the virtual learning platform, making it a comprehensive tool for course delivery and management of evaluations and deliverables. Overall, the experience with various software and hardware technologies facilitated our school's seamless transition into the alternate delivery mode.

9.5.3 Consolidated Effort and Response

Another key reason for the effective transition to remote learning can be attributed to our school leaders and administrators. They were instrumental in entrusting subject matter experts in devising a transition plan. The goal was to ensure a feasible and consistent plan with minimal impact on the learning outcomes of courses. Empowered by administrative support, faculty members created contingency plans for all engineering courses within our programs.

For instance, our faculty members, support staff, and technologists created an equipment sign-off procedure to provide senior students access to portable equipment for remote hands-on learning activities. As for first-term courses, they were switched to a fully online format with video lectures, simulations, remote labs, and online evaluations. Meanwhile, in engineering and technology education two types of courses caused additional challenges: (i) courses that are reliant on expensive equipment, where equipment sign-off is not feasible; and (ii) courses that contain significant hands-on training, where simulation alone was insufficient for meeting the learning objectives. For the latter, some instructors developed VR-based laboratory exercises. This approach provided a unique solution to compensate for the lack of practice with actual on-campus equipment.

9.5.4 School's Agile Response

Since the success of the initial transition to remote education, Ontario has gone through various waves of COVID-19 cases followed by lockdowns (see Fig. 9.1). During this time, some of our community members were infected or exposed, and required to quarantine for an extended period. We made sure that all our live streaming lectures be recorded so that impacted students that missed lectures can review the content asynchronously. When students are in quarantine due to either case confirmation or possible exposure, we offered accommodation for laboratory deliverables.

Overall, compared to previous academic years, our programs have sustained and produced a similar retention rate during the pandemic. Moreover, informed by students' key performance indicator survey, on-campus education pre-pandemic, and remote education during the pandemic resulted in a comparable level of satisfaction. These encouraging feedback and observations are driving us to further improve our remote and hybrid course delivery.

9.6 Lessons Learned and Strategies for the Future

Through this unprecedented pandemic, the Ontario higher education sector has gone through a tremendous amount of pressure to maintain quality education while ensuring the safety of its learning community. Via creative problem-solving and agility, we were able to overcome critical educational challenges. Reflecting on what has been done since the start of the pandemic, we feel the following key points resonate with many of our experiences and can serve as lessons and strategies for the future.

9.6.1 Transition into Smaller Class Sizes

Because of physical distancing on-campus due to the pandemic, we noticed some of the unique benefits of smaller class sizes (i.e., fewer students per classroom). While smaller class sizes have been an indicator of scholastic quality in higher education (Wright et al., 2019), engineering schools have typically preferred large lecture halls with hundreds of students. Although teaching F2F to many students at once is cost-effective, the educational benefits of lecturing to a smaller audience cannot be underestimated. Some of the key benefits of smaller classes for engineering education are:

- *Enhanced student engagement*: Smaller classes often lead to a more intimate learning environment. It reduces the sense of anonymity in the classroom, and it enhances student–teacher interactions. Of course, students' voice is amplified in such an environment as many students feel less reluctant to ask questions and provide comments. In addition, in a smaller class, student concerns can be addressed faster by the instructor. This leads to a more noticeable impact on their contribution and engagement in the learning environment.
- *Effective student–teacher interaction*: In a small class, more attention is given to individual students' learning progress and hands-on practice. For example, this is vital during the prototyping phase, where design, implementation, and troubleshooting skills require close consultation with the instructor. Combined with other technical and curricular improvements, a smaller and personalized class can provide a positive impact on students' learning.
- *Improving experiential learning*: Since engineering education includes the training of students' hands-on skills beyond theoretical fundamentals, engineering laboratories are a critical component of an effective curriculum (Feisel & Rosa, 2005). Smaller classes are particularly suitable when teaching engineering and technical content, where hands-on practice and instructor feedback are essential.

With the modification of learning spaces for safety purposes due to the pandemic, our students appreciated the inherent benefits of smaller class sizes. Post-pandemic, smaller classes with more personalized teaching approaches need to be emphasized and prioritized for effective on-campus engineering education.

9.6.2 Maintain a Balance Between Online and On-Campus Education

While it is widely recognized that smaller classrooms are beneficial to learning, the debate between online, hybrid, and on-campus delivery has been ongoing in literature (Beynon, 2007). During the pandemic, remote and hybrid learning became a necessity instead of an option. This rapid paradigm shift posed enormous challenges to instructors, of which many were unfamiliar with the subtleties of online education. At the same time, students were forced to switch their entire education remotely, and overnight, they had to change their usual learning practices. Students as well encountered various difficulties with online learning. With time, both students and faculty members overcame major obstacles and, to some extent, embraced some of the flexibilities and benefits of remote education.

However, embracing online teaching in the interim should not necessarily be an indication that programs should switch to long-term remote education. Instead, extensive research and investigation are needed on the effectiveness of the different course delivery models. Certainly, an abundance of experiences has been gained on delivery models during the pandemic. In particular, the topic of virtual and hybrid education has generated an increasing interest during the pandemic (Dhawan, 2020; Rapanta, Botturi, Goodyear, Guàrdia, & Koole, 2020). These research results, and the like, should be assessed carefully by different stakeholders in education, and through a cost–benefit analysis, a decision can be made on the best approach to follow for each specific discipline.

Meanwhile, for engineering education, online teaching and learning is not a panacea post-pandemic. For various engineering specializations, on-campus hands-on education is paramount. Thus, an exclusive online delivery may not necessarily be a sustainable solution for all applied disciplines. As discussed earlier, applying a blended or a flipped-classroom approach with a mix of online and on-campus components will likely produce a better educational alternative.

For such a blended learning transition, designing effective online and on-campus learning modules by relying on the current expertise of faculty members may not be sufficient. Rather, it will also depend on the continual professional development of instructors. For such reasons, institutional support, funding, and research opportunities in the scholarship of teaching and learning should be available post-pandemic.

9.6.3 Leverage Multiple Digital Learning Methods

During the pandemic, online education is implemented using different technological tools and methods. Today, many course modules are developed using digital learning techniques that include, e-learning platforms, courseware programs, video conferencing, video recording, voiceover slide presentation, computer-based simulation, remote examination, etc. With the rise of digital learning methods, educators and researchers are now interested in exploring how these technologies complement each other to enhance the learning experience of students. With growing awareness and competence of digital learning skills by faculty members, the integration of these methods to support students learning will be an ongoing trend for the future of higher education.

Besides, with the rapid introduction of alternative delivery modes during the pandemic, engineering students have been exposed to various ways of remote and hybrid education. Within a relatively short period, students were able to experience and compare the effectiveness of learning under different delivery models. Based on various accounts, this experience shed light on their learning method of choice. Post-pandemic, instructors should still strive at exposing their students to multiple digital learning methods and delivery modes in an attempt at aiding their students discover their learning preferences.

9.6.4 Balance in Equipment and Technology Investment

In our electrical engineering laboratory facilities, we have various industry-grade equipment for measuring and testing electrical systems and signals. During strict lockdowns, our on-campus lab was inaccessible, and therefore unusable. With remote delivery, these on-campus equipment that are not connected to the internet were significantly underutilized.

Post-pandemic, we recommend a balanced approach of investing with hardware equipment, software applications, and cloud-based technologies useful for remote and on-campus course delivery. The planning, procurement and curricular design of future laboratories should for instance focus on providing:

- *Portable systems*: Despite being small, portable, and generally less powerful than on-campus equipment, these devices (e.g., off-the-shelf equipment, development kits, IoT devices, SDR units, etc.), provide an affordable alternative to state-of-the-art devices. They do not require specialized facilities for operations, and they can be transported for remote education by students. Students can gain confidence and entry-level skills by using, testing, and measuring with such devices.
- *Remote instrument access*: Setting up network and cloud-based remote access systems can be used to connect remote learners to centralized on-campus equipment. This sophisticated setup provides online access to state-of-the-art equipment that is physically located in different laboratory facilities on-campus. This requires proper online platforms and compatible devices to make such equipment remotely accessible.

In addition to traditional on-campus equipment, portable devices, and remote instrument access will all be necessary for hands-on engineering education for future course delivery with a blended learning model. Overall, the experience of the COVID-19 pandemic should be a reminder that we need to smartly plan laboratory environments that can be compatible with the different course delivery models.

9.7 Conclusion

As the story of COVID-19 and its more transmissible variants is still unfolding, we still lack the full understanding of when the educational sector will return to a fully *normal* state. With the increase of vaccinated individuals and the prospect of reaching herd immunity, a *new normal* seems closer within reach. With this in mind, we aimed in this chapter to provide a rationale for the educational response over the past year and a half of teaching under the impact of the pandemic in Ontario, Canada. For us, this unique experience was instrumental and a paradigm shift, as it propelled us to significantly advance with educational innovation during the pandemic. With this momentum, the trend of further modernizing engineering education will continue post-pandemic, as there are more technologies and practices that we are interested to experiment with and apply in our school.

Overall, we see great challenges and opportunities that require special attention from the higher education system. For instance, engineering disciplines that rely heavily on experiential learning need to explore new ways of course delivery when in-person training is reduced. With greater reliance on online and remote delivery, technological innovations will provide alternative ways for in-person access to state-of-the-art facilities. Meanwhile, upholding academic integrity and deterring plagiarism with remote evaluations remains a constant struggle. Stakeholders in education will need to creatively think of how to engage and evaluate student performance for an adaptive course delivery model approach.

Despite some of these challenges, remote delivery has proven effective thus far. However, for the future of engineering education post-pandemic, we believe that a *blended learning* approach with a combination of *online* and *on-campus* delivery with *synchronous* and *asynchronous* learning contents can provide a much-needed variety in education. This change will undoubtedly make the higher education sector more flexible and accessible to students. On the whole, the discussions and discoveries throughout the past few months since the onset of the pandemic will certainly serve as a springboard and a catalyst for the future of applied education.

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Chapter 10
Applying Hybrid Mode in Different Pedagogical Approaches on Design-Related Tertiary Education Programmes in Hong Kong

Emmy Kit Yin Wong and Raptor Yick Kan Kwok

Abstract Hybrid teaching mode, meaning synchronous online and face-to-face teaching is inevitably applied in tertiary education in Hong Kong due to the unprecedented pandemic situation. The creative-oriented and practice-based design-related programmes have to follow though it is more challenging. This chapter studies the student learning experience when applying hybrid teaching mode in different pedagogical approaches on design-related tertiary education programmes, namely theoretical-based, studio-based, technology-based and group project-based on a mixture of teaching formats including lecture, tutorial, in-class discussion and workshop, etc. The study adopts mixed methods to investigate design students' learning experience and challenges under hybrid teaching mode. Semi-structured interviews with online questionnaires were conducted targeting four years' students to understand the personal and in-class learning context, and initiate recommendations that apply to the pedagogical approaches. Our findings conclude that despite of better attendance and punctuality, students' disciplines, technical problems, in-class interaction and teachers' class management capability are the main concerns.

Keywords Hybrid teaching · Tertiary education · Design education · Teaching and learning · Pedagogy · Hong Kong

10.1 Introduction

COVID-19 outbreaks in 2019. The virus is spreading quickly worldwide and is highly contagious. During the pandemic era, off-campus study mode was enforced in our Institute. Shifting to online hybrid teaching mode, students and teachers are forced to

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get familiar with these online tools in a short period. The pedagogical approach was very different from the face-to-face teaching approach. Without fully face-to-face classes, some classes encountered hurdles when teaching remotely. Switching to the hybrid teaching mode is challenging for teachers; lots of changes have to be made to fit the new teaching ecology. Usova (2011) claims that the course design has to be changed to adapt to hybrid teaching mode on design-related programmes. From learning goals to creating ways for students to learn before, during and after class, there are numerous aspects to take care of for teachers to deliver hybrid teaching mode to students. Some teaching materials have to be re-created as well. Online teaching tools are explored and employed for pedagogical uses in our Institute include online teleconferencing software like Skype, Zoom and Microsoft Teams, as well as learning management system Moodle; sometimes student feedback systems, such as Socrative and Kahoot, are also employed.

The frequently-used term hybrid learning itself is ambiguous among researchers (Oliver & Trigwell, 2005). Oliver and Trigwell summarise that the term requires just two things to be combined in the learning process, which they argue almost anything can be regarded as blended learning. Driscoll (2002) argues that blended learning has various methods, such as combining online and offline technology, pedagogical approaches, instructional technologies and actual job tasks. Garrison and Kanuka (2004) concludes that hybrid learning, also known as blended learning, is the integration of face-to-face classroom learning experience, combined with online learning experiences via online teaching tools. According to Analysis on *Application of Hybrid Teaching Mode in Higher Education* (2008), hybrid teaching mode is defined as integrating the advantages of the traditional face-to-face teaching along with modern distance network-based teaching.

Having the unprecedented change in academia, design-related discipline especially faces crucial challenges. However in the design-related discipline, their experience of teaching is understandably limited, and their teaching practice is often influenced by their experiences as learners. For example, Cheung (2015) shows that design discipline teachers tend to apply the same master-apprenticeship model in their teaching that they were experienced as learners. Although this model may have its advantages, recent research shows some serious limitations including feelings of failure or humiliation on the part of the learner. In this book chapter, blended learning is defined as the hybrid teaching mode in different pedagogical approaches, with a focus on design-related tertiary education programmes. The approaches combine theoretical-based, studio-based, technology-based and group project-based lessons with a mixture of online and offline teaching formats including lectures, tutorials, in-class discussions and workshops, etc. The four main teaching approaches are described below:

10.1.1 Theoretical-Based Teaching

With theoretical-based teaching, the lecture contents, including lecture notes and presentation slides, are directly instructed by teachers. Lessons usually took part in general classrooms, which are equipped with a projector and a computer. Apart from direct instruction, there are several other approaches. The inquiry-based approach initiates by asking students' questions, asking them to analyse various scenarios and evaluating problems. The activity-based approach plans activities that complement students' learning. The learning cycle approach tailors instruction to how students learn. Usually, around 70% of teaching hours are lectures while the remaining hours are tutorials. Marketing, Dissertation, Design Thinking, Art History, Consumer Behaviour and Design Management modules are examples of theoretical-based teaching.

10.1.2 Studio-Based Teaching

Studio-based teaching includes the modules that focus on works and experimentation that take part in a hands-on studio environment such as Photographic Studio, where students learn how to use photographic equipment in a professional scene. Apart from Photographic Studio, our Faculty, the Faculty of Design and Environment, has the Printing & Packaging Workshop, Knitwear Design Workshop, Digital Laser Cutting Workshop, CNC Workshop, Spray Painting Workshop and many other studios for Advertising, Fashion Design and Product Design students to learn various techniques. Lessons that take part in workshops are also categorised in this teaching approach. Usually, 50% of teaching hours are practical workshops, 30% are lectures while 20% are tutorials. The Videography, Prototype Modeling, Sketching and Fashion Photography modules are examples of studio-based teaching.

10.1.3 Technology-Based Teaching

Technology-based teaching includes the contents that teach software skills in computer labs. This teaching method requires students to learn software and related technical skills in a computer lab; these essential skills are usually used to assist in creating design works. Training of operating special equipment or devices is also in this category, such as operating a drone. Similar to studio-based teaching, usually 50% of teaching hours are practical workshops, 30% are lectures while 20% are tutorials. Modules such as 3D Modeling, Animation, Video Editing, Technical Drawing, Web Design, and Game Production are examples of technology-based teaching.

10.1.4 Group Project-Based Teaching

Group project-based teaching includes the contents that involve teaming up with students to work on the same topic. This teaching method requires students to team up and tackle complex problems based on a project brief; sometimes the project involves actual industry clients. Group projects can help students develop time management, communication, teamwork and leadership skills that are essential in the professional world. Students learn how to break down large tasks into chunks and multiple phases, evaluate group mates' performance, delegate tasks to group mates, establish a shared identity among group mates and learn from other group mates. Usually, most teaching hours are group tutorials with lecturers. Modules such as Collaborative Projects and Design Studios are examples of group project-based teaching.

10.2 Literature Review

10.2.1 The Paradox of Hybrid Teaching Mode

According to Brown and Duguid (2000), the phrase "new learning ecology" is adopted to describe blended learning. The interactive and reflection capabilities between teachers and students have formed a new culture, which is beyond traditional culture.

Garrison and Vaughan (2008) argue that transformation of teaching and learning in higher education is made possible by synchronous and asynchronous connectivity and collaboration through blended learning. They also conclude that a quality higher education learning environment is characterised by a purposeful, open and disciplined study community, not just purely based on the medium of communication.

While design-related programmes, without a face-to-face learning process, students cannot communicate with their teachers actively and efficiently. Qi (2008) argues that online teaching and learning cannot provide the real atmosphere where teachers' personalities can influence students, and teaching and learning can interact with one another in time. He also argues that in face-to-face learning experiences, students can constantly combine lectures with their knowledge frame by refining and abstracting, and integrate knowledge segments into their knowledge system.

However, since face-to-face learning is infeasible in the pandemic era as the campus has closed down and students cannot study on campus, teachers and students have to learn and adapt to the brand-new hybrid-mode teaching environment.

10.2.2 The Strategy of Hybrid Teaching Mode

Switching to the hybrid teaching mode is challenging for teachers; lots of changes have to be made to fit the new teaching ecology. Ramsden (2003) argues that the two most important elements in shaping approaches to learning are the teaching contents and assessment.

According to Garrison and Kanuka (2004), blended learning should address three aspects: a description and rationale for strategies of blended learning, course structure and expectations, and support and resources. He also concludes that blended learning addresses the issue of quality of teaching and learning, which is an opportunity to address pressing pedagogical concerns.

Through hybrid teaching mode, teaching contents are delivered to students through various synchronous and asynchronous channels. For synchronous channels, lecture notes in the form of PowerPoint presentation slides are presented to students via telecommunication software such as Skype. For asynchronous channels, teaching materials are distributed to students via websites, learning management systems such as Moodle, email and online shared folders such as Google Drive and Dropbox. For assessments, assignments are submitted to Moodle and presentation is done via Skype.

This book chapter investigates students' learning experience in design-related programmes in tertiary institutes under hybrid teaching mode by understanding the following questions:

1. What are the advantages students think of having classes conducted under hybrid teaching mode?
2. What kind of challenges do they encounter?
3. How do they think about the learning experience under different pedagogical approaches?
4. What kind of support is needed to enhance their learning experience?

10.3 Methodology

The study adopts mixed methods to address the questions above to investigate design students' learning experience and challenges under hybrid teaching mode. First, we conducted face to face semi-structured interviews to understand the personal and in-class learning context of the participants. Five respective students of design-related programmes from Year 1 to Year 4 agreed to participate. Online questionnaires were then distributed to all four years' students of design-related programmes, to further examine the advantages and challenges of attending classes under hybrid teaching mode, 42 questionnaires were returned. We then based on the results, initiate recommendations that apply to the pedagogical approaches.

10.4 Research Findings

Table 10.1 below lists the basic information of the semi-structured interview participants. Participants were selected to represent their year of study. The major differences between the participants are their year of study.

Table 10.2 below summarises the basic information about the 42 survey respondents.

The following shows the research findings from each year's students about their perspectives on hybrid teaching mode in design-related programmes and their learning experience when applying to different pedagogical approaches.

10.4.1 Advantages of Applying Hybrid Teaching Mode Mentioned in Student Interviews

10.4.1.1 Higher Flexibility for Students Who are Capable of Self-learning

Students said that they are capable of learning online via the Internet nowadays. There are many apps and websites which provide tutorials including instant messenger apps such as Skype and Microsoft Teams. Other than that, students can choose to listen to the recorded teaching videos uploaded to Moodle after the classes for revision. Having said that, offering recorded teaching materials will lead to lower intention to attend either online or face-to-face classes, as students can choose their own time flexibly to study on their own.

Table 10.1 Semi-structured Interview participants

Name	Gender	Year of study	Faculty
Participant A	F	1	Design
Participant B	M	2	Design
Participant C	F	3	Design
Participant D	M	3	Design
Participant E	M	4	Design

Table 10.2 Survey respondents

Year of Intake	Year 1 (61.9%)	Year 3 (38.1%)		
Year of Study	Year 1 (2.4%)	Year 2 (19%)	Year 3 (31%)	Year 4 (47.6%)
Gender	M (31%)	F (69%)		

10.4.1.2 Attendance is Probably Higher If Classes Are Under the Online Teaching Approach

Under hybrid teaching mode, for certain modules, students can opt to join the class online or face-to-face, they can attend the class based on their preferences so they are more eager to attend the class. Senior years' students mentioned in the interview that their learning experience of the online teaching approach is better than the traditional face-to-face approach, as they are capable of arranging a better self-learning time afterwards, which is also good for exploring and establishing their expertise. Out of our expectations, they tend to spend more time asking teachers questions during online classes. Moreover, all years' students agreed that they can have a better arrangement of time for attending online classes, as they do not need to stay at school for the whole day, especially having long hours idle between two classes, so the absence rate is much lower. However, inevitably, certain students were just lingering during online classes.

10.4.1.3 Punctuality is Improved

Students can receive the alert from the learning platform, reminding them to attend the class; they can also attend online classes everywhere, even on transports or at work. All years' students claim that it saves transportation costs and time, especially for those who live far away from the campus, so they can have longer sleeping hours if online classes are conducted. At the same time, students said that they can also attend online classes everywhere, even on transports or at work. Also, students need not wait for other students like they were in face-to-face classes while they can make good use of the waiting time during the online classes. Nevertheless, as mentioned, some students are just lingering, and they do not even log out after the online classes ended.

10.4.1.4 Inactive Students Have Better Responses in Class

The hybrid teaching mode benefits inactive students. Inactive students are normally becoming more active during online classes, as they are willing to ask and answer questions in-class compared to face-to-face classes, while they tend to not answer questions in face-to-face classes, so teachers may find difficulties in understanding what they are thinking and understanding.

10.4.2 Senior Year Students Found Better Cooperation With Classmates Under Hybrid Teaching Mode

Since senior year students are more familiar with their classmates, they found that cooperation with classmates on group projects is better when classes are conducted online, as they can pause a while and immediately perform online research if they noticed something unclear during group discussion. On the contrary, if group discussion is conducted face-to-face, the discussion would be ineffective if group mates have not done any preparation beforehand. Moreover, students mentioned that they can spy on other groups' progress during online tutorial sessions, so they can improve the progress and secure the quality of work. However, junior year students found difficulties in connecting and cooperating with their classmates as they are all new intakes and are not familiar with each other. They said that the difficulties are getting more serious for the class to form cliques under hybrid teaching mode, but it is probably less serious for face-to-face classes; meanwhile, it is easier to be misinterpreted and have conflicts during online discussions, therefore sometimes it would be better to have teachers formed project groups for them.

10.4.3 Findings of the Online Questionnaire About the Positive Side of Attending Classes Under Hybrid Teaching Mode

To further examine the positive side of attending classes under the hybrid teaching mode of design-related programmes, students were asked to respond to the online questionnaire on the following attributes. Amongst the attributes shown in Fig. 10.1, all of them exhibit a significant positive tendency on attending classes under hybrid teaching mode, while the following attributes, i.e. Saving transportation cost and time (95%), more personal free time (93%), can be more multitasking (88%) and more convenient (88%) represent the highest number of agreements, which are consistent with the findings from student interviews.

10.4.4 Challenges of Having Classes under Hybrid Teaching Mode Mentioned in Student Interviews

10.4.4.1 Students Lack Self-discipline

Students indicated that they could have more personal time during online classes, which may delay or distract from the class from time to time, so they will be lazier in the study. Some students are even unaware of teachers' questions during the class, thus they cannot give instant responses. More importantly, the procrastinating

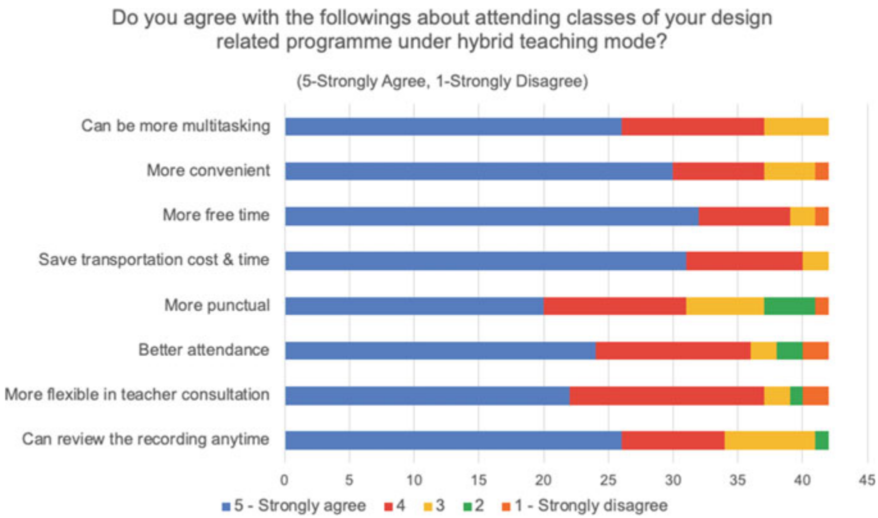

Fig. 10.1 Attributes that students agree about attending classes of the design-related programme *under hybrid teaching mode*

problem is more serious when having more online classes, especially when students have group discussions with text messages, they may delay the response to each other. If they can meet face-to-face, they are forced to brainstorm ideas with their group mates.

10.4.4.2 Students are Less Aggressive and Cannot Concentrate Easily

Generally speaking, It actually depends on students' commitment. They mentioned that If students themselves are motivated, there is no difference between online or face-to-face classes, and they will tend to respond no matter if it is face-to-face or online classes, by just voicing out during the class with text messages; however, the efficiency is lower. Also, it is particularly more challenging to show the design work progress to the teacher during online classes, and their work will be less serious than having classes face-to-face. Having said that, in general, students stated that their attention is lower in online classes. Understanding that it is more tiring to concentrate on the screen for a few hours during an online class. Student attention during face-to-face classes is not good already, though junior students pointed out that they are more willing to raise questions in face-to-face classes. They said that they can still pay attention to class when they find the topics that are of their interest, and some of them will actively ask teachers questions after the class. Besides, if classes are conducted face-to-face, sometimes they are mandated to respond especially when teachers call their names. No matter how hybrid teaching mode has to be enforced due to school policy. As mentioned before, students tend to concentrate more on their activities during the classes, such as having meals or snacks, browsing other favourite sites, playing video games, texting with friends, etc. it always happens that less interaction and lower participation when using online teaching approach, and only a limited number of students response to teacher's questions, while some of them tend not to ask questions even when they are in class, they may also be afraid of their text messages being kept for a long time in the chat box, it may make them upset if the teacher does not give a response, so they only ask questions at the last minute though they are unable to fully understand the teaching.

10.4.4.3 Communication is a Challenge Between Teachers and Students

It is challenging for teachers to ensure students' understandability as they cannot witness students' facial expressions and instant responses. All students agreed that face-to-face interaction is much better, as students sometimes may not know what the teacher is talking about, especially for technology-based classes. Also, upon showing the work or reference online to teachers, it takes a longer time for teachers to understand and review. If the assignment submission deadline is approaching, all of them agreed that it's better to have face-to-face classes (tutorial sessions) with teachers. Ironically, junior students specifically indicated that they need to be brave to make their microphones unmuted if they speak in online classes. They are just afraid of other students thinking they pretend to be ambitious, and being called to answer teachers' questions is embarrassing. While some argue that introverted students may tend to ask questions freely as they feel less embarrassed online, some of them may even enjoy challenging the teachers online. The learning atmosphere is not always satisfying.

10.4.4.4 Self-studying Burdens of Students are Heavier

Students stated that more homework was given by teachers as there are fewer in-class assignments under the hybrid teaching mode. However, teachers cannot witness students' difficulties in handling lots of assignments.

10.4.4.5 Design Students Particularly Find Difficulties in Following Some of the Technical Classes

They stated that it is more difficult to learn technical skills such as Adobe Photoshop and Premiere Pro via online classes. Even when hybrid teaching mode is carried out, several normal face-to-face classes are condensed to one face-to-face class, while the rest of the teachings have to be supplemented online. Therefore, students find difficulties in acquiring knowledge.

10.4.4.6 Technical Problems Happened Frequently During Online Classes

Students reported that there were always some audio or video recording problems (e.g. audio feedback, video delay or lagging, etc.) during online classes, while teachers' information technology skills varied, it may also take a long time to start the online class smoothly. Also, some software cannot support using the screen sharing feature in Microsoft Teams, so students would prefer listening to recorded teaching notes instead, especially for workshops.

10.4.4.7 Communication With Classmates is an Issue

Online communication is a barrier especially when having group assignments, students cannot see each other's facial expressions, and there is a higher chance to misinterpret each other's meanings so their relationship will be affected. As mentioned, it is challenging to have in-class discussions amongst students as some of them were lingering online without involvement, so students who are committed are forced to work individually. If having face-to-face discussions, students can keep track of each other's progress. However, if classes are mostly conducted online, students have to deliberately reserve a day for face-to-face group assignment discussion. If the face-to-face class is conducted, they do not need to do so as they can meet each other after class. Nevertheless, it is a paramount issue that new intake students find difficulties in knowing each other under hybrid teaching mode. They pointed out that they could not be able to contact some of the students if he or she did not show up online, therefore there is always a free-rider problem. Under hybrid teaching mode, students reported that about 80% of the classes were not conducted face-to-face, they are exhausted from managing their time with other students on group projects, especially assignment deadlines are usually tight.

10.4.4.8 Variation of Class Management From Different Teachers

Teachers and students are more relying on online learning platforms like Moodle for teaching notes sharing and assignment submission, there are always some discrepancies in the material management amongst different teachers. However, students said sometimes they may get confused about where to download the teaching notes. At the same time, having online tutorials, the class schedule could be more flexible but at the same time the timetable will be more complicated; both teachers and students need to have a better scheduling approach, but students may sometimes be confused when there will be online class and when there will be face-to-face classes. Also, the responsiveness of teachers is different while after online classes were conducted, students tend to ask questions 24/7 with higher expectations on teachers' time to respond. They also pointed out that some teachers may organise online breakout sessions during the lesson, but students may leave the class after the session and will not be back to the second part of the lecture. Controlling the class is a concern.

10.4.5 Findings of the Online Questionnaire about the Main Challenges Compared to the Classes Under Hybrid Teaching Mode to Fully Face to Face

It is important to understand further the main challenges that students encounter compared to the classes under hybrid teaching mode to fully face-to-face, as there is still uncertainty for the academic environment which will possibly be affected by the pandemic situation. Figure 10.2 shows that technical issues (50%), in-class interaction (20%), self-discipline (19%) and pay attention in class (19%) are the major attributes of challenges that students are encountering during classes under hybrid teaching mode, which are compatible with the feedback obtained from student interviews.

10.5 Students' Learning Experience of Design-Related Programmes in Different Pedagogical Approaches

Students' learning experience in different pedagogical approaches is shown below with their feedback generated via student interviews about applying various teaching formats to each of the approaches.

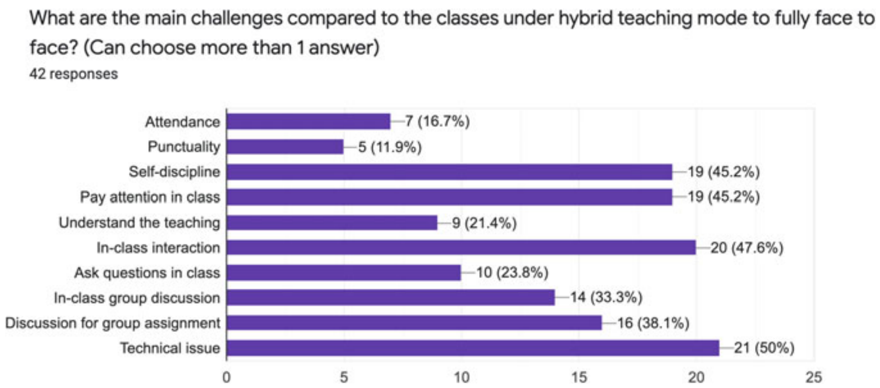

Fig. 10.2 Main challenges compared to the classes under hybrid teaching mode to fully face to face

10.5.1 Theoretical-Based

From students' point of view, theoretical-based lectures are feasible to be conducted online, as it generally delivers specific principles and concepts directly. Tutorials could also be hosted online as it is always a follow-up session after lectures for discussing the assignments and group projects under specific contact hours, so the appointments could be more flexible, the class could be efficiently and effectively carried out. Workshops are suggested to be conducted face-to-face as students can raise questions directly in class which teachers and students can interact with immediately. However, as said, some students tend to be more passive if not meeting face-to-face. Online in-class discussion is sometimes a problem, especially when adopting some interactive learning platforms such as Kahoot and Socrative, some students with lower information technology proficiency may encounter technical problems. If there is no such kind of technical issue, it would be fine to use those interactive learning platforms. Assignment submission during the hybrid teaching mode of the theoretical-based classes is smooth and students are comfortable with the submission method as the file sizes of the assignments are normally small.

10.5.2 Studio-Based

Face-to-face class is suggested as it is easy for students to not show up if it is conducted online whereas appointments normally have to be compromised between tutors and students, so the contact hours may not be too regular. It is necessary to rely on students' self-discipline to attend the class. Furthermore, there are many in-class workshops for studio-based so students mentioned that it's better to have face-to-face classes, as teachers can keep track of the progress of the students. Also, they may be required to do some practical assignments such as taking outdoor videos, so face-to-face is a must, but students are always late for face-to-face classes. Although students mentioned that tutorial sessions could be conducted online, sometimes there may be technical problems that affect the smoothness of tutorials, as well as online presentations and online workshops. Assignments submission for studio-based modules is always a problem, as the file size limit of the submission box is always inadequate, which either lead to a long uploading time (up to a few hours) or system errors. Therefore, students suggested having assignment submissions in photo formats instead of video formats to reduce file size, e.g. take pictures of their physical deliverables instead of filming the deliverables using video format. In reality, physical deliverables are more realistic and appealing, which could convince audiences with their physical touch to various textures brought by different materials, haptic feedback and close-up inspection. Some interactive installation deliverables can even be interacting with the audience, whereas such interactions cannot be mimicked via an online presentation.

10.5.3 Technology-Based

As mentioned before, students find difficulties in following technical classes such as learning software like Adobe Illustrator, Photoshop, Premiere Pro and After Effects, especially when they missed one step during the class. When hybrid teaching mode is adopted, it is always necessary to recap the teaching from online classes in face-to-face classes, as it is difficult for students to catch up the teaching from online classes; while students can see the teaching step-by-step and raise their questions immediately when they attend face-to-face if they cannot follow. The teacher can review the situation on the student's computer screen and point out the problem easily. In reality, students always have some technical questions but they may not know how to ask, as if students share their screen with the teacher, it will interrupt their teacher's teaching progress. End up what they can do is just discussing with other students online. Nevertheless, they mentioned that they are not willing to ask questions even during face-to-face classes as quite a number of them are passive. Although students tend to review the recorded teaching videos more frequently after the online classes, and at the same time supplementing their skill sets from tutorial videos on the internet, they still prefer having fully face-to-face classes for technology-based modules. If hybrid teaching mode has to be enforced, it is suggested to have a better online learning platform like Zoom as the main online class application and require all students to turn on their web cameras to ensure that they are present. More technological-based classes are carried out during the junior year of study, it comes to a bigger concern for the junior year students that they would prefer the classes being conducted fully face-to-face, as it happens that they either do not have the required software on hand, or the software they acquired are not the same as teachers' in terms of the version and language applied. It accelerates the challenges to follow the teaching. Students encounter difficulty in getting the right software as most design software is expensive, or design and photographic equipment in hybrid teaching mode, which sometimes impacts students' assignment submission progress.

10.5.4 Group Project-Based

Students prefer having the hybrid teaching mode for the group project-based modules, as they can choose to have online chat or face-to-face meetings. Different students have different preferences, senior year students indicated they are fine with online teaching. If it is optional for online or face-to-face classes, students will normally choose online, because there is not much theory and information required for group projects. During their group discussion, they can also search for information together without being attracted to browse other things when doing online. Also, they reiterate the feasibility of hybrid teaching mode because it is compatible with the real commercial world, as clients nowadays tend to do briefings online or via phone calls instead of meeting face-to-face. Moreover, students pointed out the fact that some of the students will just be superficial and ignore each other's work progress during face-to-face class, so they suggested setting it mandatory to go back to campus when necessary. Junior year students would not prefer having the hybrid teaching mode on group project-based modules as isolation amongst classmates always happens in class, and some students may find difficulties in contacting their group mates, so free-rider problems always happen. Furthermore, they found that it will take longer for online group discussion, as students who are not concentrated will just spend their time doing their tasks, highly initiated students will have a heavier workload on group projects. What is more, for the classes consisting of many new student intakes, it is recommended to be conducted face-to-face as they can meet their classmates if they are required to go back to school, while it will not be a matter of concern about getting a physical venue for group discussion.

10.6 Recommendations for Pedagogical Approaches

Table 10.3 below shows the suggested teaching modes for different teaching formats under various pedagogical approaches. The pedagogical approaches and teaching formats are normally adopted by design-related programmes. Under hybrid teaching mode, recommendations were made based on students' qualitative feedback on their perspectives towards hybrid teaching mode under different pedagogical approaches.

Hybrid teaching is more feasible for theoretical-based classes, but the learning atmosphere and motivation would not be satisfying, and it would be easier to let students pay more attention to the class. In general, it is suggested to have all modules conducted face-to-face, as students expect to learn more in face-to-face classes especially when referring to their tuition fee paid; students can at least utilise the resources provided on campus. Also, in face-to-face classes, students can ask teachers questions and get instant responses. Considering the enforcement of hybrid teaching mode, some students pointed out that it is about the proportion in the number of

Table 10.3 Suggested teaching approaches for different teaching formats under various pedagogical approaches

	Teaching formats				
Pedagogical approaches	Lecture	Tutorial	In-class discussion	Workshop	Group discussion
Theoretical-based	Online	Online	Online	Face-to-face	Online
Studio-based	Optional for face-to-face or online	Optional for face-to-face or online	Face-to-face	Face-to-face	Face-to-face
Technology-based	Face-to-face	Face-to-face	Face-to-face	Face-to-face	Face-to-face
Group project-based	Online	Optional for face-to-face or online	Optional for face-to-face or online	Face-to-face	Optional for face-to-face or online

online and face-to-face classes, they rather agreed for all lectures being conducted online, while workshops in all pedagogical approaches and classes of technological-based modules have to be conducted face-to-face, provided that more interactive and interesting activities could be conducted in class. Having experience in imposing the hybrid teaching mode in the past year, students stated that it would be appreciated if it is possible to let them choose to attend classes under face-to-face or online teaching mode, as they are probably more self-initiated to participate in classes. More importantly, providing necessary software to students is essential if teaching is conducted online, as design students always need to use software for their design work, having an Apple computer with the macOS version is crucial. If they do not have the required software at home, they can only use the Internet version instead. Technical problems are raised as a concern by many students. Adopting a better online communication platform for teaching can ensure a smoother learning experience; the frequently used channels such as Microsoft Teams and Skype are usually unstable, which would be an institutional concern. Finally, to secure better interaction for either online or face-to-face classes, students suggested including marks on in-class participation, so that students will be more motivated in the class participation.

10.7 Conclusion

Online teaching changes student behaviours. Regarding the design-related tertiary education programmes in Hong Kong, the hybrid teaching mode seems to encounter a lot of hurdles. The self-discipline of students is a major concern that affects their initiatives in class. Although attendance and punctuality are improved under hybrid teaching mode, student feedback and interaction are limited during virtual classes. Apart from the technical issues during online classes, communication between teachers and students, and among students in the same class is always a problem. The technology-based approach is difficult to teach online, as it involves teaching software and techniques step-by-step, also the availability of the software is always a problem if classes are conducted online. Despite students' preferences of online teaching for theoretical-based lectures, they can easily be distracted and lose focus, especially in online classes. Class management becomes a more important matter for teachers. Satisfaction of students with the learning experience remains sceptical without extra support given to students and teachers. Reviewing mechanisms may lead to the enforcement of hybrid teaching modes to deliver a more positive learning experience and advance the institute's technological edge.

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Chapter 11
An Investigation of Using Blended Learning Pedagogy to Sustain Student Interest in Basic Science Subjects

Kim-hung Lam, Po-yee Chung, Ming-hin Chau, Alex Wong, Chunghin Chui, and Kai Pan Mark

Abstract Blended learning has been increasingly implemented in undergraduate courses, and can foster a better learning experience for students. The purpose of this paper is to present our current practice and evaluate the effectiveness of blended learning activities to enhance students' engagement and motivation in learning science for two foundation-year GE subjects (ABCT1D09 and ABCT1D10). Various types of blended learning activities and technology (interactive program) were employed and among the designed activities, students have a preference for activities with interactive components, such as poll function, Panopto videos, self quizzes and shared work sheets, to help their learning. It is also interesting to us that our students are happy to have the laboratory classes and projects to supplement their learning. Overall, students are satisfied with the designed pedagogy with high satisfactory level (average 4 out of 5), implying such pedagogy probably sustained students' interest of learning science subjects.

Keywords Blended learning · Blackboard · MS Teams · EDTools · Science education · STEM

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11.1 Introduction

Blended Learning (BL) combines online learning and traditional face-to-face classroom approach of education (Thompson et al., 2019). Blended learning is increasing being adopted and is more promising approach when compared to fully online or face-to-face for education (Berga et al., 2021; Graham, 2004). Researchers believed that blended learning approach impact positively to learner performance and satisfaction (McCutcheon et al., 2018; Owston & York, 2018; Owston et al., 2013; Smith & Hill, 2019). Leidl and coworkers (Leidl et al., 2020) systematically reviewed that blended learning approach is very common and important for nursing courses, and researchers reported that blended learning is particularly effective for clinical education and healthcare students (Berga et al., 2021; Coyne et al., 2018; Rowe et al., 2012). Their findings revealed that students' perception is positive and can be efficacious on a larger scale. Similarly, Alsalhi et al. (Alsalhi et al., 2019) reported that blended learning can significantly improve science students to learn with respect to control group.

Jowsey and coworkers (Jowsey et al., 2020) reported that blended learning with integrated technology support can facilitate and enhance student interaction (Bliuc et al., 2007), which helps nursing students to learn across distances and satellite campuses (McGarry et al., 2015). Grønlien and coworkers (Grønlien et al., 2021) reported that their blended learning approach improves students' study effectiveness and perform better in biosciences. Gao and Tang (2020) reported that blended learning can promote deep learning and help students to understand and apply knowledge. Biddle and Hoover (2020), Yang et al. (2021) reported their study on third-year pharmacy students and found out that student can successfully learn and retain skills using blended learning.

Most recently, blended learning could be used as alternative learning pathways for students to access instructions and to catch up their learning and prevent from unnecessary drop-out (Shi et al., 2021). Shi and coworkers (Vanslambrouck et al., 2018) suggested that blended learning approach must take instructors and practitioners to redesign a motivating and engaging learning environment via pedagogical, social and technical affordable approach. For higher education, blended learning have been adopted for providing more flexibility to meet students' learning needs and backgrounds (Lapitan et al., 2021). McGarry et al. (2015) reported that the flexible learning design can promote student engagement and can develop metacognitive skills.

Lapitan et al. (2021) reported the shift to distance teaching and learning during COVID-19 pandemic brought challenge to both instructors and students, and they reported their blended approach to conduct the teaching and learning context of undergraduate chemistry courses for chemical engineering students. In their study, students were satisfied with their learning experience and can maintain interest and engagement. In addition, blended learning can help to overcome drawbacks of pure online learning and particularly important for current pandemic situation with suspension of certain face-to-face teaching activities (Chango et al., 2021; Gao et al., 2020; Vo et al., 2017).

As front line teacher and educator (Lam et al., 2020), we discovered that some students do not communicate and work well with their peers which was out of our expectation. Furthermore, this situation can be even worse when classes conducted purely online during the pandemic situation. In fact, it is difficult for us to engage students' participation, particularly for General Education (GE) subjects with class size of around 100 students. In addition, we found out that students are required to engage in various activities (such as service learning, projects or others) and their core subjects, which in general may create study pressure and discourage their study.

Based on the university strategic initiatives, our undergraduate curriculum is designed to provide a balanced and all-rounded education experience for our students. In this study, we selected two undergraduate foundation GE subjects to address (1) the understanding of scientific context of global warming (ABCT1D09) as well as basic food science (ABCT1D10); (2) the enhancement of analytical and critical thinking; (3) the practice of lifelong learning and teamwork skills as well as (4) effective communication of our students. As reported by many educators, blended learning can benefit students, and we would like to enhance students' learning experience, and to investigate the effectiveness of using the blended learning components for our selected GE subjects (ABCT1D09 and ABCT1D10).

In this project, we utilized more blended learning activities to improve the learning experience of our students, such as independent learning, life-long learning skills, communication skills and sharing among peers as well as certain characteristics of all-roundedness. We also maximized the use of blackboard and other tools to facilitate the active learning of students both inside and outside classrooms. In addition, we encouraged our students to engage more group and individual activities in our GE subjects.

11.2 Methods

11.2.1 Design and Procedures

This study involved the implementation of various blended learning activities (outside classroom activities, group project, group discussion cases, laboratory classes, self quizzes, videos) with the use of virtual learning environment (Blackboard collaborate ultra, Blackboard discussion forum, Panopto, MSTeams, EDTools, Poll, online MS Form and shared documents in Onedrive) and technology (interactive program e.g. PolyU EDTools) to improve students' learning experience by enhancing students' engagement in two large General Education (GE) classes (around 100 students per class). Two foundation year subjects (ABCT1D09 Greenhouse Gases and Life (registration number: 91) and ABCT1D10 Food Color Taste and Smell (registration number: 100)) were selected for this study. A total of 191 full time undergraduate students having broad academic background were invited to participate in this research through questionnaire survey and focused group interview. The effectiveness of this study was evaluated by questionnaires and by focus group interview on students' perception.

For both ABCT1D09 and ABCT1D10, students' academic performance was assessed based on continuous assessments only, and the blended learning activities were breakdown and design into various task for selected topics. The design blended learning activities for both subjects including (i) team work tasks from students and (ii) student-initiated voluntary learning activities. For design team work including (a) a group video proposal production by students via MS Teams/Zoom/Blackboard collaborate ultra/others; (b) group project presentation (via Blackboard collaborate ultra); (c) peer evaluation via Panopto discussion; (d) group learning and sharing in design cases via shared documents (word/powerpoint) in Onedrive); (e) group laboratory study and reports. For individual learning task, students can learn through via (a) you-tube videos; (b) short questions and MCQs in MS Form; (c) PolyU EDTools, online polling; (d) project report (via turnitin) and (e) Blackboard quizzes. We have also designed student-initiated voluntary learning activities including (a) museum visit; (b) public seminars attendance; (c) interview non-local PolyU staff/students for opinion in global warming issues; (d) survey on food products and their nutritional value, (e) comments on peer group work via Panopto video/discussion and Blackboard discussion forum; (f) preparation of food products and the related science context (e.g. sensory evaluation and food science).

11.2.2 Data Collection

This study is reference the research work of Reschly et al. (2007, 2014), Christenson et al. (2008), O'Steen (2007), Crandall et al. (2015), Dalgarno et al. (2009) and our previous work (Lam et al., 2020). The questionnaire survey was conducted in semester one of 2019/2020 academic year. The selected subjects were ABCT1D09 Greenhouse Gases and Life (class size: 91) and ABCT1D10 Food Color Taste and Smell (class size: 100). The survey questionnaire was designed on a scale of 1 to 5 where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The students' feedback is voluntary, and they chose their opinion in the questionnaire. One question in the survey questionnaire was designed in open-ended format and focused group interview was arranged to collect some in-depth comments from the respondents regarding best aspects of the existing course. The aims of this study was explained to the participants and the response rate for ABCT1D09 and ABCT1D10 were 44% and 37%, respectively.

11.3 Results and Discussion

(A) Students' Perception on the Survey Questionnaire

From our preliminary results for ABCT1D09, the response rate of the students' survey is 44%. In our preliminary findings, the overall mean ratings and average % of students responded positively on the development of generic competencies and use of active learning, inquiry-based learning, etc. after intervention. The mean score ratings given by students were closed to 4.0 (agree) for these generic competencies, such as critical thinking (3.85), problem solving (3.83) and creative thinking (3.83). Also, highest mean rating was also given for agreement that relevant knowledge and skills were gained through active learning approach (3.87) and communication skills (4.06).

Table 11.1 shows that survey mean score and the average percentage of students' opinion (agree (4) and strongly agree (5)). From the summarized data, students' responses to the survey questions were positive, with average high % of students chose 4 (agree) and 5 (strongly agree) for the incorporate learning skills in our design GE course. In general, the survey results showed that the students believed that various student learning skills were generally close to 4.0 (agree). In general,

Table 11.1 Students' responses for ABCT1D09 (n = 44) and ABCT1D10 (n = 37) to the survey questions

	Average % of students chose 4 (agree) and 5 (strongly agree)		Average score	
Student learning skills	ABCT1D09	ABCT1D10	ABCT1D09	ABCT1D10
Active learning (e.g. museum visit and public seminar, experiments and enquiry-based approach study, self-quizzes, TED talk, you-tube videos, ELC consultation)	84.5	80.2	3.87	3.80
Critical thinking (critical judgement, review and opinions)	84.1	87.9	3.85	4.04
Creative thinking (self-initiative, innovative)	77.3	83.8	3.83	3.99
Problem solving (use and integrate knowledge to solve problems)	76.1	86.5	3.83	3.97
Inquiry-based learning (find information to resolve problems)	83.7	81.6	3.91	3.92
Communication skills (interchange knowledge and ideas)	88.7	83.8	4.06	3.77
Interpersonal skills and group work (i.e. effective team)	90.9	83.8	3.97	3.92
Teaching and understanding (teaching staff and course design)	90.9	90.6	4.15	4.00

the students chose agree/strongly agree (76–90%) for various learning skills. The significant high scores for communication skill, interpersonal skills and team work implied that the inquiry-based learning mode through case study and students' group work (project and laboratory) had significant impact on the students in terms of the understanding of the subject knowledge, course content, and can help to enhance the ways of students' thinking and building up confidence to interact different people. The in-depth comments from the respondents regarding best aspects of the existing courses (ABCT1D09 and ABCT1D10) were tabulated in Tables 11.2 and 11.3.

For the questionnaire survey of students' perception for ABCTD10. The response rate of the students' survey is 37%. The students' responses were positive, with all mean ratings being close to 4.0 on five-point scale. The overall comments on the open-ended questions are all tabulated in Table 11.3. From our preliminary results, the response rate of the students' survey is 37%. In our preliminary findings, the overall mean ratings and average % of students responded positively on the development of generic competencies and use of active learning, inquiry-based learning, etc. after intervention. The highest mean ratings were given for agreement that these generic competencies were close to 4.0 (agree) such as critical thinking (4.04), problem solving (3.97) and creative thinking (3.99). Also, highest mean rating was also given for agreement that relevant knowledge and skills were gained through active learning approach (3.80) and interpersonal skills and group work (3.92).

For the survey results for ABCT1D10 (Table 11.1), students believed that various learning skills can be improved Many of them chose agree/strongly agree (80–90%) for various learning skills. The significant high scores for critical thinking, interpersonal skills and team work implied that the inquiry-based learning mode through case study and students' group work had significant impact on the students in terms of the understanding of the subject knowledge, course content, and can help to enhance the ways of students' thinking and building up confidence to interact different people.

One question in the survey questionnaire was designed in open-ended format to collect some in-depth comments from the respondents regarding best aspects of the existing course. The results were tabulated in Table 11.3.

(B) Focus Group Interviews with Students

We have conducted focus group interviews in semester one of 2019/2020 academic year. Students were randomly selected from the course of ABCT1D09 and ABCT1D10 participated in interviews respectively. In this study, we tried to identify challenges and weaknesses that students raised. Students shared examples in terms of the usefulness and effectiveness of the activities as well as the course design. (see Tables 11.4 and 11.5). From the summarized results, it seems that our students appreciate our blended learning approach for our GE subjects. In particular, students were happy with laboratory and project work to support their learning.

Table 11.2 Students' comment on the good aspects of ABCT1D09

ABCT1D09 subject context	Frequency
Laboratory study	17
Specific comment: • Fun, learning through mistakes, make learning more fun and interesting • Laboratory sections that can let us to understand and try different techniques and experiments that are difficult for us to have in daily life • The lab section is the best aspects in this course we can have fun with the experiment • Working in lab with groupmates • Learn more about global warming via experiments	
Subject content; course design and others	Frequency
Greenhouse gases, nature, knowledge	4
Expect to learn chemical knowledge	1
General concept of why GHG affects the planet, potential solutions to tackle global warming	1
Greenhouse gases via Videos from TED	1
I like site visit, using interactive media	1
I expect that I can learn how to tackle the greenhouse gases problems. Watching video is the learning activity that I like most	1
I expect to learn GHGs detail	1
I expect to learn more about the impacts of increasing greenhouse gases. Using online questions, such as some interactive videos, is the active learning activity I like most	1
I expect to learn more knowledge about the greenhouse gases and our livings	1
I expect to learn the basic information and the consequence of greenhouse gas	1
I expected to learn the relationship of greenhouse gases & global warming, as well as the solutions with global warming	1
I hope that through this course I would learn more about greenhouse gases and would make an effort to improve the current situation. I also hope that I would be a better team player	1
Learn more about climate change	1
learn more about greenhouse gases effects and climate change. I like watching TED talks or documentaries	1
lecturer very experienced	1
No examination	1
Design problems related to greenhouse gases	1
To improve my communication skills	1
The teacher, the teaching staff	1
To learn how to cooperate effectively	1
To learn what greenhouse gases and how to solve the problem	1
Worldwide perspective of understanding GHGs	1

Table 11.3 Students' comment on the good aspects of ABCT1D10

ABCT1D10 subject context	Frequency
Food Science knowledge	28
Specific comment: • Basic science of food e.g. chemical reaction of food, cooking theory, chemistry, different food • Behind theory in cooking • Understand food component • Chemicals that contribute to the colour and taste of food • Chemistry of food taste, smell and color • Principal of food color, Taste and smell • What cause the food's color and smell change • The chemical reactions in food processing I expert to learn the chemical reactions and explanation of food reaction. I like the online questions to learn critically • How to cook & basic chemical components in the food • Learning some basic components of food • Learnt about more science knowledge. I like the learning activity most • I expect to learn about the chemical and biological knowledge that bring color, taste and smell to food. I like the public seminar the most as it gives the most up-to-date information about food which impress me a lot • I expect to learn knowledge about food • To appreciate the food science and understand that it is highly related to our daily life • To learn the principles in food science which is related to our daily life • Nutrition things related to healthy diet • I expect to learn more about the nutrition value of dairy food items so I can choose my diet more easily • Which food can make us become health?	
Laboratory study	12
Specific comments: • Learning chemical reaction of food via lab work/experiments, Lab techniques • I'm eager to learn about more science concepts & principles through lessons & experiments! • I expect to learn different science principles of food we eat in our daily life. Using experiments to recognize science theory is my favorite • The food laboratory procedure, as I'm weak in chemistry • I expect to learn about the science of food. I like the experiments most • I expect to learn more about the components of the food and how they work in my body. I like the lab in this course	
Others	2
Public seminar; team gathering	

11.4 Conclusion

We incorporated various blended learning activities for subjects having broad academic background students and we presented here our current practice of blended learning for the foundation year subjects (ABCT1D09 and ABCT1D10). Our results

Table 11.4 Summary of focus group interview with students (ABCT1D09)

Items	Summary
1. Ways to understand/learn the basic science principles	• Gained knowledge from lecture • Analyzed and distilled relevant information for presentation through searching different topics
2. Gained knowledge/theories through activities/teaching & learning approaches	• Gained knowledge in experiments • Reviewed course materials • Enhanced understanding and acquisition of relevant theories • Participated site visits: the museum • Understand green-house gas, and climatic changes including impacts on ecological system, animals and well-beings
3. Gained knowledge using interactive activities	• Laboratories, presentation, in-class videos and answering short questions in worksheets and PolyU U-reply
4. Self-learning through Backboard Learn	• Use of Blackboard Learn including pre-class reading materials, self quizzes, revision exercise to review course materials/relevant information, to submit assignments • Use of Blackboard collaborate to broadcast live laboratory briefing for students located in two physically separated laboratories
5. Gained basic skills in this course	• Written skills: write reflective report after site visit and public seminars • Lab skills and teamwork skills: during lab experiments. ELC writing service is arranged for students' project report • Time managements: presentations and group meetings, assignments
6. Guidance from instructor	• Constructive feedback and guidance gained from the subject teacher
7. Challenges and weaknesses of this course/experience	• Practical lab skills; knowledge of green-house gas, knowledge on environmental issues around us, knowledge applicable to real-life setting, broadening knowledge and views on researching specific topics

demonstrated that blended learning with different form of activities can provide a better learning experience in undergraduate courses.

From our preliminary survey results, among the designed activities in our utilized learning management systems (Blackboard Learn) and online tools, students' preference more on using the following features, such as poll function, Panopto videos, self quizzes and shared work sheets for their learning. It is interesting to us that our students were happy to have the laboratory and project to supplement their learning in our teaching subjects. Our students satisfied with the designed pedagogy with high satisfactory level (average 4 out of 5). Further investigation is required to confirm the findings.

Table 11.5 Summary of focus group interview with students (ABCT1D10)

Items	Summary
1. Ways to understand/learn the basic science principles	• Gained knowledge from lecture, group project, reviewing lecture notes and lab experiments
2. Gained knowledge/theories through activities/teaching & learning approaches	• Learnt the ways of using both ice-cream maker and liquid nitrogen/mixer to make ice-cream • Gained knowledge of how to use different chemical compounds with skills to make dairy products • Butter experiment
3. Gained knowledge using interactive tools	• Answered short questions through the in-class videos • Visual classroom is an online platform for students to communicate with each other • Reviewed materials via online platform • Enhanced our relevant knowledge and understanding of the materials when watching videos in the tutorials • Learnt independently via hands-on experiments
4. Self-learning through Backboard Learn	• Used Blackboard collaborate for group discussions in a selected case study • Review course materials/relevant information, to submit assignments
5. Gained basic skills in this course	• Developed teamwork skills during lab experiments, and problem-solving skills when working on the report and group project
6. Guidance from instructor	• Gained incessant support from instructor throughout the course
7. Challenges and weaknesses of this course/experience	• Gained knowledge through the participation of the fun activities and experiments

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Chapter 12
Budding the Next Entrepreneur in the Applied Learning Education

Peter ChunYu Yau

Abstract Teaching courses such as Final Year Project (FYP) involves lots of ideas exchange between project supervisor and the students: how can they communicate effectively over the monitor in this year-long study is challenging. FYP often represented a consolidated output which summarizes what they learned in the four years program. This production is valuable to the graduates themselves and their future employers. Influenced by the worldwide start-up waves: supportive government policies, and the mature technology infrastructure turned what students learned from school into something impactful to the society, FYP became one of the keys to this door. In this chapter, we will discuss the global needs concern from the SME perspectives: how the new economy interacts with people under the gig economy. We will talk about how the technology was used, applied, and backboned the innovation project completed by the FYP students by showing two successful example cases.

Keywords Entrepreneurship · Applied learning · Gig economy · SME · Technology adoption · Covid-19

12.1 Back to Origin: Reflections from a Decade of Vocational Teaching

In the blink of an eye, it's already my ten-plus year's vocational teaching life in Hong Kong. Thanks to the Vocational Training Council (VTC), I was first admitted as a teaching assistant in the academic year of 2009/2010 at the Department of Information and Communication Technology (ICT), Hong Kong Institute of Vocational Education (Tuen Mun) campus, now the Department of Information Technology (IT). This place gave me the very first step to begin my teaching career.

One of the reasons that I like vocational education much, is that being an engineer, we believe that practice makes perfect. We also believe that an ultimate understanding

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and skills mastery, was gained by unlimited experiments, uncountable trial and errors, led us to the knowledge truth and correct decision marking.

Being a casual faculty in the business and technology domains, I would like to take this valuable opportunity, to share my two cents, about the view on how technology, new business, and society can interact together during and in the post-COVID-19 period. This writing is especially for those students who are completing their applied education learning. The world is too dynamic, in which a good discussion and sharing are keyways leading us to a better future; this is examined by history and time.

Last but not least, we will share two stories from my dedicated students, who just successfully commercialized their final year project into the industry. They just finished a Bachelor of Business Administration (BBA) degree and a Higher Diploma program in Information Technology (IT). We understand that learning and teaching were challenging during this COVID-19, we appreciate a lot for their ambition, passion, and continuous commitment in their learning journey. We wish them every success in their future.

12.2 Start-Up Business, Small-And-Medium Enterprise (SME) and Future Economy

According to the World Bank (2021a), an international financial group aims to provide financial support such as loans and grants to the low- and middle-income country governments for project development. According to the World Bank report: Small and Medium Enterprises (SME) play an important role in global economic development, especially in those developing countries. SME contributed 90% of the business activities and 50% of the employment opportunities in the worldwide market (World Bank, 2021b). Social stability is essential to social development and job stability is one of the key factors to achieve social stability (German & Latkin, 2012).

Trucano (2014), a senior education and technology policy specialist from World Bank wrote a blog post "Promising uses of technology in education in poor, rural and isolated communities around the world", shared how the technology can be better used in those areas. Methods such as re-use the old technology in an innovative way (e.g. radio broadcast), sharing technology devices among the peers (an alternative sharing economy), and increase the literacy rate by the use handheld devices to re-educate the teachers; are some suggested practices which can try out. Per said, SMEs play an important role in the world economy, contributed for 40% of the national income on average in the emerging economy (Ndiaye et al., 2018); SMEs are especially important in the developing regions: how can technology, or specifically how the financial technology can be supported in the scenario above is an interesting study to be investigated.

As shown in Fig. 12.1, a survey conducted by Kumar (2017) in his report "Targeted SME financing and employment effects", the employment rates of SEM

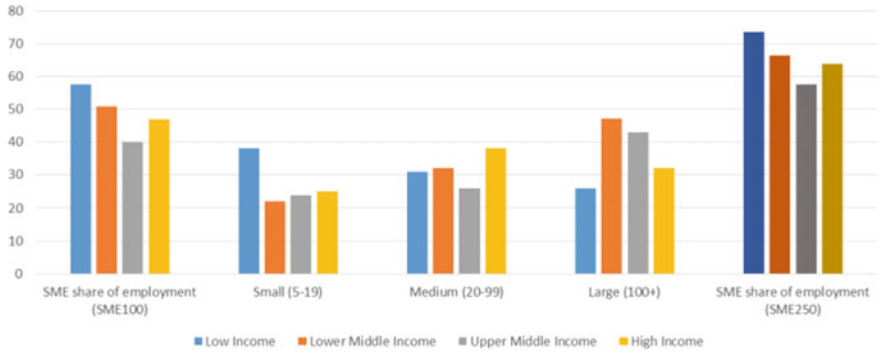

Fig. 12.1 SME shares of employment by firm size and income groups (*Source* The World Bank)

across different levels of income regions are relatively average, this revealed that the manpower market provides almost equal employment opportunities to teenagers. The smaller the company, the higher degree of flexibility (Bryson et al., 1993); this kind of SME features do quite well fit into the society nowadays: with the rise of the gig economy, multiple-talented professionals perform several jobs at the same time. This kind of dynamic job nature facilitated the need for a continuous learning environment.

The Federal Reserve of the United States kept the interest rate to near zero (Dickler, 2021) already for some of the years, this kind of setting made people seeking alternative investment opportunities rather than putting money into the bank. Advancement of technology drives the technology section stock price raised to historical high (Li, 2021), in addition to the popularity of mobile technology and the services provided by mobile apps. Lots of new business opportunities came out in recent years.

12.3 Gig Economy, Slashers and Continuous Learning

Gig Economy represents a new form of economic activity, referring to the people no longer attached to work in a particular industry for life-long, or a long enough period of time. According to Wikipedia, Gig workers can be classified as independent contractors, online platform workers (Vallas & Schor, 2020), on-call workers (Russel, 2019), and temporary workers (Alvarez, 2021). Gig workers can perform their services on-site and off-site, depend on the agreement between the Gig worker and the company. Gig workers can be commonly found or referred to the service providers such as Uber driver (Ravenelle, 2019), host of Airbnb (Cassell & Deutsch, 2020), Youtuber (Chan, 2019), and services usually able to provide by the digital platform.

Due to the fact that gig workers can enjoy great flexibility to the work location and the time arrangement; they can usually work receive multiple service contracts in one single period of time. Just like the English punctuation "slash", with the meaning "and"; gig workers are sometimes referred to as "slashers" (Wares, 2012), i.e. those who own various job titles at that moment of time: Uber driver/Youtuber/Airbnb host.

One of the characters of slashers is freedom, gig economy providers have natural characterize of freedom to pick a job, freedom to arrange their time, and freedom to plan their career pathway: this made slashers more willing to learn new technology, new knowledge; slashers become one of the big supporters of continuous learning. Take an example of Youtuber and social media live-streamers (Niam, 2021), the number of people involving in this new industry greatly increased under the COVID-19. Related skills such as customer service, public speech, video shooting, stage setting, etc. are popular in the past two years. The trend of continuous learning will become more popular in the format of the short course, in both online and physical teaching; this allows people to master certain new skills in a short period of them for the upcoming challenging jobs.

12.4 Entrepreneurship Education with Learning Technology in Cloud

Since 2010, the start-up atmosphere was greatly supported by governments around the world. One of the reasons is that SMEs are supporting a large portion of the economic activity (as discussed above), another reason is that innovation is an important driver, a major facilitator to create new business and the new economy.

Entrepreneurship education aimed to provide students with the knowledge, skills, and motivation on building a successful business, under the matrix of complex settings in scenarios (Von, Harhoff & Weber, 2010). Entrepreneurship education does not limit to the degree and graduation program, it is also offered at the junior level such as primary and secondary school education.

As a result, according to the observation, we found that by giving enough opportunity to the students who are enrolled in the applied learning education programs, they can build an introductory industrial grade product like a professional; although this also involved the supervision with their teachers, it is a big indication that students can be trained further to outperform. Right now, the social structure requires SMEs to provide various employment opportunities; applied learning provides an experimental place to train students with an entrepreneurship mindset, by practices it out in their final year project. How is the latest technology supporting all these settings?

12.4.1 The Use of Video Conferencing System

At the early stage of COVID-19 development, there are a couple of video conferencing software launched to the market for public use, such as Zoom, Microsoft Team, and Google Meet. As a teacher in the department of IT, we take this opportunity to let students build their video conferencing system by using the open-source software Jitsi (Jitsi, 2021). We take this opportunity to educate students as vocational students, we can build something and make an impact on society, send a positive message to the class that how technology can help in a critical situation. Since our video conference system was built, the teams involved in final year projects have used this system to communicate about their graduation projects.

12.4.2 Internet of Things (IoT) and Cloud Technology

Amazon AWS (2021) being one of the earliest cloud solution providers, Amazon AWS invested lots of resources in the education sector. Their educational supporting programs include Amazon Educate and Amazon Academy, while the first one is a program with around 300 selected teaching and working professionals to become an Amazon AWS Educate Faculty Ambassador, to promote the use of cloud technology to the general public; the latter one is aimed to facilitate teachers at the schools in daily teaching use. Apart from the Amazon AWS resources, we also utilized the database resources and free examination vouchers powered by Oracle (David & Anbuselvi, 2015). By having the Oracle Cloud resources used in the teaching environment, we provide a real-world setting to the students on how various kinds of technology can work together in project development.

12.4.3 Productions

The best place to perform the final year project experiment is where the school can provide a space for students to create and innovate. In a project of Smart Shop Laboratory (HKIVE, IT/TM, 2019) by the Department of Information Technology, Hong Kong Institute of Vocational Education (Tuen Mun), and the Fashion Archive (FA) by the Department of Fashion and Image Design (FID), Hong Kong Design Institute (HKDI) (FID/HKDI, 2019). Teachers and students work out together to implement various kinds of technological products such as blockchain, system control, mobile payment, remote sensors, etc (Fig. 12.2).

Fig. 12.2 S-SHOP@TMIT, the first unmanned technological smart technology laboratoryfor research, teaching and research purpose (*Source* Department of Information Technology, Hong Kong Institute of Vocational Education (Tuen Mun))

12.5 Final Year Project and Capstone Project

Final Year Project, commonly known as FYP in Hong Kong, is a year-long practical course enrolled by final year students in the tertiary education. The aim of FYP is to allow students to work out what they have learned in school from the very first day of their fundamental study, till the end of the program to master complex and advance skills to create and manipulate project and business case. In other countries, such as the United States, Final Year Project (FYP) is called Capstone Project. There are no major differences in the course context apart from what it is called. In an engineering discipline, or courses, research topics related to the technology concept (Halim et al., 2014), require hands-on experiment to try things out. It is more and more common that the business faculty used to this approach to train their students, due to the facts that technology involved everywhere in the new innovation, business place and working environment.

In the next section, we will share two example cases about how the project supervisor act as a facilitator to transform a student project into a real-life product. These two cases are managed by the students from the author: A Higher Diploma (HD) student majoring in Information Technology (IT), and the other one is a degree student majoring in Business Administration (BBA). They are both having their final year study in the year 2020, suffering from the big changes mentioned above under the COVID-19 in their learning journey.

12.6 Case Study: Health Information System (HIS), and Logistics Research Project

A Health Information System (HIS) is a computer system designed for the use of healthcare data management. HIS comprises different functional modules such as patient system, drugs system, accounting system, human resources system, etc. (Haux, 2006). In the first case study, a mature student, Daisy, a student who enrolled in the Business of Administration (BA) program, an offshore degree program offered by the University in the United Kingdom, a year before the outbreak of COVID-19. She is a human resources officer who is working in a private hospital in Hong Kong. The reason why she pursued a bachelor's degree is mainly aimed to enhance her competitive power in the career ladder and seek more understanding in a scholarly manner to support her daily work. One of her observations in the daily operation is that the high pressure from the medical officer in their daily job, is the misuse of technology, in both over-use and under-use scenarios. Daisy believed that by sorting out her observation in an organized manner, with the theoretical support from academia, it could be a possible small innovation and enhancement to her industry.

At the very first beginning, Daisy did not realize that her final year project can become a potential solution for her working hospital. After series of discussions with us, we try to suggest an alternative where her idea can be write-up as a mini proposal, then via our professional network, seek and source interested parties to be a pilot tester. After several months' connection and presentation, we found a private clinic that operating several shops in Hong Kong. Daisy agreed that having a real-life example can make her study more visual and easier to picture the pain points. It's lucky that by the end of her project study, the clinic is willing to pay a fee as a format of private scholarship, praise the hard work of the student.

In our second case, student DL is a higher diploma student major in information technology. DL is a hard-working student who is in his final year of study. By participating industrial attachment program offered by his department, each of the students is required to complete ninety (90) hours of workplace training offered by the indusial partner. The aim of the industrial attachment program is to provide workplace experience, allowing students to experience what would happen in the real world.

DL was assigned to an SME logistics company that provides transport services between Mainland China, Australia, and United States. Under the COVID-19, similar to many other industries, their normal operation is greatly affected by the border closure. The company received lots of complaints and inquiries about the status of goods, arrival status, and price issues. The current system used by the company is canned software which provides the standard template, standard format, and limited configuration options (Dannewald et al., 2007).

DL suggested to his teacher if he can make a suggestion to the company that he can cater to the need of the customer under this special situation, making additional add-on, plug-in to the system to fulfil the needs of extra requests. This task requires over 300 h of development time and we are glad that DL is willing to put extra effort on top of his 90 h duty. We then suggested to the company if we can partner with them for the extra development project as a final year project to make it work. Final results are favourable and similar to Daisy, DL is awarded additional remuneration.

12.7 Make It Work in Real Life

The make-it-to-work concept in the cases above is not talking about a million-value project. As a teaching staff, our goal is to educate students, motivate them and maximize their potential in appropriate areas. We value the outputs from the above cases including how a conceptual product is actually using in the real-life scenario, how the students opened a new door to an unknown potential apart from the learning journey, and how the industrial partner resolves their problems with research outputs from the academia.

As we can see from the above cases, some of the elements are essential to the success of the commercialization: student passion, appropriate business partner, and a facilitator. We strongly encourage teachers, especially those who supervise in the final year project: FYP is one of the important modules that show the student's capability after all these years of learning in one place. Their potential employers are looking forward to the FYP showcase: this is exactly how the importance and the value of vocational education and applied to learn. We want our students not only to understand the theory, but we also want them to transform their knowledge, supported by the theory, into something practical to the world. How students can be motivated is one of the primary tasks for the teachers.

On the other hand, appropriate business partner: we noticed that some of the training partners offered routine work to the training students, we understand that this is an effective way to train students to get used to the daily operation of the business. We would like to suggest an alternative, which a training partner can set up a preliminary survey, offering a short project overview about the company, this may provide out-of-expectation bonus just like the two successful cases mentioned above.

12.8 Conclusion

It is now the year 2021, almost two years' time after the COVID-19 outbreak: people started to adapt and get used to various kinds of new normal in daily life. With the introduction of remote learning technology, cloud technology; and by the influence of the Work-from-Home (WFH) concept, these kinds of new interactions made the chemical reaction interesting in the form of the new economy, included but not limited to the way how people educate, how they innovate the new idea into the business, and how they make it grow into the next unicorn.

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Chapter 13
Does Online Practice Based on an Adaptive Curriculum Work Better than Written Feedback for EAP?

Tristan Currie

Abstract This article compares 12 Masters' students at a Hong Kong University with Pre-Advanced level fluency with a control group, who completed online practice exercises receiving written feedback only on essay draft samples, submitted to their communication tutor for feedback prior to formal essay submission to their lecturers. The aim of this study is to discern whether written feedback, focusing only on essay structure, can be taught solely by feedback on student output (their own writing), or if practice in identifying structure features (in other peoples' writing) is a necessary component in teaching Academic English. Class average scores were found to be slightly higher for the written feedback only group, however the relatively low skill-related scores in "positioning" suggests that a skills deficit existed. Thus, feedback alone was deemed insufficient, and three recommendations were made related to the use of rubrics, adaptive curricular and the role of practicing "positioning".

Keywords Adaptive curriculum · Written feedback · Digital learning environment

13.1 Introduction—Course Syllabus

This paper compares two semesters of running the same subject "MPP enrichment" as part of the Master of Public Policy program at HKUST. The MPP Enrichment A121 (T2) subject is for the purpose of providing Academic writing enhancement opportunities for students. The first time the subject was run the students received essay feedback only after watching online lecture videos about Academic English Skills. The second time it was run an adaptive curriculum was used along with the essay feedback from an external website called NoRedInk.com. This paper aims to compare the written essay feedback and adaptive curriculum results side-by-side from both semesters. Below is the syllabus for the subject for the first semester and for the second semester:

[First semester]

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The MPP Enrichment A121 (T2) subject is for the purpose of providing Academic writing enhancement opportunities for 1st, 2nd, and master's level HKUST students. The subject involves watching three, 30 min lectures regarding the academic writing skills: "drafting", "reasoning" and "positioning".

[Second semester]

At the end of the three previously named modules there are assessment tasks to be completed as online tasks at www.noredink.com

Drafting assessment tasks

- Online practice essay

Reasoning Assessment tasks:

- Identifying Claims, Evidence, and Reasoning

Positioning Assessment tasks:

- Formal and Informal Language

13.2 Teaching Academic English as Skills: Drafting, Reasoning and Positioning

Systemic Functional Linguistics was the theoretical basis upon which students were guided towards improved use of Academic English in their essay writing. By concentrating on three core skills of (1) Drafting, (2) Reasoning and (3) Positioning, a practical emphasis was placed on what students should be able to do with their writing after having completed the enrichment subject. A quick description of what these three skills are in theory and in practice now follows.

At the end of this section, some examples of how these three skills can be taught either using direct written essay feedback or using adaptive curriculum tasks, are described. The examples are taken directly from student work from the two semesters at HKUST. They are not an exhaustive list of feedback types but are included for illustrative purposes.

13.2.1 How the Skill of Drafting Can Be Taught

In theory, the skill of drafting concerns clarity of expression. In practice, it involves separating out the main argument, separating out the premises and separating out the conclusions drawn in an essay and then rewriting them using a clear, non-repetitive order so that what you are trying to say (or claim) is clearly presented to the reader. A student that possesses the skill of drafting should be able to write using a clear paragraph structure, avoiding repetitive writing, and using signposting to improve readability.

In essay feedback comments, the following types of *clarity of expression* related feedback were given:

- *ensure key concepts are defined early in the essay (avoid ambiguity, give practical descriptions).*
- *use a variety of connectives to link sections and sub-sections of text smoothly and substantively.*
- *you said this earlier, it is redundant, cut it.*

Note. In an adaptive curriculum the following additional types of feedback/practice were given:

- Completing practice essays that provide paragraph heading descriptions, and paragraph word limits,

  E.g., "Introduction", "Body Paragraph #1", "Body Paragraph #2 (optional)" and "Conclusion".
- From completed practice essays a holistic rubric-based overall score is given, I.E "with all criteria to be included in the evaluation being considered together (e.g., clarity, organization, and mechanics)" all receiving individual scores that are then averaged out to one final essay mark (DePaul Teaching Commons, n.d.).

  See an example of this in Fig. 2.1

In theory, the skill of reasoning concerns soundness of argument alone. In practice, it involves identifying basic text structures (Descriptive versus Cause & Effect versus Argumentative) and then applying a process of critical thinking to ask core questions about the logical foundations of that text and the reasoning that supports it conclusions.

A student that possesses the skill of reasoning should be able to match and recreate the basic text structure of the essay question to the text structure the essay answer necessitates. They should also be able to apply critical thinking to their own writing to identify any rectify any logical fallacies present.

13.2.2 How the Skill of Reasoning Can Be Taught

In essay feedback comments the following types of *logical soundness* related feedback are given:

- *clearly define the scope of your argument, state which context/s (state/national or public/private) you include.*
- *Including evaluative statements with a direct quote is a powerful form of evidence. Give evidence frequently.*
- *Summary should include a clear problem and solution.*

Note. In an adaptive curriculum the following types of practice were enabled:

- Individually identifying Claims, Evidence and Reasoning from sample paragraphs taken from student relevant literature.

In theory the skill of positioning concerns reader engagement by creating a feeling of necessity and obligation in the reader towards what is being said by the writer by understanding who your intended audience is and meeting their expectations.

In practice it involves highlighting the central role of evaluative language alongside quoted material and use of hedging and intensifiers to convey one's point of view fairly, by being succinct and subtle in tone of language, yet keeping the purpose of your text (to persuade a disbelieving audience, or to instruct, to explain, etc.) central to the way the message is presented.

A student that possesses the skill of positioning should be able to improve the academic tone of language used by clearly discerning subjective and objective claims, expressing a point of view unambiguously yet even-handedly, and being able to enhance a text by being succinct, subtle, and nuanced in the delivery of their message.

13.2.3 How the Skill of Positioning Can Be Taught

In essay feedback comments the following types of *reader engagement* feedback are given:

- *introduce the structure of your argument first before the detail, to entice the curiosity of the reader.*
- *the meaning of tables can lead to differing opinions, so put a descriptive title below your visual data,*

that states your intended meaning (interpretation). Otherwise, the reader may not get your point.
- *Is this a summary using your own words or a quote? Your point of view is not clear enough in your conclusion.*

Note. In an adaptive curriculum the following types of practice were enabled:

- Recognising tone by Individually identifying formal and informal language in sample paragraphs taken from student relevant literature.

In the essay that follows, two semesters of the same Academic English subject will be compared. The comparison will be made by analysing the essay writing of the experimental group (who received feedback and adaptive curriculum learning materials in 2021) with the control group who only received direct written feedback in 2020.

Once the methodology for data collection and analysis is discussed, results in the two main areas of "Student Engagement and Writing Autonomy" and "Evidence of Academic skill application" will be presented. Finally, some recommendations regarding teaching Academic English, especially in the areas of curriculum material choices and longer-term academic literacy will be made.

13.3 Data Collection

13.3.1 Participants

For the master's program, entry requirements for students are to have obtained an overall score: of 6.0 on the IELTS (Academic Module). Thus, the experimental group (essay feedback only) were 12 Masters' level students at HKUST with Pre-Advanced level fluency in the year 2020. The control group (written feedback and Adaptive curriculum) were 12 students who completed online practice exercises in the year 2021, of the same fluency level.

13.3.2 Research Design: Adaptive Curriculum

Analysis focuses on the results of students that received both written and adaptive curriculum feedback with those that received written feedback only.

13.3.3 Approach to Analysis

The aim of this study is to discern whether written feedback, focusing only on essay structure (as opposed to content), can be taught solely by feedback on student output (their own writing), or if practice in identifying structure features (in other peoples' writing) is a necessary component in teaching Academic English effectively in mixed-mode teaching settings.

13.4 Evidence of Engagement and Academic Skill Application

13.4.1 Student Engagement and Learner Autonomy

Previous research has shown that it is the relevance of the material to the students that drives learner engagement with materials. As Mercer (2019) explains,

> "In order to be willing and ready to engage, learners need to be in the right frame of mind to do so. To better understand what the key motivational antecedents for engagement are… (we must look at) insights from self-determination theory (SDT). This theory suggests that we all have needs that must be met in order for us to feel willing to engage with learning opportunities"

In Table 13.1 "page views" are interpreted to be a fair representation of student engagement, while "Participations" are interpreted to fairly represent learner autonomy because participations are a count of times students have contributed to a specific page on the Canvas Learning management system used by HKUST as a digital learning environment. Figure 13.1 supports the research position that use of relevant materials fosters learning opportunities, because in Fig. 13.1 we can see the highest amount of page views occur during the earliest module (drafting). Though the number of page views declines from first module to last (second column of Table 13.1), a steady "participations" level can be seen during the second and third modules (third column of Table 13.1). Based on the above evidence it is believed that student engagement and learner autonomy for both the experimental and control groups were sufficient to enable meaningful comparison of the two groups.

Table 13.1 Total page views and online participation by students over two semesters. (*Source* Canvas)

Resource	Page views	Participants
Module 1—Drafting—assessment	167	10
Module 2—Reasoning—assessment	42	4
Module 3—Positioning—assessment	21	4

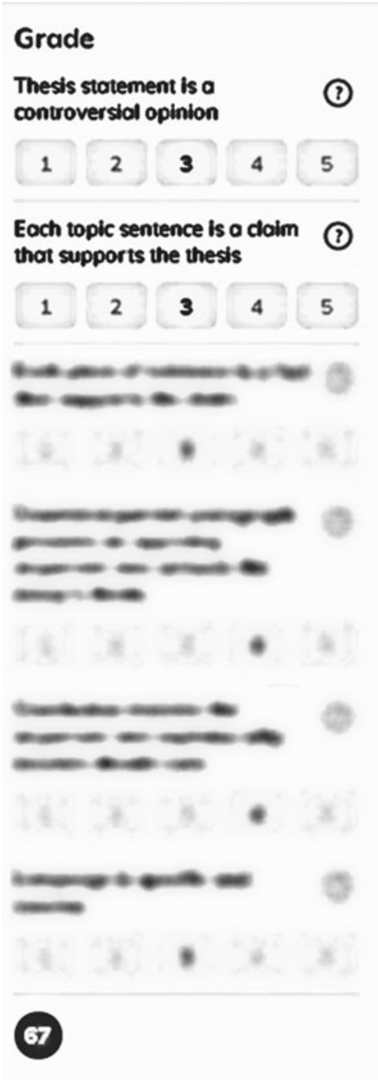

Fig. 13.1 A holistic rubric with scaler criteria out of 5 and a total score out of 100. (*Source* NoRedInk)

13.4.2 Evidence of Academic Skill Application

Class average scores are slightly higher for the written feedback only group, however the relatively low average score out of twenty, particularly for the skill of positioning suggests that there clearly is a skills deficit in this area. It may be that feedback alone is insufficient and what is needed is sufficient time for practice of these other skills, before they will result in a tangible improvement in overall essay quality (Tables 13.2 and 13.3).

Table 13.2 Class average score, control group—written feedback only. (*Source* Canvas)

	Module 1—Drafting—assessment (100 points)	Module 2—Reasoning—assessment NOT ASSESSED	Module 3—Positioning—assessment NOT ASSESSED
Class average	67		

Table 13.3 Class average score, experimental group—Adaptive Curriculum. (*Source* NoRedInk)

	Guided Draft Due Oct 31 Module 1—Drafting—assessment 100 points	Practice Due Nov 30 Module 2—Reasoning—assessment 20 points	Practice Due Dec 4 Module 3—Positioning—assessment 20 points
Class average	67	16	7

13.5 Recommendations

13.5.1 Adopt Analytic Rubrics Rather Than Holistic Rubrics

The disadvantage of a holistic rubric is that it "Does not provide specific feedback for improvement. When student work is at varying levels spanning the criteria points it can be difficult to select the single best description. Criteria cannot be weighted" (DePaul Teaching Commons. (n.d.)). With Analytic rubrics the advantage is they "provide useful feedback on areas of strength and weakness. Criterion can be weighted to reflect the relative importance of each dimension." (DePaul Teaching Commons. (n.d.)).

When given written feedback on essay drafts individual comments can become a bit of hit- and-miss affair. Singular comments on singular essays may at first glance by the learner seem arbitrary points of order rather than tangible learning opportunities. That is why written feedback (with comments in the margin of the essay) accompanied by an average score based on an analytic rubric is recommended, to give the feedback functional context.

13.5.2 Adaptive Curricular Are More Engaging but More Time-Intensive

The adaptive curricular used during these semesters was developed by a third-party website called www.noredink.com who claim that "the adaptive curriculum engages learners by personalizing exercises to their interests, boosting their skills through differentiated practice, and guiding them step-by-step as they draft and revise essays (NoRedInk Corp. (n.d.))."

The amount of time involved in being able to collect, sort and make accessible online this many different sources of popular young adult novels is quite formidable for a EAP teacher working alone. It is important to point out that, even though the experience has been that an Adaptive Curriculum was more engaging with students, this was only practical by engaging the services of a third-party to prepare these materials. Lecturers with access to and assistance from a well-funded and helpful library staff could undertake such an enterprise given sufficient preparation time. Individuals teaching a course alone would need to be comfortable working with third-party materials. So, while an adaptive curriculum can alleviate the problem of reduced relevance of the learning material to the young adult student, and they are a bountiful resource especially during COVID19 restrictions, it is best to remember they are a time-intensive resource to develop in the first place.

13.5.3 Feedback Improves Scores, Practice Improves Skills. Use Both

Though developing an adaptive curriculum from scratch is time intensive it does open new avenues of mixed mode teaching possibilities. Throughout the two semesters of teaching Academic English skills to master's students it was clear anecdotally from students that they found written feedback to their essays very useful.

The challenge with teaching Academic skills is that the bulk of the work might end up in focusing solely on proper referencing. Though teaching proper referencing techniques is very important, so too is nurturing the long-term academic literacy of students, particularly as they find themselves pursuing post-graduate trajectories. That is why this research focused on those skills (drafting, reasoning, positioning).

The data presented here supports three recommendations: Firstly, adopting analytic rubrics to give written feedback functional context makes that feedback more digestible for students. Secondly, using elements of adaptive curriculum to keep learning materials as relevant to the learner as possible benefits both student engagement and learner autonomy. Thirdly and finally, using a combination of written feedback along with the opportunities to practice skills (using adaptive curriculum) make both short term (proper referencing) and long-term academic literacy ambitions realisable.

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Chapter 14
Improving Students' Learning Experience Using Simulated Environments in Applied Degree Education in Architecture, Engineering, and Construction

Shoeb Ahmed Memon, Nipuni Sumanarathna, and Aravinda Adhikari

Abstract An applied degree education is about using work-integrated learning approaches in student learning. Unfortunately, the Covid-19 pandemic has severely affected how applied education may continue to enrich students' knowledge of the real world. In various degree programs, a simulated environment is an essential part of the curriculum and applying it to applied degree education cannot be ignored. A simulated environment plays an essential role in linking theoretical knowledge acquired in the classroom to the real world. It exposes students to real-world problems but in a controlled simulated environment. This chapter introduces several approaches in creating simulated environments for applied degree programs in Architecture, Engineering, and Construction (AEC). It discusses the key benefits of using technologies, such as Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and the A Real Organization Unit Simulated as Life (AROUSAL) system, to improve the student learning experience in applied degree education in AEC.

Keywords Applied degree education · Architecture · Engineering · and Construction (AEC) · Teaching and Learning (T&L) · Simulated environment

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14.1 Introduction

Applied degree programs are part of the education system in Hong Kong. The Education Bureau (EDB) has recently announced a Pilot Project on developing applied degree programs in the self-financed degree sector. These programs aim to promote Vocational and Professional Education and Training (VPET) and produce skilled human resources for professions such as Architecture, Engineering, and Construction (AEC). It is advocated that an applied degree education provides a perfect blend of theory and practice for students to produce work-ready graduates (Hong & Ma, 2020).

The demand for work-ready graduates has recently surged in AEC industries, since they are heavily reliant on a skilled workforce. Additionally, it is not very common to find recent graduates with traditional degree qualifications who also have applied skills. The mainstream degree programs taught at universities generally focus on building students' theoretical knowledge with some practical experience from site visits, internships, and industry projects. This enables students to have a general overview of industry practices; however, additional work experience is required for students to polish skills in a particular area in the field.

On the other hand, applied degree programs offset these obstacles to provide a market-oriented workforce. The task force established by the Government of Hong Kong suggested that an applied education program should have at least a degree-level qualification, which accommodates applied skills as part of the admission requirements, provides a good blend of theory and practice for the holistic development of students, and has strong industry involvement. An applied degree education enables students to polish their skills during their degree. For example, in AEC programs, students can polish their skills through heavy laboratory work (e.g., concrete, Building Information Modelling (BIM), geotechnical, pavement), supervised work-integrated learning program with industrial partners (e.g., with architectural firms, contractor companies, or building services companies), and complete industry-oriented final year projects, as well as regular course work. These activities ensure that graduates are equipped with applied and professionally relevant skills.

In an ever-changing world, delivering applied degree education has become a challenging task. The new challenge brought about by the Covid-19 pandemic has made it almost difficult to provide students with real work exposure (e.g., laboratory experiments, onsite training, and visits). An applied degree in AEC requires both classroom teaching (theoretical knowledge) and experiential learning. Instructors in the field are now adopting technological tools to provide a simulated environment to mimic reality. The recent technological advancement and digital transformation, such as Industry 4.0, creates intelligent networks through automation, Building Information Modelling (BIM), Artificial Intelligence (AI), Internet of Things (IoT), Big Data (BD), Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and A Real Organization Unit Simulated as Life (AROUSAL), have transformed AEC education, requiring better information management (Agdas et al., 2019). Likewise, these digitalized elements can successfully be incorporated into learning for an applied education in AEC. On the one hand, students are provided with an alternative for continuing their education during the pandemic. On the other hand, students can receive hands-on experience of recent technologies and digital transformation globally, which meets the criteria for applied education and the industries in AEC (Pan, Chen, & Zhan, 2020).

In this chapter, we review the teaching and learning requirements of applied degree education in AEC and the difficulties that occur particularly due to the covid-19 pandemic situation. Most importantly, we elaborate on the possibility of using simulated environments to enhance students' learning experience in the context of applied degree education in AEC.

14.2 Applied Degree Education in Architecture, Engineering & Construction

An applied degree education is about using work-integrated learning approaches in student learning. Globally, universities, colleges, and tertiary education institutes have long been delivering undergraduate and postgraduate degree programs. Applied education degrees are provided through academia-industry partnerships (Chapman & Kirby, 2008). It has become a de-facto prerequisite for becoming a professional (i.e., Architect, Engineer, and Surveyor) in the AEC industry. Some of the major applied degrees in the AEC field are civil engineering, construction engineering, construction technology, building construction, architecture, surveying (quantity/land), and town and country planning (Abudayyeh et al., 2000; Irizarry, Meadati, & Gheisari, 2010; Tener, 1996). Table 14.1 below presents a summary of AEC degree programs.

The degree programs listed in Table 14.1 are designed with teaching and learning in mind to cover both theoretical and practical knowledge. Hence, the education mission, objectives, curriculum, course content, and even the qualifications of educators are determined and delivered through industry-academia collaborations (Tener, 1996). In addition, academic institutions that deliver applied degree education use several dimensions to enhance students' exposure to the industry, such as supervised work-integrated learning programs, site visits, laboratory experiments, and learning in virtual environments (Chernikova et al., 2020; Tener, 1996).

These degree programs strictly follow professional standards and institutional regulations to produce work-ready graduates. Educational institutions may make several changes to align the curriculum with any technological developments and market needs. For example, changes need to be made to individual courses when the industry transitioned from using traditional AutoCAD software to BIM (Abdirad & Dossick, 2016) and introducing a new engineering contract as part of the curriculum. More importantly, educators and researchers emphasize designing a curriculum comprising phenomena such as interdisciplinary collaboration, as it is becoming

Table 14.1 Applied degrees for AEC

Program	Focus	Source
Civil Engineering	• Produce leaders and engineers in civil engineering practice (i.e., design of facilities such as environmental, geotechnical, structural, transportation, or water resources) • Comprises of both undergraduate and taught postgraduate degrees	Tener (1996); Abudayyeh et al. (2000)
Construction Engineering/ Construction Management	• Prepare students for the engineering and management positions • Programs strike a balance between engineering, management, and business aspects of the industry • Comprises of both undergraduate and taught postgraduate degrees	Tener (1996); Abudayyeh et al. (2000)
Construction Technology and Building Construction	• For entry-level construction engineers • Usually, undergraduate programs	Tener (1996)
Surveying	• Produce surveying professionals (quantity, land, and building surveyors) • Quantity surveyors specialize in areas such as cost management, procurement, and value management • Land surveyors specialize in land surveying • Building surveyors specialize in building management and life cycle costing	Wong et al. (2007)
Architecture	• Produce architects who are usually considered as the leader of the construction process • Architects design and visualize the structure based on the client's requirements • Landscape architects design the landscape of the structure • Both undergraduate and taught postgraduate degrees	Boarin et al. (2020)

(continued)

Table 14.1 (continued)

Program	Focus	Source
Town and Country Planning	• Produce planners who design and create liveable human settlements for people • Both undergraduate and taught postgraduate degrees	Mohamed (2016)

standard practice in the AEC industry (Irizarry et al., 2010). Thus, curriculum modifications enhance the interdisciplinary collaboration component in AEC degree education (Abdirad & Dossick, 2016). Besides BIM, other aspects of project management, construction safety, design, construction procurement, and innovation require practical/real-world experience, other than mere theoretical knowledge (Abudayyeh et al., 2000; Senior, 1998). Hence, students' knowledge should be taken to the required level, and this level would be achieved by maintaining the quality of teaching and learning.

14.3 Bloom's Taxonomy and Applied Degree Education in AEC

The proposed Bloom's Taxonomy of Educational Objectives focus on skills that we wish students to master going forward (Bell & Fogler, 1995). Bloom's Taxonomy is a result of the efforts from educators trying to improve teaching effectiveness through clear objective identification. It is a widely used taxonomy to measure the appropriateness of course materials, and for applied degree education, it is no exception.

The original taxonomy has six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Paul, 1985). Later, the revised version, called "*a taxonomy for teaching & learning and assessment*", focuses on the dynamic classification of knowledge and cognitive processes used by students while working with knowledge (see Table 14.2). The revised taxonomy adopts verb and action word approaches to describe the cognitive processes (Krathwohl, 2002).

In general, a teaching and learning plan contains the intended learning outcomes that an instructor plans to achieve through different instructional methods/techniques. It contains both the core subject matter and what needs to be done, which is the intersection point between knowledge and the cognitive process as described in the revised Bloom's taxonomy. For example, the statement: students will be able to remember new engineering contract applications in construction. The initial part of the statement presents a verb phrase "*students will be able to remember*," and the latter is the noun phrase "*new engineering contract application in construction.*" Although the original version of the taxonomy considered a noun and verb structure in a static form, it was more beneficial to keep it separate and provide clear directions

Table 14.2 Structure of the knowledge and cognitive process dimension of the revised taxonomy

Knowledge Dimension	Cognitive Process Dimension
Factual Knowledge—*The basic elements that students must know to be acquainted with a discipline or solve problems in it*	**Remember**—*Retrieving relevant knowledge from long-term memory*
• Knowledge of terminology	• Recognizing
• Knowledge of specific details and elements	• Recalling
Conceptual Knowledge—*The interrelationships among the basic elements within a larger structure that enable them to function together*	**Understand**—*Determining the meaning of instructional messages, including oral, written, and graphic communication*
• Knowledge of classifications and categories	• Interpreting
• Knowledge of principles and generalizations	• Exemplifying
• Knowledge of theories, models, and structures	• Classifying
Procedural Knowledge—*How to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods*	• Summarizing
• Knowledge of subject-specific skills and algorithms	• Inferring
• Knowledge of subject-specific techniques and methods	• Comparing
• Knowledge of criteria for determining when to use appropriate procedures	• Explaining
Metacognitive Knowledge—*Knowledge of cognition in general as well as awareness and knowledge of one's own cognition*	**Apply**—*Carrying out or using a procedure in a given situation*
• Strategic knowledge	• Executing
• Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge	• Implementing
• Self-knowledge	**Analyse**—*Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose*
	• Differentiating
	• Organizing
	• Attributing
	Evaluate—*Making judgments based on criteria and standards*
	• Checking
	• Critiquing

(continued)

Table 14.2 (continued)

Knowledge Dimension	Cognitive Process Dimension
	Create— *Putting elements together to form a novel, coherent whole or make an original product*
	• Generating
	• Planning
	• Producing

Source Adapted fromKrathwohl (2002)

Table 14.3 The placement of objectives on the taxonomy

The cognitive process dimension						
The knowledge dimension	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create
A. Factual knowledge						
B. Conceptual knowledge			Objective one			
C. Procedural knowledge						
D. Metacognitive knowledge						

Source Krathwohl (2002)

to the instructors by visualizing the objectives in a two-dimensional table (see Table 14.3). For example, students shall *apply key management practices of NEC contracts* (e.g., payment procedures, compensation events, schedule of cost components, final accounts, and dispute resolution methods) in projects. The placement of noun phrases in a statement *"key management practices*", which correspond to the knowledge dimension in the taxonomy. On the other hand, "applying it" would correspond to the cognitive process dimension, as shown in Table 14.3.

The two-dimensional Table 14.3 is a highly effective tool for instructors to visualize objectives, activities, and assessments for a course (Krathwohl, 2002). Table 14.3 can be adopted in applied education for AEC. Once all objectives are plotted on the table, it can guide instructors to design and re-design course curriculum to focus on tasks and activities relevant for an applied degree education, such as to focus on applying knowledge learned in practice and analysing and creating context-specific knowledge that is needed for the situation in AEC.

Traditional AEC programs require students to complete internships to gain industry experience. The internship is usually unsupervised or may not even involve work-related experience. Since most engineering and construction sites involve heavy industrial work, it poses a hazard for students who have not received training on fundamental safety issues. These unstructured/unsupervised internships may not be effective for improving the overall understanding of the practice. Thus, the concept of work-integrated learning is gaining momentum to offer students supervised work experiences in a particular field. Since AEC are predominantly applied fields, it requires students to have exceptional knowledge and understanding of the practice. To work in these fields, students need to learn and utilize their learned knowledge and polish their skills to become work-ready graduates.

In the case of the Technological and Higher Education Institute (THEi) of Hong Kong, students are required to complete a supervised work-integrated learning training with industrial partners before students are allowed to graduate. This way, through their work-integrated learning activities, students can apply the knowledge they learned in the field to their jobs after graduation. The feedback from industrial partners in work-integrated learning reports and logbooks provides an opportunity for instructors to reflect/adjust intended learning outcomes to suit the appropriate level of knowledge, align objectives, activities, and assessment tasks using Bloom's Taxonomy for the cohort of students.

Apart from aligning objectives, activities, and assessment, teaching and learning styles may contribute significantly to student learning and thus shape knowledge delivery in AEC degree programs. The Felder and Silverman learning style classification provides essential grounds for applied education in AEC. They suggest that engineering students prefer the learning style for type 1 students, which involve facts, pictorial representation, observation, practice, and learning by doing (Felder & Silverman, 1988), yet most teaching styles in AEC provide a teaching style best suited for type 2 students (see Table 14.4). It is a common practice that instructors in AEC heavily rely on theories, discussions, and explanations to understand the subject matter. Felder and Silverman (1988, p.678) explained that "*Active learners do not learn much in situations that require them to be passive, and reflective learners do not*

Table 14.4 Teaching and learning styles

Classification of students	Type 1	Type 2
Sensory/Intuitive	Prefer facts, data and experimentation	Prefer concepts, principles and theories
Visual/Verbal	Prefer pictures, diagrams, charts, movies, demonstrations and exhibitions	Prefer words, discussions, explanations, formulas and equations
Inductive/Deductive	Prefer observations and natural learning approach to develop principles	Govern principles to develop applications and natural learning approaches
Active/Reflective	Learn by doing and participating	Learn by thinking or pondering
Sequential/Global	Learn step by step. May understand the subject partially yet it's effective	Must see the whole picture to understand the entire subject

Adapted from Felder and Silverman (1988) *learn much in situations that provide no opportunity to think about the information being presented*" (p.678). Thus, they highlight the need to align teaching styles to reflect student's needs. Although we cannot underscore the importance of both types of students and their learning preferences in a single lecture room, we can benefit from the best of both worlds and devise a teaching style to deliver effective teaching and achieve learning outcomes for applied education in AEC.

14.4 Impact of Covid-19 Pandemic on Applied Education in AEC

According to the International Association of Universities (IAU) Global Survey Report (2020), the Covid-19 pandemic has affected schools and higher education institutes in more than 185 countries, resulting in the disruption of education of more than 500 million learners. Even in these disruptive environments, some educational institutes managed to continue teaching and learning through online lectures, learning management systems, and video-recorded lectures (which was also the case in most of the higher education institutes in Hong Kong, SAR China). However, the impact on learners remained significant. On the one hand, most educational institutes had been using conventional approaches due to a lack of adequate knowledge, skills, and resources for online learning, to respond to the rapidly changing environment. On the other hand, online teaching does not comply with specific skills and learning styles (i.e., Bloom's taxonomy, 1956), and teaching and learning styles (Felder & Silverman, 1988). For example, online teaching lacks experimentation and real-world experience, particularly in applied degree education (Basha et al., 2021). Thus, responding to rapidly changing situations became difficult for many educational institutes.

The transition from conventional teaching to distance teaching has been difficult for both institutes and learners because technological infrastructure and the availability of online access are prerequisites for distance teaching and learning. From the learners' perspective, not having access to the online teaching platforms due to financial difficulties (particularly in developing countries) and other social phenomena (i.e., psychological impact from social distancing and disruptions at home) have made distance learning a daunting task. Even if these issues were managed, most institutes have claimed that they did not have the most suitable technical infrastructure to optimize distance learning (IAU Global Survey Report, 2020). Another essential issue that institutions are suffering from is insufficient teaching staff with capabilities to conduct distance teaching. Hence, the quality of teaching is unguaranteed. Moreover, the fields that require 'learning by doing' in specific conditions (i.e., site visits, laboratory experimentation) have failed to compromise with distance learning (c.f. Howell et al., 2003).

Nevertheless, educators in such fields have come up with alternative teaching and learning strategies to minimize the negative impacts of distance learning. In relation to applied education in AEC, introducing and promoting technical infrastructure that provides 'real-world experience' has been a game-changer (Chernikova et al., 2020).

14.5 Simulated Environment for Applied Education in Architecture, Engineering & Construction

Architecture, Engineering, and Construction are predominantly applied fields, where students are required to undertake heavy laboratory work, conduct site visits, complete work-integrated learning training, design studios, and many other roles, which require a physical presence of teachers and students. In a situation where the Covid-19 pandemic has severely affected the education and work environment, a simulated environment may replace many activities that would otherwise require a physical presence. A simulated environment provides the closest version to reality without risks and limitations from real life. As defined by Cook et al. (2013), simulation is an educational tool that provides physical interaction to learners through mimicking real life. It is often described to reproduce an environment by offering real-life characteristics of a situation. According to Chernikova et al. (2020), simulation-based learning eliminates the distance between real life and academic knowledge studied by the students. They describe simulation-based learning as an opportunity for students to have an active role in work and learn on a trial-and-error basis.

A simulated environment also provides an opportunity to regulate reality as instructors deem fit for teaching and learning situations and meet educational needs. For example, explaining safety risks associated with cranes in a construction site may be easier to explain in a simulated environment through virtual reality than in actual practice, as onsite visits may have associated risks. Virtual reality may provide opportunities for students to practice crane operation as well, which otherwise would be an expensive activity to cover, as well as being extremely difficult to organize on a construction/training site. Similarly, an architect/instructor can use virtual, augmented, or mixed reality environments to create real-time videos of proposed projects to help explain to students/clients' issues related to design and any changes. The most important aspect of using a simulated environment in education is the feedback to learners to identify issues and expectations. Chernikova et al. (2020) explained that the environment involves interaction with a simulated reality, which allows learners to perform role-play activities and arouse critical thinking and problem solving for skill development. It provides a controlled environment to focus on key aspects of students' learning and skill development, such as virtual reality games for confined space training, working at heights, and safety issues.

Although many approaches are available to create a simulated environment for specific needs, some commonly used technologies to create a simulated environment in applied education for AEC are discussed below.

14.6 Virtual Reality, Augmented Reality, and Mixed Reality

Virtual Reality (VR) is explained as: a newly emerging computer interface characterized by high degrees of immersion, believability, and interaction, with the goal of making the user believe, as much as possible, that s/he is actually within the computer-generated environment, as opposed to being an external observer looking in (Bell & Fogler, 1995, p.1719).

It provides essential means to realize theory into practice using a simulated environment. VR has been incorporated in several educational programs in universities around the globe. It provides instructors with an opportunity to design specific VR modules in compliance with Bloom's Taxonomy and teaching and learning styles to suit skill needs (Bell & Fogler, 1995). The ability of VR is to provide a real-time experience without major expenses on the actual work, making it suitable for educational use (Olmos et al., 2018). According to Hamilton et al. (2021), the effective use of VR as a pedagogical tool can only be appreciated when adequate consideration is given to assessment and learning outcomes. They highlighted the role of immersive VR in architecture and engineering studies to visualize the concepts and ensure a better understanding of complex problems. As a result, it helps students to retain knowledge processed through VR tools. It is reported that cognitive processes invoked by VR add value to the activity because it enables a user to develop context-specific knowledge (Araiza-Alba et al., 2021). According to Rupp et al. (2019), direct exposure to the learning environment, like actual situations, improves VR use in education and practice using VR games, 360-degree videos, and intervention-based VR training programs. These technologies are widely used for context and situation-specific needs of the course or training program for applied education in AEC.

Augmented reality (AR) is a blend of the real and virtual world for bringing meaning to the world. It enables real-time interaction between the real and virtual world through computers, handheld devices, and head-mounted displays, etc. (Wu, Lee, Chang, & Liang., 2013). AR-based learning enhances learners' experimentation and active participation, which is one of the key aspects of applied education in AEC. In addition, it provides learners with a sense of presence, immediacy, and immersion (Bronack, 2011). AR enhances the extent of realism that comes with VR through its sense of presence (Wu et al., 2013). Particularly in applied education in AEC, AR enables experiencing theoretical phenomena such as building design, building construction (i.e., structural elements, safety hazards), magnetic fields, and molecules. It allows learners to adopt trial and error approaches for different scenarios for decision-making using AR. According to Squire and Jan (2007), game-based learning, participatory learning, and location-based learning approaches are frequently being adopted with AR. It provides a solution to visualize concepts that are not easy to grasp with the naked eye, e.g., the solar system, magnetic moment in atoms, and social interaction among various construction project stakeholders.

Mixed Reality is introduced as the next step of AR that allows integrating and manipulating virtual objects in the physical world in real-time (Bowman et al., 2012).

MR provides control of experimentation to the learner, as independent variations of a higher number of parameters are included. Learners can benefit from inherent features of MR such as superimposition, interactive annotation, and information visualisation (Dai et al., 2021). Similarly, MR can be a real benefit for use in education compared to VR and AR, as it can be applied comfortably for a wide range of people and is less physically demanding as it frees the user's hand from holding handheld devices (Wang et al., 2020). MR and VR are conceptually different to each other as VR intends at providing a completely immersive virtual environment while MR are an integration of virtual objects to the real world. MR comprises both benefits and drawbacks compared to VR, as MR users might feel more comfortable because they see the activities around them at the expense of a sense of privacy that VR provides in its concealed environment (Allcoat et al., 2021). Moreover, both MR and AR fall under the reality-virtuality continuum (Milgram et al., 1995), and only MR is recognised as spatially aware with the ability to interact with virtual objects with physical objects (Allcoat et al., 2021). Since users can see their actual surroundings, the issues that come with VR, such as motion sickness and dizziness, are eliminated in MR. Thus, improved, and effective user interaction can be achieved. Similarly, activities and processes inside MR environments can be streamed to a conventional digital screen using devices such as HoloLens and thus, expanding the audience's coverage (Wang et al., 2020).

In terms of active learning, researchers have recognised that VR and MR performs well compared to traditional classroom settings (D'Angelo et al., 2014; Freeman et al., 2014). The literature appreciates and endorses VR, AR, and MR as educational tools to enhance students' experiences and learning outcomes. These technologies can be adopted in applied education in AEC to provide exposure that are more practical for students, especially in the Covid-19 pandemic when real-time experimentation, onsite training, and many face-to-face activities are affected. VR, AR, and MR tools are highly aligned to the learning styles, and instructors could adopt them in applied education in AEC (c.f. Bell & Fogler, 1995). For example, to educate students about the problems of working in a confined space through VR, AR, or MR based games, explaining onsite heaving lifting operations, discussing issues with manual handling operations, and identifying mistakes in formwork (see www.newtonlowe.com). Many other examples can be found where VR, AR, and MR can be incorporated into courses based on intended learning outcomes and learning styles to promote applied education in AEC. However, we need to acknowledge and address some of the common issues with the implementation of such advanced technologies as part of the curriculum, such as the high upfront cost of developing customized scenarios to match learning objectives and the impact on students with special needs.

14.7 A Case of Organizational Simulation in Architecture, Engineering & Construction

Previously mentioned technologies, such as VR, AR, and MR, provide a simulated environment for an object, a short event, or even multiple events. These are handy tools for enhancing understanding of an event, object, or issue in a controlled environment. On the other hand, the A Real Organization Unit Simulated as Life (AROUSAL) system provides exposure from an organizational perspective, for example, a Contractor Company. It provides a new dimension to the soft skill development of students through simulation-based activities. The system considers a medium-sized contractor company that is keen to expand its business. It utilizes real-time information of the contractor organization to create a realistic environment where a team of students can engage in acting as the management teams. By being involved in various sections of the business such as marketing, bidding, and human resources, students can mimic a realistic business situation under teacher supervision. It helps students understand a holistic view of a business organization, allows them to make independent and team decisions, and later reflect on the results of their decision in terms of business performance (AROUSAL, 2015) (Fig. 14.1).

The AROUSAL system enables students to learn and practice several soft skills that are not easy to grasp unless they are practically involved in a situation (such as bidding, human resources, and organizational management), which can be quite tricky for junior professionals. The AROUSAL system enables students to practice skills from analysis, strategy, decision making, planning, and problem-solving, which are skills required in the twenty-first century (Casner-Lotto & Barrington, 2006), thus, ensuring holistic development of students. Professor Peter Lansley initially developed AROUSAL to train students and professionals on management skills and construction processes in the UK, Australia, Hong Kong, and the USA (Lansley, 1982, 2003). Although it has been predominantly used in construction and project management areas, it can potentially be adapted in various areas of AEC education. The AROUSAL system can be used in independent courses in alignment with the program's learning outcomes, it can be incorporated as a part of the course focus on specific intended learning outcomes and as a tool to enhance students' soft skills (Lansley, 2003). The flexibility of AROUSAL provides an opportunity for instructors to adapt it based on a specific situation. For example, instructors may adopt it in conjunction with theoretical lectures about bidding practices to supplement a specific knowledge area on a contract administration course, which is a more realistic approach to teaching contract administration in applied education in AEC. By doing this, instructors may reflect on issues with the current bidding practice in the industry, knowledge, and skills required to be part of such exercise. As the AROUSAL system has realistic data available for practicing, students may run and re-run simulations as many times as they wish to grasp the process.

The AROUSAL system, as an education tool, ticks most of the boxes on Bloom's taxonomy in terms of the knowledge areas and cognitive process dimensions because it helps students to evaluate, analyse, and apply key knowledge areas relevant to

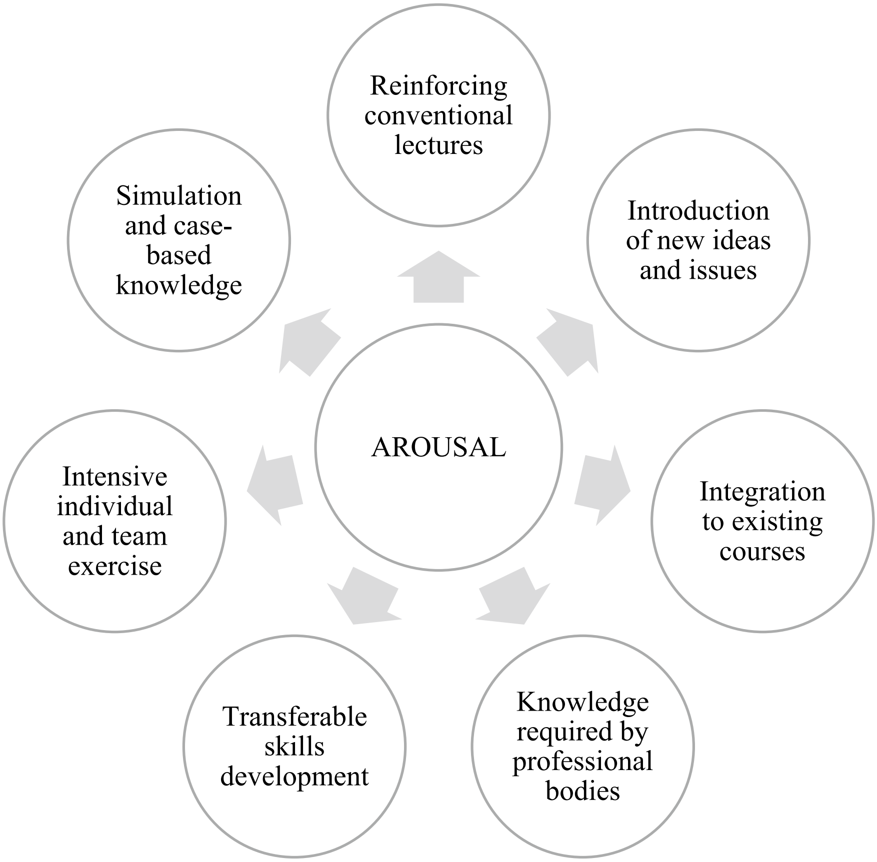

Fig. 14.1 Benefits of using the AROUSAL system in courses. (*Source* AROUSAL, 2015)

specific situations. For example, students may need to analyse factual data about a business to make a firm decision for human resource planning or apply theoretical knowledge of project management in structuring an organization in AROUSAL.

14.8 Obstacles in Adoption of Simulated Environments

The consistent requirement of fundamental change in the traditional education system, forces universities and higher education institutes to adhere to the change (Schneckenberg, 2009). Ametova and Mustafoeva (2020) highlighted, lack of funds, qualified personnel and technical support as some of the key challenges of this transition. Not only lack of resources, but also not being able to recognise the potential of cutting-edge learning technologies hindered the implementation of such technologies in the education sector. Additionally, high initial costs, negative attitude of the faculty and staff towards the change, security and privacy issues, unsupported management and organizational structure, complexity of initial implementation, lack of training, vendor issues and poor IT infrastructure (Garg et al., 2015) are also recognised as prevailing challenges in implementing simulated environments in applied degree education.

14.9 Concluding Remarks

The chapter has introduced various technological tools that can enable instructors to create simulated environments based on students' needs for AEC education. Although the tools suggested help explain objects, small events, and the business environment, as a whole, these technologies can improve students' learning experience and the teaching quality in applied degree education AEC. These technologies also provide an alternative to real-world experiences in the time of the Covid-19 pandemic and the digital age. The authors see this as an important direction for the future of applied degree education in AEC.

Despite the usefulness of these technologies as a part of the curriculum in applied degree education in AEC, issues related to technological adoption, skills of teaching staff, and support systems for these advanced technologies in educational institutions are discussed in earlier sections. These issues are common to almost every educational institution around the globe as we turn to a new era of technology. Thus, educational institutions may require a change in business processes or business strategies for adopting these technologies, reskilling teaching staff, and upgrading digital systems to enable digital transformations.

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Chapter 15
Developing an Online Practicum in Professional Education: A Case Study from UK Teacher Education

Moira Hulme, Anna Olsson-Rost, and Rachel O'Sullivan

Abstract A 'practicum', 'clinical experience' or 'internship' is an established component of professional preparation in education, health, social work, law, accountancy and engineering. Across diverse occupational fields, employability and work readiness are gaining prominence in college marketing strategies. The disruption to work placements during the Covid-19 pandemic in programmes linked to licensure rapidly increased the pace and scale of virtualisation and the need for systematic evaluation of curriculum re-design. This chapter presents a case study of the transition to a fully online practicum for UK university students training to be teachers during 2020/21. Drawing on interviews with students, university tutors and school partners, the chapter outlines key learning about partnership formation and innovation. The evaluation suggests that online supervision requires participants to work harder to establish a positive working alliance and sense of belonging across time–space-digital media. The study highlights the importance of iterative review to promote reciprocity, transparency and voice.

Keywords Practicum · Internship · Online learning · Online teaching

15.1 Introduction

Within tertiary education, there is general agreement on the value of experiential or work-integrated learning. The reported benefits of workplace learning include enhanced learning outcomes, graduate employability, smoother transitions into employment and reduced risk of attrition (Pereira et al., 2020). Experiential learning outside academia is a critical component in diverse occupational fields that include hospitality (Park & Jones, 2021), engineering (Male & King, 2019), sports management (Lu, 2021), translation (Schnell & Rodríguez, 2017), as well as disciplinary subfields such as applied psychology (Schweinsberg et al., 2021). Work experience is

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variously described as the ‘practium’, ‘residency’, ‘internship’, ‘field experience’ or ‘industry placement’ (Hora et al., 2017, 2020). Experience ranges from formal assessment linked to occupational licensure, to work-inegrated learning within academic awards, to community-based ‘service learning’. All forms aim to combine academic learning with practical skills and/or civic responsibility (Grassetti et al., 2021). Experience within workplace settings for tertiary students draws on the dual discourses of human capital theory (preparation of the future workforce and contribution to the health of the economy) and cultural capital (the inculcation of civic values). Community engagement through service learning is commonly used within narratives that support the civic mission of public universities.

Interest in work experience placements has intensified as a result of reported mismatches between college curricular and students’ and employers’ needs (Abelha et al., 2020). Higher Education Institutions (HEIs) are under increased pressure from students, employers and policy makers to offer work-relevant (marketable) skills and attributes. Attention to employability skills has increased in response to the needs of graduate students seeking entry to de-regulated employment markets. Employability, approached as a multidimensional concept, includes a range of generic or transferable skills such as teamwork, communication, being flexible and adaptable, possessing organisational skills and a capacity for critical thinking and problem solving (Suleman, 2018). Economic insecurity and precarious graduate employment increased following the 2008 economic crash and deepened with the economic legacy of the global pandemic of 2020 (Wyn et al., 2020). Employability has emerged as an individual responsibility for job-seeking millennial graduates and a public responsibility to sustain the quality of public services. As an established metric and measurable commodity, employability is used to differentiate between providers in an increasingly competitive domestic and global market for higher education services.

Within neo-liberal education policy, fee-paying university students are positioned as citizen consumers making rational choices between alternative providers. For example, in England, the Teaching Excellence and Student Outcomes Framework (TEF) was introduced in 2015 to help students make informed admission choices. Employment outcomes are measured in terms of the proportion of graduates who obtain highly skilled professional employment. The TEF uses data from the annual Graduate Outcomes survey, which is completed fifteen months after graduation, to construct university rankings (NAO, 2017). Other metrics include outcomes from the annual undergraduate National Student Survey (NSS) and Postgraduate Taught Experience Survey (PTES) that cover Assessment and Feedback, Academic Support, and Learning Resources. Rank position is important in universities that are more dependent on up-front student fee income. More recently established and teaching-intensive universities receive less support from research quality funds from government, or grant income from funding councils and philanthropic bodies. In the face of changing demographics and an increased number of alternative providers (including for-profit, non-state organisations), institutional marketing strategies emphasise graduate employability (Durazzi, 2021).

Although the marketisation of higher education is intended to promote student choice, the evidence base on which to differentiate between alternative forms of work experience in applied education programmes is neither extensive nor robust. While the acquisition of work relevant knowledge, skills and attributes is regarded as an increasingly desirable component of an applied university education, the academic design, delivery and evaluation of such activity remains under-researched. There is little conceptual clarity concerning the orientation of the diverse range of employability development initiatives promoted by HEIs (Divan et al., 2019). For example, Holmes (2013) distinguishes between 'possessive', 'positioning' and 'processual' approaches (p. 540). The first is most closely aligned with human capital theory, and empathises the acquisition of skills and attributes. In contrast, the second stresses the social value of connectedness and cultural capital. The third, empathises the longer-term interaction of learning and work experiences over time. Across disciplines and institutions, at an operational level there is little consistency in the design characteristics of work experience placements (that is, their duration, frequency, supervision/mentoring, performance criteria, or resourcing). Moreover, extant research emphasises the positive outputs of work experience, with scant empirical research examining the challenges of operationalisation and the possibility of less than optimal outcomes (Lopes et al., 2019).

In this chapter, we use 'practicum' to refer to work-integrated learning that is a formal requirement of professional preparation programs undertaken by university students. Arrangements for practicum vary across regions and nationally, and between professional fields. Practicums are a critical component of clinical education in nursing, social work, and teacher education. Readiness to practice has become a key policy concern following high rates of early career attrition in the United States, Australia and Europe. Policy makers emphasise the need for 'classroom ready teachers' (TEMAG, 2014) and 'ready to practice' nurses and social workers (Nathaniel, 2018; Ragsdale & Schuessler, 2021). Calls for reform to improve readiness have produced waves of external regulation. Professional preparation in the human services (i.e. licensure pathways) in the Global North are typically highly regulated by national agencies in terms of recruitment and selection of candidates, course content, supervision and assessment. National regulatory bodies often specify the number of credits, minimum hours and weeks attached to work placements; and there is sector level agreement on threshold competence standards, that are subject to periodic inspection by national quality assurance agencies. Because professional education is subject to such high levels of external regulation and accountability, it occupies an uneasy place in the university ecology (Labaree, 2004; Furlong, 2013). As the response of HEIs to the 2020 pandemic demonstrates, managing multiple accountabilities adds complexity when pursuing innovation at pace in response to rapidly changing needs.

15.2 Research Aims

This case study examines the partnership forged between a university and a multi-academy trust (MAT) in England to sustain practicum arrangements for Pre-Service Teachers (PSTs) during the Covid pandemic of 2020/21. Multi-Academy Trusts (MATs) are networks of publicly funded but independent schools that are similar to charter schools in the United States. The disruption to teacher education arising from the pandemic provided an opportunity to revisit the critical components of the practicum experience and the relationship between school and university locations as sites for teacher learning. Following the UK-wide lockdown announced on 23 March 2020, the ITE sector came to a 'screeching halt' (Ellis et al., 2020, p. 560). UK universities pivoted to 'virtualisation' of ITE practica in the early stages of the pandemic (March-June 2020) due to school closures (la Velle et al., 2020). While some universities resumed in-person school experience in autumn 2020, others postponed provision to reduce demands on schools contending with the impact of a second wave of Covid-19 infections, learning loss among returning students, remote learning rotas and local lockdowns. One of the largest providers of teacher education in the UK, the case study university elected to offer a parallel model of in-person (the 'conventional' model) and remote practica (the 'flexible placement model') for the 2020/21 cohort of postgraduate secondary pre-service teachers (PSTs). While the PSTs were assigned a host school within a MAT on the flexible model, they did *not* physically attend this school site. Learning and support was achieved in synchronous and asynchronous online interaction.

During the pandemic, the online practicum was made possible by a temporary relaxation of the minimum requirement for 120 days of school-based learning (DfE, 2020). Pre-Service Teachers (PSTs) in England are usually required to spend 24 weeks of a 36-week postgraduate programme in schools. While experimenting with new modes of delivery, training providers needed to remain compliant with the nationally mandated *ITT Core Content Framework* (DfE, 2019) and prepare PSTs to demonstrate achievement of the *Teachers' Standards* (DfE, 2011), which specify minimum requirements for threshold competence. The reimagining of school experience for the academic session 2020/21 demanded reflection on the design principles, strengths and limitations of the existing practicum model, the affordances and constraints of the current and developing context, and the future needs of Newly Qualified Teachers (NQTs).

The scale and pace of virtualisation in ITE increased the need for iterative formative evaluation. The research reported here was undertaken during the second wave of the UK Covid-19 pandemic in England. Curriculum development at this time remained within the mode of emergency adaptation, without the usual timescale afforded for the design and development of online and distance methodologies (usually 6–9 months) (Hodges et al., 2020). Extant research on the use of virtual learning environments in ITE typically addresses interaction between pre-service teachers (PSTs) and their university tutors, PST peer collaboration, or the experiences of teacher educators' teaching online (Carrillo & Flores, 2020). This research is distinctive in addressing curriculum redesign for fully online school experience. The flexible placement model was founded on the expectation that aspects of the remote practicum had the potential to enhance support for teacher learning beyond current public health concerns. We use Ellis et al.'s (2020:561) definition of innovation in ITE as, 'intentional, creative change that adds value'. This small-scale qualitative case study offers an appraisal of the processes of partnership formation, how the first iteration of online practicum was resourced and delivered, and the lessons learned to inform future developments.

15.3 Research Setting

The university is one of the largest providers of teacher education in the UK. Each year the University's School of Teacher Education trains over 1,000 schoolteachers to work in primary education (age group 5–11 years) and secondary education (age group 11–16/18 years). At the time of writing, there are 14 routes into teaching in England. This case study focuses on PSTs training to be secondary schoolteachers by completing a Postgraduate Certificate in Education (PGCE). The PGCE is a one-year, full-time programme for graduate students. The University offers a Secondary PGCE course in 20 specialist subject areas. The course involves three core masters-level units addressing subject pedagogy, critical studies and reflection on professional development. Each of the three taught units carries 30 masters-level credits on the UK Credit Accumulation and Transfer System (CATS) (which is equivalent to 15 credits on the European Credit Transfer and Accumulation System (ECTS)).

Teacher education is founded on partnership work. The School of Teacher Education works in partnership with over 500 secondary schools, locally and regionally. The university-school partnership network extends 150 miles between north and central England. The University aims to place all PSTs within 50 miles or 90-min radius of their term-time address. A fee per student is paid to schools to support PGCE students during school placement. In England, the fee paid to schools that support PSTs on university courses varies between £400 and £1,600 per placement (Allen et al., 2014). Within the case study partnership network, this fee can vary from £600 (Euro 697, US$ 842) to approaching £1,000 (Euro 1,161, US$ 1,404) per placement dependent on demand. Placement fees are extracted from income generated from annual student tuition fees of around £9,000. Partnership agreements are made through formal Memorandum of Agreement between the university and participating schools. At the case study university, PSTs following the PGCE pathway experience three placements: two placements in contrasting schools with different age ranges, and a third placement in a Special Educational Needs (SEN) setting.

The flexible placement model created during the pandemic was designed for PSTs without placements to provide opportunities for understanding schools, planning to teach in a Covid-secure environment and opportunities to teach online. The model enabled the university to remain fully compliant with national regulatory conditions (specified by the Department for Education and the education inspectorate, Ofsted).

From a cohort of 600 PGCE students in 2020/21, a total 134 PSTs were supported through the Flexible placement model in their first placement (November 2020–January 2021) and a further 29 in their second placement (March–June 2021).

The material in this chapter relates to a new partnership with one multi-academy trust (MAT) that the university approached in October 2020. The Trust is comprised of two high schools and six local primary schools (with a total of 3,700 school pupils on roll) located 50 miles (80 km) from the university campus in a Northern market town. Both high schools were awarded a 'good' rating for overall effectiveness in their most recent inspection by the inspectorate, Ofsted. Patterns of pupil attainment in both schools are marginally above the national average and improving. The schools are average size, with over 800 pupils on roll, and a mixed gender intake of pupils aged 11–16 years. The Trust employs between eight and twelve newly qualified teachers per annum.

15.4 Methods and Data Sources

A case study design was adopted to allow for triangulation of multiple perspectives. This study sought to understand the experiences of pre-service secondary teachers (PSTs) assigned to the flexible placement model; university tutors and a technologist supporting PSTs on the flexible placement model; school teachers acting as link personnel for the flexible placement model; and school leaders with direct involvement in developing the school-university partnership for the online practicum.

Prospective participants received an invitational email that explained the purposes of the study, how data would be used, and a realistic estimate of the time commitment involved. Participation was voluntary. The research team was mindful of any perceived pressure to participate. In addressing this issue, care was taken to emphasise that the evaluation was in no way linked to student progression on the PGCE programme or to staff appraisal. The research team was not involved in formal assessment of the PSTs in the subject areas involved in the evaluation. Moreover, none of the researchers held line management responsibility for faculty participants. The evaluation protocol was reviewed by the university Faculty ethics committee and adhered to the ethical guidelines of the British Educational Research Association (BERA, 2018).

The primary data collection methods were semi-structured individual interviews and focus group discussions convened between January and May 2021. Interviews were conducted remotely using video call technology or telephone. Individual interviews were held with three key informants within the multi-academy trust. These were the Director of Secondary Education, the Deputy Headteacher of the largest school in the Trust, and the Head of the Department that hosted the largest number of PSTs in one subject at this school (n = 10 PSTs). Two mixed focus groups involving 13 PSTs in seven subject specialisms (English, Science, Maths, French, Spanish, Geography, Social Science) were convened at the end of the first ten-week placement. A further group interview was convened with four university tutors, with specialisms in secondary English, Science, Geography, and Religious Education, supporting PSTs on the online practicum; and an individual interview with the university learning technologist supporting the use of video technology for guided reflection on this model.

Data were analysed using NVivo qualitative data analysis software. The analysis draws on the three dimensions of the workplace curriculum articulated by Billett (2006): the intended, enacted and experienced curriculum. The findings consider the period in which the 'intended curriculum' was planned, before considering how the curriculum was 'enacted' (what actually happened) and 'experienced' by participants (Billett, 2006, p. 32).

15.5 Findings

15.5.1 Partnership Brokerage

Motivation for involvement in the flexible placement model was multi-layered. Participation was both altruistic and instrumental. By providing places, the schools helped to support the professional learning and certification of new teachers at a challenging time. However, as the Trust Secondary Education Director commented, 'On the most mercenary level, it's a recruitment tool'. Both high schools within the Trust had a previous record of providing ITE with other HEI providers. In supporting ITE in shortage areas, schools are able to review potential recruits prior to qualification. The Trust was able to consider participation because it had moved relatively swiftly into live lessons during the first lockdown. By April 2020, the Trust provided live-streamed lessons to all exam classes (Years 10 and 11, aged 14–16 years) and expanded this to other year groups through the summer term. By autumn 2020, all staff had accessed continuing professional development to support remote learning. The Trust Secondary Education Director felt the teaching staff were well prepared to cope with the demands of hybrid teaching (with some pupils isolating at-home) and a possible second period of regional school closures from November 2020. As a result, supporting PSTs remotely did not appear too onerous. In deciding to participate, the Trust chose to accommodate PSTs with a subject specialism that aligned with the school's need to address learning loss in English, mathematics, science and Modern Foreign Languages (MFL). These subjects contribute to the English Baccalaureate (EBacc) measure. In England, schools are measured on how well their pupils perform in these subjects. Hosting larger groups of PSTs was seen as offering potential bespoke support for pupils in need of 'catch up' tuition. The approach from the university was regarded as 'timely' by the Deputy headteacher, who described the model to parents as a 'mastery programme' delivered by graduates in specialist subject areas.

Agreement was reached at senior level (i.e., MAT and School of Teacher Education Executive Groups) that the proposed partnership could be mutually beneficial.

However, customary ITE roles and responsibilities needed to be re-negotiated to accommodate the additional demands made of schools during the pandemic and the volume of PSTs who needed an online placement. The role of subject mentor that is usually undertaken by a cooperating teacher in school was re-configured. Subject mentorship responsibilities were transferred back to the university. It was agreed that the subject link would provide curriculum guidance only, and the HEI tutor would take all other roles including individual support with lesson planning, target setting, and pastoral support. The agreement to scale up to clusters of PSTs contributed to the decision to transfer roles back to the university. Smaller subject departments in school could not move from hosting one or two PSTs to the cluster model. For example, the MFL department (Spanish and French) that would be supporting ten PSTs was comprised of three qualified teachers, one of whom was newly qualified. The fee to schools for the online model was reduced to £200 per student, and students were placed in groups of a minimum of five (i.e. multiples of £1,000 per school for each five PSTs placed).

Schools participating in the flexible model needed to be able to support full virtualisation. Access for university tutors and PSTs needed to be fully compliant with the digital security policies of both the host school and university. The possible use of recorded lessons from a remote school site for guided viewing raised ethical and data security issues. The online practicum used IRIS Connect (www.irisconnect.com) to support lesson observation. IRIS software tracks the movement of the teacher around a classroom and is used subject to school, multi-school trust or local authority policies on recording classroom interaction for the purposes of professional development. These policies are subject to parental approval and ratified via local governing bodies. In line with these policies, digital recordings were deleted on conclusion of the online school placement. Table 15.1 summarises the affordances and challenges of using video technology in remote placements.

Distance engagement required attention to safeguarding. As the MAT Director noted, 'We took the challenge of having our pupils online with somebody we didn't know'. The participation of PSTs was subject to mandatory records check by the UK Disclosure and Barring Service, and safeguarding training at the university. Groups of two or three PSTs working from their homes engaged with pupils who were to be supervised by a member of the school staff in a computer room at school. Recorded consent would be required from pupils, and their parents/carers, before participation.

15.5.2 Curriculum Enactment

15.5.2.1 Challenges

The speed of development presented significant communication and coordination challenges. The Trust Chief Executive Officer (CEO) made the decision for the Trust to participate and relayed this to the senior management team in the Trust, who worked with Deputy headteachers (DHTs) in schools to make it happen. As a

Table 15.1 Using video technology in online placements

Advantages	Challenges
• Data security—the device recording the lesson sends the data directly to a secure server which is not accessible outside the platform • The teacher has ownership of what is shared. The teacher recording their own lesson has full editing tools to select which segments will be shared, and which will remain private for personal reflection • Permits secure individual, pair and cluster-level reflection • Develops professional etiquette and language to discuss professional learning—skills of offering constructive developmental (rather than judgemental) feedback in practice to peers in a professional manner • Video extracts can be time stamped and comments/questions added to specific actions to support reflection • Enables multiple perspectives on the same teaching segment—from students and tutors • Video recordings can be revisited to support reflection at a later stage and reflection on different aspects of practice (e.g., students asked to share a segment of video where they used question and answer, or formative assessment, or demonstrated some form of behaviour management) and to evidence progression through the course	• Navigating school policies on safeguarding (e-safety) and national legislation re. data protection (privacy and storage) • Negotiating access to tools that are not centrally supported by HEI IT services • Does not allow migration or storage of video files outside the platform for later use • Video data cannot move with the individual teacher e.g. for inclusion in digital portfolios that are carried into the early career phase • Teacher unions may express concern about the possible use of video data for other purposes e.g. teacher appraisal or performance management • Schools use different systems for recording video e.g. Teams, Google classroom etc • Recordings depend on the positioning of the hardware and can only offer a partial view of what is happening in the classroom or 'tunnel vision' • Requires significant recurring investment in licensing (external) and provision of student technical support (in-house) • Depends on tutor buy-in for optimal benefit (to promote high levels of student engagement). It is good practice to specify the number of video segments to upload for personal reflection and the number selected to share, and with whom • Clear parameters need to be set for timely responses and to manage student expectations (online tutors are not available 24/7 to respond immediately to student uploads)

result, there was some 'confusion' (DHT) at the start of the first placement period. The pace of the development meant that the school 'went in a bit cold' (DHT) and did not initially fully understand the level of commitment required. Following online induction with the DHT, some PSTs joined classes for live observation using Google classroom and subsequently commenced tutoring small groups of pupils before meeting the usual class teacher. School curriculum leaders shared schemes of work and targets for individual pupils with PSTs, subject to required data privacy checks. The re-negotiated role of the Department subject link 'evolved' in the first two weeks of the online placements (DHT). Subject leads were unsure of their day-to-day role in the initiative, and how and when to engage with PSTs. School teachers first commitment was to the learning of their pupils. For example, one Head of Department commented, *'My first commitment is to deliver high quality education* *to the students in front of me. I didn't know what was expected of me, really. If I needed to the take the first step or not'.*

The pupils selected by the school for PST tutoring did not include any for whom the school received additional grant funding to address disadvantage. In England, mainstream schools receive a Pupil Premium grant to help improve the attainment of disadvantaged pupils. In 2021, schools received £955 for every secondary age pupil eligible for free school meals, or who claimed free school meals in the last 6 years; and £2,345 for every pupil who experienced local authority care or adoption. The school decision to exclude these pupils removed PST contact with around one third of the student body. In addition, the DHT excluded pupils who staff felt would not engage fully with the process. A small number of families declined to take part. In order to take part in the tutoring programme, school pupils were excused from non-assessed Physical Education (PE) classes (PE classes during the pandemic were restricted due to social distancing requirements). The Trust acknowledged that this strategy would not be sustainable when the full timetable resumed as tutoring was additional to scheduled whole class tuition.

Despite the stated aim of improving coherence between course work and school work, participants reported limited communication around the focus and submission of university coursework by PSTs. When asked, the MAT Secondary Education Director could not comment on the university curriculum and saw no linkage in terms of their operational role. Similarly, senior staff in school did not extend their knowledge of the academic programme beyond accommodating the direct needs of the PSTs assigned to their school. The school focus remained at the level of practical teaching. The contraction of the subject mentors' role in school and the transfer of greater responsibilities to the HEI tutor may have supported this separation.

During the pandemic, the workload of participants intensified. There is a limit to the number of roles that can be undertaken by senior staff in schools and HEI tutors, especially during a period of unprecedented challenge. For example, the DHT with responsibility for ITE also held responsibility for continuing professional development (CPD) and for remote learning during the pandemic. Setting up the logistical details of the flexible placement across subjects areas in the school, recruiting pupils and organising parental permissions, technological support and timetabling fell to the DHT in the period in-between school closures (March–June 2020 and January–March 2021). School-level subject leads were recruited 'on a goodwill basis' (DHT) with no additional timetable remission or other form of remuneration. This meant that some cooperating teachers made offers of support to PSTs that proved unrealistic amid other demands on their time. University tutor hours were costed at 4.8 h per PST over the 10-week placement (i.e. around 5 h per cluster every week). Given the transfer of responsibility to the HEI tutors from the school subject teachers, the *actual* cost of high quality mentoring for a large cluster was under-resourced. Such considerations need to be balanced by possible sanctions that might be imposed by the Department for Education in terms of reducing future allocation of student places if the HEI failed to support PSTs to complete their PGCE programme. Failure to support registered students would also be grounds for complaint through the Office for Students (OfS), the independent regulator of higher education in England.

> It was all very fast … We were going through a challenging moment with hybrid teaching. It was quite a challenge to maintain the attention of the children in front of you while at the same time teaching the children at home. I was dividing myself into pieces and then on top of that student teachers joined us. (Head of Department)

While grateful to be able to complete their course, PSTs initially expressed concern that one of their placements would be online. PSTs assigned to the flexible model in November 2020 feared they might not receive an equivalent experience to peers assigned to schools that remained open. These concerns were mitigated as a second national lockdown was announced on January 3rd 2021 and UK schools closed to all pupils except the children of critical workers and the most vulnerable pupils (January–March 2021). The intermittent nature of online engagement reinforced a sense of isolation. Some PSTs struggled to identify as a member of the school community. One PST reported, 'We felt like we were on an island'. Another suggested, 'We felt like we were outsiders and something to avoid if possible'. While technology enabled connections to be made, a perception of distance and exclusion persisted for a minority, with some reporting feeling like 'intruders'.

Through 2020/21, the ITE sector was buffeted by changes to policy in response to the shifting public health situation. In early January 2021, the school paused ITE provision as the school workforce focused once more on transitioning to at-home learning. PSTs were informed that they would not be required to resume online tuition until January 18th. This was in part due to pupils now being in their own homes rather than supervised by a staff member in the school building. However, after consultation with the Trust and university, the school instructed PSTs to resume their classes leaving PSTs with very little time to plan and prepare. The challenges of moving to remote working with pupils dispersed to their home locations, in addition to the impact of lockdown on PSTs personal wellbeing, proved stressful.

In addition, the workload for PSTs began to increase as university coursework progressed alongside a menu of elective tasks each week. The 'menu' offered a wide range of curriculum enhancement activities to compensate for exclusion from a physical school site. At pressure points in the assessment calendar, HEI tutors fulfilled the dual role of subject mentor (support for pedagogy) and academic tutor (support with research engagement and academic writing). The escalation of activity resulted in some PSTs feeling that they were hurrying along rather than engaging deeply for optimal benefit.

> In the beginning, the menu of tasks was fine because you could manage your time but as we moved into teaching the tasks kept on piling up. You are working with different people who have different needs and it was like a running race. You're doing something without really comprehending it. I didn't learn as much because I had to do it quickly, so that I didn't accumulate a lot of weekly tasks. (PST)

Although all PSTs on the remote practicum spent longer analysing lesson sections in their specialist field, PSTs were concerned that the range of live lessons they were able to observe was limited. PSTs benefitted from preparing lessons collaboratively and analysing these in-depth, but expressed a desire to supplement this introspective and self-analytical approach with opportunities to observe approaches deployed by a wider range of experienced practitioners in whole class settings. PSTs would have liked to observe teaching in contrasting curriculum areas, age phases and across the schools within the Trust. While the schools were in the same town, organising access to different intranets proved too challenging within the pilot timescale. Where IRIS was used to support observation of teaching, the fixed camera mount often restricted the view of the PSTs observing remotely. As the teacher moved around the classroom to support pupils, PSTs heard but could not see much of the teacher–pupil interaction.

> You prepare for your lesson: you research, you do your language analysis, you research websites, you research videos, you are trying to look for specific vocab, you look for idiomatic expressions to test some of the more gifted students, to push them a bit further. So, you do all that but I haven't had a chance to have a series of observations of different teachers in action. For me, that's been a missing component. I still feel to this day I don't have a really good idea of what a strong language lesson should look like. (PST)

While some issues were addressed more fully at this stage in the ITE year others areas remained underdeveloped. Class management, marking and moderation, and engagement with parents was limited. PSTs were particularly concerned about developing classroom management skills. The small groups of pupils did not exhibit challenging behaviour and PSTs were concerned they were less well placed to complete university coursework on this theme, and less prepared to manage behaviour in the classroom in subsequent placements and first teaching posts. Restricted access to the full life of the school impeded the development of a strong professional identity among a minority of PSTs. As the online experience was organised in clusters, most PSTs were teaching in pairs or trios. Some PSTs had reservations about how individual progress towards qualification would be assessed. This was evident where there was a perceived imbalance in contributions from PSTs in a cluster or pair. While the course was collaborative, assessment was ultimately based on individual merit.

> I feel I can personalise learning and tailor learning to individual needs. There have been many opportunities to develop those skills but in terms of teaching a large group, which is what I'll be doing for the majority of my career, I feel like I'm still unprepared. I haven't had to do that. The theoretical foundation is quite good but there just hasn't been any opportunities to realistically transfer it into a practical setting. (PST)

15.5.2.2 Benefits

During the early stages of the online placement, PSTs valued the opportunity to engage in-depth with educational theory and research due to the reduced level of contact hours. PSTs had access to a wider range of professional learning opportunities than would usually be available had they attended a full-time placement. Practitioner input, via live-streamed lectures from lead teachers and headteachers, on a range of applied topics gave breadth of insight into the wider role of the teacher at an early stage in professional formation.

> 'It's slowly eased us in, which for me personally is better than going on a placement and being thrown into doing twenty hours a week in a classroom with thirty students' (PST)

Co-planning, co-teaching and collaborative reflection were highly valued by PSTs in the cluster model. Strong peer relationships were forged at an early stage of the PGCE course. The online practicum according to one PST had *'created this community of people that I can turn to any time, any hour of the day. That's quite special'*. Another described, the '*sense of community and knowing that we can all turn to each other and have each other's back, build each other up and encourage and develop each other's skills, to watch that develop and flourish'*. PST clusters spoke of valuing the different strengths and insights drawn from a range of undergraduate studies. For example, graduates with literature degrees and graduates with language degrees.

PSTs valued the timely focused support from HEI tutors that helped them move forward. Beyond academic support, PSTs valued the pastoral role of the HEI tutor as personal tutor. Experienced HEI tutors anticipated when PSTs began to feel overwhelmed and anxious. PSTs acknowledged the role of the HEI tutor as hybrid educators moving back and forward between school and university spaces, acting as an advocate for the PSTs, providing reassurance and support for development.

> No question is too daft. If we want a one-to-one, they'll fit time in. They are always there if we need feedback or help [...] When I felt a bit trapped in my routine and there are things that I knew worked and things that didn't work but I didn't really know how to change them. (PST)

PSTs suggested the online practicum helped them to be more resourceful, resilient and adaptable, whether contending with technology, learning to collaborate online, sourcing materials for remote learning, or supporting one another through different personal and professional pressures.

> The most positive thing is the way we have to work together, reflect together, learn together, make mistakes together, and get on together. Teamwork is the basic skill we need to gain in our teaching life because once you're in a school you need to work with your colleagues […] We are all in the same boat and we have to keep rowing in the same direction. (PST)

Tutors invested more time in building relationships with PSTs on the online practicum and reported accelerated progress in lesson planning, meeting individual needs, subject knowledge, questioning strategies, observation skills and digital skills. Regular online dialogue with a university tutor, focused on specific aspects of pedagogy, broke down barriers associated with the conventional high stakes tutor visit. Online clusters supported by the regular presence of a tutor were more open to feedback. Tutors valued the opportunity to recalibrate the learning partnership with PSTs on placement. In the conventional placement model, tutor engagement was evaluative rather than developmental: *'With our other students, we only really tend to fix the negative problems' (University tutor).*

> 'Had they been in school, they would be worried about being criticised. Whereas we've built a relationship where it didn't matter about making mistakes in front of me' (University tutor)

The case study presented here was undertaken to identify key learning to support practicum development. Drawing on Gazley et al. (2013), the benefits and challenges of reconfiguring practicum partnerships are summarised in Fig. 15.1, Three-legged stool of the online practicum. The findings have relevance for a range of occupational fields in tertiary education.

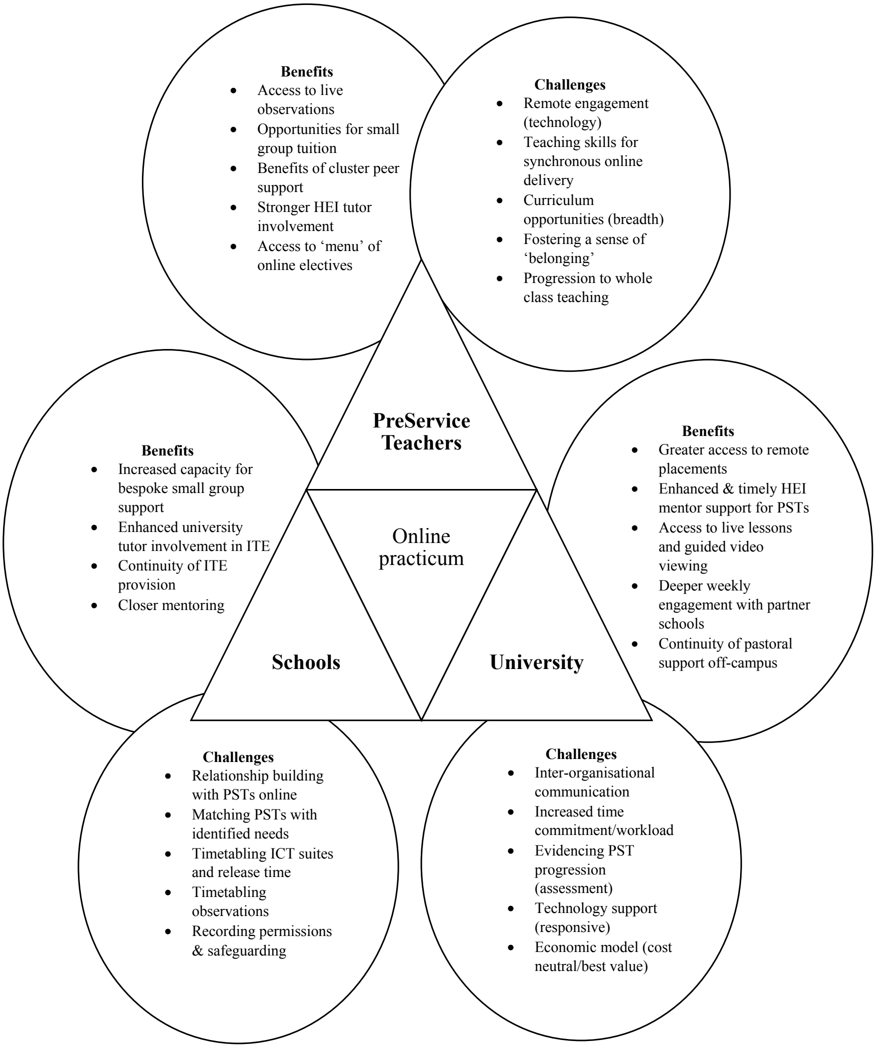

Fig. 15.1 The three-legged stool of the online practicum. (adapted from Gazley et al., 2013, p. 562)

15.6 Conclusion

There are clear advantages to digital professional learning for schools and universities. Online technology can overcome geographical isolation and provide cost-effective, enhanced support for schools with higher rates of teacher absence or mobility, and/or diverse student needs. Distance from PST home residence is no longer a limitation. Practicum settings can be utilised in regions far beyond the university campus. Technology allows greater access to specialist provision from a distance, and bespoke support in targeted areas (EEF, 2018). In this case study, for example, remote tutoring addressed the specific learning needs of individuals and small groups of learners. Online platforms can support synchronous (real time) as well as asynchronous (consecutive) interaction among participants. Education technology, such as the IRIS Connect video platform, affords opportunities for online collaboration between clusters of PSTs and remote mentor teachers. A key benefit in this case study was the re-engagement of HEI tutors in the school space as the responsibilities of the school subject mentor were redrawn. HEI tutors re-engaged directly in applied pedagogy in supporting PSTs with guided viewing of teaching. This case study reiterates that the ability to observe what is happening in a classroom is an acquired skill. Social practices of seeing involve skill and sensitivity. Research indicates that novice teachers exhibit 'selective attention' (Fadde & Sullivan, 2013) when viewing video of classrooms. The online practicum helped new and experienced practitioners to develop cultures of observation within stronger professional learning communities (Patton & Parker, 2017).

Digital technology will be increasingly important in preparing tomorrow's workforce. The professional preparation of future teachers will need to accommodate support for learning outside the 'normal' classroom (Kalloo et al., 2020:9), while also addressing a stark digital divide (Cullinane & Montacute, 2020). The need to foster 'technological pedagogical content knowledge' (Mishra & Koehler, 2006) has become more acute in the post-covid context. Going forward, newly qualified teachers will need to learn digital competence and gain experience in supporting online/at-home learning as well as in-presence classroom learning (Konig et al., 2020; Kim, 2020). New challenges include how to foster an ethic of care as well as technical competence, and how to support curriculum continuity away from in-person interaction at school. Equally, this implies digital competence among a teacher educator workforce that can model effective support for online learning, with attendant resource implications (Scull et al., 2020).

While the contribution of theory to teacher development has been the focus of intense debate in the Global North, the value of different approaches to school experience is less examined. Proponents of Professional Development Schools and clinical practice models of teacher education have challenged the archetypal high stakes visit by a university tutor to a host school (Conroy et al., 2013; Darling-Hammond, 2014). The one-off 'crit lesson' for assessment purposes promotes inauthentic interaction and 'the need to please and perform' (Aspden, 2017: 134). This case study contributes to the body of evidence that asserts that the quality of mentoring is more influential in shaping practice than the amount of time spent in school (Lofthouse et al., 2020; Ronfeldt & Reininger, 2012).

The (time limited/temporary) removal of in-person school experience for some pre-service teachers (PSTs) necessitates new forms of collaboration between schools and universities, and a renewed focus on high quality practice-oriented mentoring. As shown here, remote supervision may be more 'intentional' than in-situ supervision as participants need to work harder to establish a positive working alliance and sense of community (Inman et al., 2018). Research in allied human service fields suggests that online supervision in clinical practice can compare favourably with face-to-face supervision in terms of quality of supervision and rapport building (Bernhard & Camins, 2020). However, this needs to be supported by a robust infrastructure, communication strategy and realistic costings. Such calculations include not only hardware and software (licensing) costs, but the full economic cost of staff time (legal, administrative, technical and academic), especially time invested in relationship building (with external partners) and timely provision of support (for students, HEI tutors and school partners).

The great pause of 2020 created an opportunity to reflect on the purposes of partnership work in higher education in general and initial teacher education in particular. The emergency response took university teacher educators back into a space that had been ceded to schools over the last decade. The distancing of university teacher educators from schools was accelerated by central government's promotion of school-led ITE and the comparatively higher costs of university ITE provision (in comparison with campus-based courses). This separation reinforced a longstanding division between the workplace and the academy, and threatened to reduce the aims of education to a narrow vocationalism.

Rather than retreat to separate spheres, effective partnership development should be approached as a participative process. This demands explicit alignment of goals, shared objectives and programme outcomes, a readiness to trial and evaluate new ways of working, and strong inter- and intra-organisational communication. From this perspective, brokering partnerships is an on-going commitment rather than a start-up activity or decision taken at Executive level. Such reconceptualisation would move the concept and practice of partnership work beyond cooperation at inception, towards employer involvement in the co-design of courses and HEI involvement in the co-delivery of workplace learning. Practicum partnerships built on principles of mutuality (common purpose), reciprocity (shared benefit) and collective responsibility (accountability) model the forms of 'collaborative professionalism' (Hargreaves & O'Connor, 2018) that are most likely to prepare and retain new teachers in challenging circumstances.

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Chapter 16
New Intervention Strategy in Teaching and Learning Under Covid-19 Pandemic: Nursing Simulation on Health Worker Training in Tertiary Education, Hong Kong

Pui Ki Kitty Tsui and Yin Ling Tabitha Ng

Abstract The aim of this study is to evaluate the effectiveness of using nursing simulation as an alternative mode to replace on-site fieldwork placement in health worker training for higher diploma students aged 18–22 during COVID-19 pandemic. This is a qualitative study using mixed method of focus groups and individual interviews. Students' learning experiences were explored at the simulated clinical laboratory with 3 focus groups each composed of 4 to 6 students being conducted. It followed by 5 individual interviews with purposive sampling afterwards. Thematic analysis was adopted for data analysis. The findings reveal insights on the new intervention strategy in health worker training and inform programme designers and stakeholders who together can jointly map out appropriate interventions to assist students to continue their healthcare training under the pandemic.

Keywords Nursing simulation · Health worker training · COVID-19 pandemic · Teaching and learning · Innovative intervention and strategy

16.1 Introduction

COVID-19 pandemic has a dramatic impact on tertiary education, in particular nursing and health care education. As social distancing is a key concern, traditional face-to-face clinical practice, learning and demonstration have to be abruptly suspended to protect students from the pandemic. Implementation of simulation is one of the measures to address this current issue in training healthcare professionals, allowing participants to learn and progress from error in a risk-free environment.

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Various studies were conducted to demonstrate the simulation training as a possible solution to health care professional training under the rules for social distancing and infection risk control during the COVID-19 pandemic (Dieckmann et al., 2020; Mark et al., 2020; Shea, & Rovera, 2021). However, there is no study about health worker training using nursing simulation to replace on-site fieldwork placement in tertiary institution. Meanwhile, health worker acts as an important role in nursing care in residential care home in Hong Kong. They work closely with other health care professionals in providing care to residents. They provide regular health checking for early identification of illness and treatment arrangement. Maintaining communication with residents' relatives or guardians is important as well. In addition, they have to provide some basic nursing care, for example, assisting residents in doing simple exercises, designing menu and providing basic first aid. During the pandemic, the health worker training in most of the training institutes in Hong Kong has been extended. For our higher diploma programme with components of health worker training, a new teaching strategy of using high-fidelity simulation has been adopted for replacing part of residential care home placement. In this study, with the use of mixed method of two qualitative approaches, we explored the effectiveness of this new learning mode through nursing simulation from the perspective of students.

16.2 Background

There are various difficulties encountered in education during this unprecedented time (De Gagne et al., 2021; Ellis et al., 2020), in particular poor student adjustment toward the COVID-19 crisis (De Gagne et al., 2021; Ellis et al., 2020). Recent studies showed that students had distress (De Gagne et al., 2021), anxiety (De Gagne et al., 2021), depression (Ellis et al., 2020) and loneliness (Ellis et al., 2020). Students reported less motivation and competence with self-directed learning (De Gagne et al., 2021). Unstable emotional responses to unpredictable curriculum is another problem (De Gagne et al., 2021). Student felt nervous, confused and uncertain because of sudden changes to online learning arrangement (De Gagne et al., 2021). They were overwhelmed with different online lectures, assignments and assessments (De Gagne et al., 2021). Thirdly, students might have problem of social connection (De Gagne et al., 2021; Ellis et al., 2020). Studies reflected that students spent prolonged time for online communication and social interaction by using different social media during the pandemic. They might be physically isolated from society (De Gagne et al., 2021; Ellis et al., 2020). Financial burden is another difficulty (De Gagne et al., 2021). Internet accessibility and affordability became the main students' concern during online communication and lectures (Agu et al., 2021). Some might not have adequate financial resources to have their own computer (Agu et al., 2021). Encountering these challenges during the campus closure and lockdown, new strategies of conversion to online or virtual remote learning and alternative assignment from normal classroom teaching and learning have been designed and developed, so as to maintain the quality of education for students (Blevins, 2021; Shea & Rovera, 2021).

In addition, educators have to identify effective ways to motivate the students and enhance positive learning outcome achievement.

"Simulation is a technique, not a technology, to replace or amplify real experiences with guided experiences, often immersive in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion" (Gaba, 2004, p. i2). Ranging from high to low fidelity, simulation is demonstrated as an effective mechanism to practise and learn clinical nursing skills (Aebersold & Tschannen, 2013; Galloway, 2009). It enables learners to practise a variety of clinical skills in a safe environment minimizing potential risks to patients and learners (Galloway, 2009). With a safe and supportive environment, learners feel at ease to learn. Decision making, critical thinking and clinical procedures demonstration are encouraged during simulation learning and practice (Raurell-Torredà, et al., 2015). Simulation can provide opportunity for students to communicate and collaborate in teamwork. Leadership skills and competency can be enhanced (Aebersold & Tschannen, 2013), and critical thinking is improved (Schubert, 2012). In addition, simulation can be recognized as an evaluation method to assess students' performance (Aebersold & Tschannen, 2013; Schubert, 2012). Followed by simulation implementation, debriefing is a subsequent session delivered by facilitator to review the simulation experience and promote reflective learning of participants. The comments provided are useful for future learning and further improvement (Aebersold & Tschannen, 2013). Therefore, integration of simulation and debriefing can provide students with opportunities to learn, practise and reflect in a risk-free environment preventing both clients and students from diseases especially in the unprecedented COVID-19 pandemic. However, some negative influences about simulation training were also reported. According to Au et al. (2016), simulator was not a real patient, students' attitude of caring and treating patients would be negatively affected in real clinical setting.

According to the statistics provided by Social Welfare Department (2021b), there are 35 097 places for residential care services for the elderly, including homes for the aged, care and attention homes for the elderly, and nursing homes. The main duty of health worker is to provide comprehensive health care to residents who are living in resident care home (SWD, 2021a). Therefore, contribution of health worker to health care in community, especially residential home settings, is significant. However, local literature or studies on evaluating nursing simulation on health worker training is rare. Hence the researchers attempt to conduct this research.

In view of the difficulties in resuming regular face-to-face residential care home placement due to COVID-19 outbreak, there is an urgent need to propose concrete solutions for this unique need and concern. It is challenging to strike a balance between sustaining health care education and maintaining social distancing, quarantine and infection control measures. Therefore an innovative new contingency measure is developed by the researchers with the use of nursing simulation to replace on-site fieldwork placement in health worker training for higher education students aged 18–22. The objective of this study is to evaluate the effectiveness of this new learning mode through nursing simulation from the perspective of students.

16.3 Methodology

16.3.1 Study Design

This study is a qualitative research with design of mixed method of semi-structured focus groups and individual interviews to obtain a deeper understanding of students' perceptions about the effectiveness of learning with the use of nursing simulation to replace on-site fieldwork placement in health worker training for tertiary education during the COVID-19 pandemic. The focus of the focus group interviews is to explore students' overall perception on the use of nursing simulation for their learning as a solution to the problem of social distancing and restricted contact during the pandemic. Whereas, the focus of individual interviews is to further investigate the beneficial effect of students' learning with the use of nursing simulation to address the difficulties of ongoing fieldwork placement during the unprecedented time.

16.3.2 Sampling and Participant Recruitment

Purposive sampling was adopted in this study. For the 3 focus groups, participants were recruited on the basis of the following inclusion criteria: year 2 students studying programme of Higher Diploma in Integrated Social and Health Services, and participating in the simulation workshop to replace on-site fieldwork placement in health worker training. Each group comprised four to six participants which can meet the minimum group size (Krueger & Casey, 2009). Based on the findings of the focus groups, five more students were invited to attend individual interviews to explore further and deeper on the benefits of simulation training. They were selected in terms of their socio-economic backgrounds for example, gender, age and academic performance. These could provide a fair distribution of age, gender and academic performance and allow comparison among those with different academic performance. Recruitment continued until the data saturation point was reached (Mason, 2010).

The profiles of the interviews were as follows (Tables 16.1 and 16.2).

16.3.3 Interview Guides

Interview guides were designed with four semi-structured questions for both focus groups and individual interviews. They included main questions, follow-up questions and probes for obtaining in-depth opinions and ensuring participants' information clarity. The questions were short, simple and open ended. The interview guides were designed in English first and then translated to Chinese for use. Appropriate

Table 16.1 Profile of the focus groups

Case no	Group no	Name	Age	Gender	Academic performance*
1	1	Hei	21	Male	Fair
2	1	Ching	21	Female	Good
3	1	Yan	20	Female	Good
4	1	Ho	20	Male	Good
5	1	Ngai	21	Female	Excellent
6	1	Kin	20	Male	Fair
1	2	Chak	21	Male	Good
2	2	Lok	20	Male	Fair
3	2	Yi	21	Female	Fair
4	2	Man	20	Female	Good
1	3	Coco	21	Female	Fair
2	3	Ci	21	Female	Fair
3	3	Cheong	20	Male	Fair
4	3	Hin	20	Male	Good
5	3	Leo	22	Male	Fair
6	3	Paul	20	Male	Excellent

* Remark: "Excellent", "Good", "Fair" in academic performance. GPA > 3.5 is "Excellent", GPA > 3 and below 3.5 is "Good", GPA > 2.5 and below 3 is "Fair" in academic performance

Table 16.2 Profile of the individual interviews

Case no	Name	Age	Gender	Academic performance*
1	Ching	21	Female	Good
2	Yee	21	Female	Fair
3	Paul	20	Male	Excellent
4	Hei	21	Male	Fair
5	Chak	21	Male	Good

* Remark: "Excellent", "Good", "Fair" in academic performance. GPA > 3.5 is "Excellent", GPA > 3 and below 3.5 is "Good", GPA > 2.5 and below 3 is "Fair" in academic performance

wordings and questions sequence of the interview guides were examined by nursing professionals and educators. Sample questions for the focus groups and individual interviews with different focuses were included.

Sample questions for the focus groups underline overall students' perception on the use of nursing simulation for their learning:

1. Do you think you are capable of demonstrating appropriate nursing care during simulation learning? Why? (Probe for responses to the patient's reactions and conditions etc.)

2. What have you learnt during simulation learning? (Probe for critical thinking, communication, collaboration, leadership etc.)
3. Do you have any difficulties during the simulation learning?
4. Do you think debriefing is valuable? Why? (Probe for perceptions of self-evaluation, self-assessment etc.)

Sample questions for the individual interviews put focus on the beneficial effect of students' learning with the use of nursing simulation as follows:

1. How do you feel during the simulation learning? (Probe for responses to the personal feeling e.g., nervous etc.)
2. What have you improved during simulation learning? (Probe for self-confidence, self-satisfaction etc.)
3. How do you apply the simulation learning when working in residential care home after Health Worker Registration?
4. Do you think the simulation learning / case scenario is useful for practising nursing skills? Why?

16.3.4 Simulation Workshops

Two sessions of simulation practice were provided to the participants in March 2021 at Simulation Laboratory in the campus of IVE (Sha Tin). The high-fidelity simulation activities were designed with reference to various studies (Aebersold & Tschannen, 2013; Au et al., 2016). Laerdal SimMan™ patient simulator was used during the simulation activities. Before the activities, a meeting was organized by the responsible teachers to discuss the design and arrangement of the simulation activities. A mock session was run to ensure smooth arrangement and further improvement. The students attended the workshop in groups of 6 which were assigned according to their groupings of fieldwork placement. Three of them were assigned to the roles of health worker and observer respectively. Teachers acted as facilitators to provide support throughout the simulation activity. The first session, lasting around 60 min, was a trial session for the introduction of the activity. Some concepts about the simulation activities were provided and some case scenarios were shared for their experiential learning, practice and analysis. Relevant materials of the case scenario were provided to the students. The second session, lasting around 80 min, included a 20-min briefing, 20-min preparation and discussion among the groupmates, 20-min simulation learning and 20-min debriefing. During the briefing session, the orientation of the simulated environment was provided, intended learning outcomes, amount of time given, activity details and role specification were explained. Preparation session allowed students to discuss their concerns and familiarize themselves with the environment. The scenario was then run under the time frame of 20 min. Observers and teachers could provide cues to promote collaboration learning. Observers were asked to take note on nursing care and interventions provided by health workers, and clinical presentation of SimMan. The whole process was recorded for debriefing.

Debriefing encouraged students to discuss and review the overall performance. The feedback was useful for improvement and future learning.

16.3.5 Data Collection and Measures

After attending the simulation workshop, eligible participants were invited to attend the focus group meetings. Based on the findings of the focus group, five more students were invited to join the individual interviews. All meetings and interviews were arranged at nursing laboratory.

Both focus groups and individual interviews lasted approximately 60 to 90 min and were audio recorded with notes taken by the moderator. The interviews were then conducted following the interview guides in Cantonese. Preliminary data analysis was performed on the collected data and emergent themes were obtained in subsequent interviews.

16.3.6 Data Analysis

All the audio records were transcribed verbatim. Thematic analysis was adopted to identify main themes under the six-stage model of Braun and Clarke (2006).

16.3.7 Qualitative Rigor

The guiding principles of transferability (external validity), credibility (internal validity), dependability (reliability) and conformability (objectivity) (Connelly, 2016; Koch & Harrington, 1998; Morse, 2015; Petty et al., 2012; Polit & Beck, 2018), were used to ensure trustworthiness of this study.

Details of the focus group and individual interviews, for instance, data collection methods and, inclusion and exclusion criteria were thoroughly described in this study to assure transferability.

Nursing professionals and educator were invited to examine the interview guides for achieving creditability.

For reliability, detailed description of the research methodology was provided.

Triangulation was used for reducing the effect of bias. The moderator was aware of bias and remained neutral during the procedure to ensure objectivity.

16.3.8 Ethical Consideration

Ethics approval was obtained from the Human Subjects Ethics Panel, Childcare, Elderly and Community Services Discipline Academic Committee, Hong Kong Institute of Vocational Education (Sha Tin). At the beginning of each focus group meeting and individual interviews, the participants were informed about the purposes of the study, their voluntary participation, procedures to be followed and potential risks and benefits associated with their participation. To respect human dignity and voluntary participation in the study, informed consent was provided. Participation would be entirely voluntary and participants had the right to withdraw at any time during the study without any penalties. All the data would be handled in a confidential way.

16.4 Results

Three focus groups and five individual interviews were conducted in June 2021. The participants were 20–22 years old. Four themes were identified in the focus group interviews describing participants' perception toward the simulation learning activities: (1) simulation activity has pros and cons in student learning, (2) experiential simulation activities enrich student learning in health care training, (3) debriefing can facilitate students to adequately self-evaluate their practice performance in nursing care, and (4) students may have emotional adjustments in simulation learning environment.

16.4.1 Major Findings of 3 Focus Groups

Theme 1: Simulation activity has pros and cons in student learning

Most participants' perception of simulation learning was positive. They believed that it was important to enhance a variety of skills, for example, communication, organization, team work collaboration, problem solving, ability to handle or respond unexpected situation, crisis management, leadership, critical thinking and decision making. Their attitude, self-confidence and development of professional image were improved as well. However, some reported that SimMan was not a real patient. And there was only one SimMan with no facial expression and communication with patients during the learning process. Two subthemes emerged from this theme, i.e. importance of simulation learning and drawbacks of simulation learning.

Subtheme 1: Simulation activity improve a variety of skills which are important to student learning.

Many participants believed that simulation activity was important for learning and improvement.

I think that my decision making and critical thinking are improved. Caregivers and patients may have their own opinions, for example, "I want you to take temperature for me, I want you to open windows for me…" As a health worker, I need to know whether their requests are beneficial to the patient or not. Or they may be harmful to the patient. I have to consider patient's background and past health history before making decision, not simply following patient's request.

(P1, Focus group interview 1).

I believe that my communication and organization skills are strengthened. Before the start of simulation activity, we can prepare for it by screening information of the SimMan, for example, background, past health history etc…this can enhance our communication. Because we have to communicate our roles and our job assignment during the activity… For the organization skills, I have to analyse the information with our teammate, to predict different situations and to analyse how to handle.

(P1, Focus group interview 2).

During the simulation activity, similar to residential care home or hospital working environment, there may be some unexpected situations designed to assess students' ability to handle unexpected situations and problem solving skills.

(P3, Focus group interview 1).

We have to cooperate with each other, some have to be responsible for handling oxygen concentrator, others have to take temperature, this is useful for teamwork collaboration.

(P6, Focus group interview 1).

For leadership enhancement, as a leader, you have to know how to cooperate well with other teammates and provide them with some instructions so as to promote effective teamwork operation. This can help the elderly more successfully.

(P4, Focus group interview 1).

In addition to the above enhancement, students' learning and work attitude were also improved.

With this simulation learning experience, we are more confident to deal with the real case situations when encountering the same problems. Because during the simulation activity, we have learnt how to handle the problem of breathing difficulty and fever. In real working environment, we will not feel so nervous and respond to the same problems quickly.

(P5, Focus group interview 1).

Because I am a professional staff, I cannot provide nursing care based on patient's need only. As a health worker, I have to consider different aspects for making professional decisions.

(P1, Focus group interview 1).

Subtheme 2: Lack of human interaction and real communication with patients are drawbacks in simulation learning.

Despite the above reported importance from the participants, there are some drawbacks of simulation learning, such as lack of real responses and interaction with patients.

SimMan is a simulator only, he cannot give us real response. Meanwhile, there is not only one patient in residential care home, we may have to take care of many patients at the same time. Surely, we can provide holistic care to one patient during the simulation activity. But can we achieve this when we have to take care of different patients in real working environment?

(P1, Focus group interview 2).

SimMan gets fever, we take temperature for him. Yet, he is not real and he does not have temperature.

(P6, Focus group interview 3).

SimMan is not real, we may not take a serious attitude during the activity. And so we may lack initiative during the placement.

(P3, Focus group interview 3).

Theme 2: Experiential simulation activities enrich student learning in health care training

Most of the participants believed that they could provide some appropriate nursing care during the simulation activity.

I believed that the first thing I have learnt from simulation activity is caring and nursing skills.

(P2, Focus group interview 1).

During the simulation activity, I can recognize the need of understanding patients' condition. I can practise some nursing skills, such as the appropriate use of oxygen concentrator and the appropriate way of administering oral medication.

(P5, Focus group interview 1).

Participants showed that simulation learning was the best solution to address the problem of social distancing, restricted contact and infection control measures during the crisis of COVID-19 pandemic.

During the COVID-19 pandemic, infection control measures and restricted visit of residential care home are implemented to prevent the outbreak of the diseases. All these policies impose difficulties of ongoing placement in residential care home. But practical experience is very important to us. Therefore with the use of simulation learning, we can apply our nursing skills during the activity… It can assess students' ability of responding in real case situation.

(P1, Focus group interview 2).

Simulation learning can provide a safety environment for students to learn and practise. It can protect patients from error as well.

Under the real situation, our mistakes will have a negative impact on patients' safety. For example, it is very dangerous for a patient to fall from a lifting procedure.

(P4, Focus group interview 2).

SimMan is not real. Even if we make mistake, it will not harm the patient.

(P4, Focus group interview 3).

Theme 3: Debriefing can facilitate students to adequately self-evaluate their practice performance in nursing care.

Debriefing encouraged students to discuss their performance, which could be a kind of evaluation of their performance. Self-confidence, self-reflection, self-evaluation and nursing skills were strengthened. They could learn from error and the comments given were useful for future improvement. Teachers' sharing and feedback could foster and promote learning motivation.

> *Comments and appreciation from teachers can raise our confidence in working in future. Based on the scenario, they share their working experience with us, for example, use of oxygen mask in different conditions… These can strengthen our nursing skills.*

(P5, Focus group interview 1).

> *Because we do not have practical experience, debriefing indeed can enhance our exposure. Even though we do not make any mistakes, we can know the performance of other teammates in debriefing session which is very important to our enhancement and learning.*

(P6, Focus group interview 3).

> *Debriefing is useful to us. Because we are peers and we learn together, we will have a question why other classmates perform better than me during the simulation activity. Why are some classmates invited to perform demonstration? Why do some make mistakes during the activity? All these can facilitate our self-reflection.*

(P1, Focus group interview 2).

Theme 4: Students may have emotional adjustments in simulation learning environment.

Despite the positive value and importance of simulation learning, some participants still encountered difficulties during the simulation activity, for instance, feeling of nervousness, anxious, fear and worry, and unfamiliar with simulated environment.

> *I feel that we are not professional enough. Firstly, we do not face this challenge before. Secondly, we feel very nervous during the scenario. Luckily the situation is not authentic. If it is real, we may not be able to handle the case.*

(P2, Focus group interview 3).

> *When a patient has breathing difficulty, how do we deal with it? Why does he have this problem? What are the leading factors of his problem? We learn the nursing care skills from book, it is quite difficult for us to respond to it and perform the tasks immediately… this make us feel panic and nervous. We do not know how to handle the unexpected situation during the simulation activity.*

(P1, Focus group interview 1).

16.4.2 *Major* **F***indings of 5* **I***ndividual* **I***nterviews*

Based on the major findings of the three focus group interviews, five more individual interviews were implemented to collect in-depth views on beneficial effects of student learning with the use of nursing simulation. Two main themes were identified: (1) students have deep self-reflection in the practice of simulation activities and (2) simulation activity is crucial to student learning.

Theme 1: Students have deep self-reflection in the practice of simulation activities.

During the simulation learning, the participants performed in different ways with nursing skills and attitude improved. Some would become more proactive to practise. They might be more determined in decision making and developed straight thinking. However, some might respond to the scenario poorly.

> *I recognize that taking care of a patient is difficult, I have to consider patient's feeling, for example, it is very painful for him to breath with nasal cannula, I need to think about how to alleviate his pain from different aspects, not just from the role of health worker.*

(P1, Individual interview 1).

> *My empathy is improved. Some patients need long term bed rest, I will think how to help and take care of them.*

(P1, Individual interview 1).

> *I realize that the responsibility of health worker is not just taking care of the elderly physically, but also psychologically. Holistic and all-round care is needed. This make me more understand the need of elderly who are living in residential care home.*

(P2, Individual interview 2).

> *I always feel nervous during nursing skills practice. After joining the simulation activity, my emotion becomes stable and calm during practice. Because comments from my teammates let me know my mistakes.*

(P3, Individual interview 3).

> *Teamwork, communication and comfort skills with patients are improved… in addition, my sense of achievement is enhanced. I feel that our group perform well during the simulation activity, we can communicate well with the patient and provide the nursing care needed. Teacher also appreciate our performance as well. All these can give us a sense of achievement.*

(P4, Individual interview 4).

Some participants believed that they should take more initiative to learn and develop effective team coordination.

> *I am more proactive to learn. After the simulation learning experience, teachers' appreciation, criticism and sharing in debriefing reinforce my self-confidence. I know the priority of work management. I believe my performance will be enhanced.*

(P4, Individual interview 4).

> *I become determinant and make decision for patient quickly. Because I do not know whether the condition of the patient will deteriorate or not.*

(P1, Individual interview 1).

I become more proactive with improved organization skills. My thinking is getting more logical and my speech is organized.

(P2, Individual interview 2).

Debriefing is good for learning because I can receive comments from others. Yet, during self-practice, I do not know my own performance and mistakes.

(P3, Individual interview 3).

Some participants felt frustrated, nervous and lack of confident about their performance. They considered they should have improvement on simulation learning.

I feel frustrated about the simulation learning because the scenario is out of my expectation. I will review and self-evaluate my poor performance. I have a feeling of failure. Compared with the performance of classmates, I think that I am wrong and need lots of improvement.

(P2, Individual interview 2).

During the activity, I feel nervous, I do not know how to handle and respond to the situation. I do not have confidence. Even I have prepared for the activity well, I do not know how to take care of the patient. I am still not capable to be a professional health worker.

(P1, Individual interview 1)

Theme 2: Simulation activity is crucial to student learning in health care.

The participants felt excited about the implementation and experiential learning of simulation activity, involving high technology and authentic real situation. They believed this simulation learning should be included in their current curriculum which could make their learning fruitful.

I look forward to the simulation workshop so much once I know it will be implemented. Because it involves technology of high-fidelity simulator that I have never tried before. I would like to know and experience the authenticity of SimMan under the simulation activity.

(P5, Individual interview 5).

I believe it is necessary to include simulation learning in our course curriculum. Because we need to understand nursing care at a higher level.

(P1, Individual interview 1).

I cannot have a real practice at residential care home, so the use of simulation learning is the best method to learn during the COVID-19 crisis. We can try to deal with some unexpected case scenarios such as transferring the patient to hospital and fever. This can reinforce our knowledge on some nursing care procedure.

(P3, Individual interview 3).

Providing wrong nursing care can be very critical which may result in medical error and severe consequence. So, simulation learning is very useful for assessing students' nursing skills and their knowledge application.

(P5, Individual interview 5).

16.4.3 Commonalities and Differences in Both Focus Groups and Individual Interviews

Having reported the major findings in both focus groups and individual interviews, some commonalities and differences of the results were found and summarized as below.

Commonalities in both focus groups and individual interviews.

For the commonalities, participants from both focus group and individual interviews expressed that simulation learning was the most appropriate solution to solve the problem of restricted contact and social distancing during the unprecedented time of COVID-19. Despite the patient was not real, the authentic case scenario and environment could provide students with opportunity to practice and learn from mistakes, and preventing danger of harming patients. Both group participants demonstrated an improvement of nursing skills.

In addition, they reported that their interpersonal skills were strengthened, for example, communication skills, collaboration and teamwork. Their decision making, critical thinking, organization skills and leadership were enhanced.

Feedback from debriefing was illustrated as useful for learning, enhancement and self-evaluation in both focus group and individual interviews.

Whereas, participants from both focus group and individual interviews revealed negative psychological responses during the simulation activity, for example, lack of self-confidence and feeling of nervousness.

Differences in both focus groups and individual interviews

Compared with the findings of the focus groups, the participants, with fair academic performance, in the individual interviews reported that they became more proactive in learning. The comments and sharing from teachers and classmates encouraged them to be attentive during simulation learning, even though they might sometimes compare their performance with others and have feeling of inadequacy and incompetency.

Despite the fact that both the patient and practical environment were authentic, the participants in the individual interviews revealed that their empathy was enhanced. They would try to understand more about patient's feeling and need, compared with the results of the focus groups.

However, finding of feeling frustrated was reported in the individual interviews compared with that of the focus group. A participant had a feeling of failure and she found out that her performance was not so satisfactory. It facilitated her to think more how to improve her skills and knowledge in simulation learning.

16.5 Discussion

This was the first time to adopt the strategy of utilizing high fidelity simulation learning to replace a part of the residential care home placement for health worker training in our institution. This study was to explore the effectiveness of using this new contingency measure to address the issue of social distancing, risk of infection in gathering and restricted contact at residential care home during the unprecedented crisis of COVID-19 from the perspective of students. Focus group and individual interviews were used in this qualitative study. Four themes were identified from the 3 focus group findings to describe participants' perception toward the simulation learning activities: (1) simulation activity has pros and cons in student learning, (2) experiential simulation activities enrich student learning in health care training, (3) debriefing can facilitate students to adequately self-evaluate their practice performance in nursing care, and (4) students may have emotional adjustments in simulation learning environment. Two main themes emerged from the results of 5 individual interviews to acquire in-depth opinions about the beneficial effects of the simulation learning: (1) students have deep self-reflection in the practice of simulation activities and (2) simulation activity is crucial to student learning in health care. From the findings of this study, overall perception of the simulation activity was positive. The participants believed that it is one of the most appropriate methods to resolve the current pandemic issue and problems by preventing the spread of diseases to others. This could protect both patients and students from COVID-19 by minimizing the threats. These were consistent with previous findings conducted by Dieckmann's research team and Galloway respectively (Dieckmann et al., 2020; Galloway, 2009) which stated that simulation can provide a safe learning environment without risking patients and even students.

In addition, the participants demonstrated an improvement in nursing skills, some nursing procedure, priority of nursing care and knowledge application which might be useful for preparing future health care work. These were in line with the results of Au et al. (2016) and Raurell-Torredà, et al. (2015) which showed that it was good for the participants to experience simulation learning to get ready for future clinical practice and setting in future.

Furthermore, the results of both focus groups and individual interviews indicated that the participants' confidence was improved with the use of simulation learning activity. Feedback and sharing from teachers and classmates could raise their confidence in performing nursing skills and preparing work in future. Similar findings were reported in the study of Mark et al. (2020) which showed that teaching with high-fidelity simulation could improve confidence in demonstrating nasopharyngeal swabs for COVD-19 of health care worker, and the study of McCaughey and Traynor (2010) which revealed significant improvement in confidence of undergraduate nursing students.

Besides, it was evident that the participants from both focus and individual interviews had an improvement and enhancement on communication skills, teamwork collaboration, problem solving skill, leadership, decision making, critical thinking and logical thinking. They became determinant to make decision and deal with emergency situations. They recognized the importance of teamwork collaboration. Similarly, Schubert (2012) reported the effectiveness of using high-fidelity simulation activity as teaching strategy, showing improvement in critical thinking.

Despite the importance of high-fidelity simulation learning, some students from the study perceived that the simulation learning had drawbacks. Because SimMan patient simulator was not real, it did not have facial expression and real interaction with the participants. And there was only one SimMan patient during the scenario. There was lack of real communication with different patients who might have different background and health conditions. As a result, the participants might not take a serious attitude during the activity and might lack initiative during the placement. These results were consistent with the study of Au et al. (2016) which reported the negative impact of simulation activity. This might affect students' attitude in treating real patients in the real clinical setting (Au et al., 2016).

The participants from both focus group and individual interviews reported feeling worried, nervous and even anxious during the simulation workshop. They did not know how to deal with the patient and respond to the unexpected situation. One participant in the individual interview even felt frustrated about her performance. She compared her performance with other classmates and had feeling of inadequacy and incompetency, though it also facilitated her to have self-reflection on how to further improve her knowledge and skills in simulation learning. This finding may not exactly correspond to the study of Au et al. (2016) which reported that it was relaxing for the participants to learn with little stress under the simulation setting. This suggests that more practical rehearsal and role-play demonstration could be increased in simulation learning environment. Students should have more practical skills training so as to minimize sense of inadequacy and incompetency during the process. Detailed briefing session for simulation activity is needed for future simulation training.

Surprisingly, from the findings of individual interviews, participants' empathy was improved and enhanced though SimMan is a computerized simulator. They would consider different aspects in treating patients so as to provide holistic care to them. Future study about this is necessary for further investigation.

16.6 Limitation

First, only a small sample of students participate in this research and the sample is too small in size that makes it not so representative. The year two students were included in this study because this was a part to replace residential care home placement. Year one student of the programme after completing some nursing modules can be invited for future study.

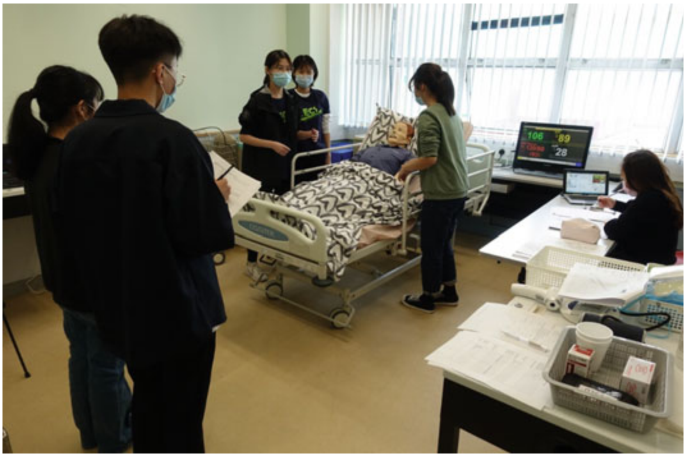
Second, this is an explorative study to investigate the views of the students with focus group and individual interviews. Questionnaire and randomized controlled trial can be considered in future to further examine the effectiveness of high-fidelity simulation activity on health worker training in tertiary institution. Quantitative research can make the research results more objective and valid.

16.7 Conclusion

This was the pilot study to adopt the strategy of utilizing high fidelity simulation learning to replace a part of the residential care home placement for health care training in our institution. This study was to explore the effectiveness of using this new contingency measure to address the issue of social distancing and infection risk during the unprecedented crisis of COVID-19 from the perspective of students. Both positive and negative influences are assessed. The utilization of high-fidelity simulation learning is highly appreciated. Students' nursing skills, interpersonal skills and work attitude are improved and enhanced. All these promote the use of high-fidelity simulation learning in health worker training and curriculum for their professional development and recognition. More preparation, practical rehearsal and role-play demonstration should be introduced to strengthen their sense of adequacy and competency which are important for their health care training and future work in real setting. Therefore, based on these findings, further solutions should be considered for developing the new learning mode through nursing simulation. Effective ways should be developed to motivate the students and enhance positive learning outcome achievement.

16.8 Appendix

Appendix I. Picture about simulation training workshop and debriefing session 1



Appendix II. Picture about simulation training workshop and debriefing session 2

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Part III
Driving Student Access, Engagement and Success Through Digital Technologies

Chapter 17
A Reflection Case to Covid-19 Pandemic: Online Learning Experience

Will W. K. Ma

Abstract The covid-19 pandemic spread throughout the world by 2020. Millions were infected, and thousands died as a result of this. Many institutions were shut down, and physical access to campuses was halted. Institutions switched to online instruction, and students took online classes at home. The purpose of this study was to better understand the shift to online learning during the coronavirus epidemic. It also attempted to identify roadblocks and hurdles in the process so that ideas for the future of learning could be proposed. Between February and May 2020, teaching staff and students at a local applied degree institute in Hong Kong were asked about their online learning experiences. There were six major themes identified: (1) online learning experience; (2) support; (3) engagement; (4) group work; (5) time; and (6) assessment. These were examined in light of past literature, and recommendations for further learning were made.

Keywords Online learning experience · Online teaching · Institute support · IT readiness · Group work · Time

17.1 Introduction

In 2020, covid-19 pandemic spread over the whole world. This was so serious that millions were infected, and thousands died. Many schools were closed, and physical access was suspended. Students stayed at home to isolate themselves and to prevent from being infected. Schools were transitioned to online teaching. Some countries were infected and in serious condition in the early stage, for example, China while other countries were affected in a few months' later, for example, Europe and the American countries.

In this study, the purposes are two folds. It aims to understand the online learning and teaching experience of the transition to online learning during the coronavirus

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pandemic. It also aims to identify obstacles and challenges in the online learning and teaching process to suggest online learning and teaching approaches for the future.

Previous literature studied blended learning in a number of perspective, including use of technology in blended learning (e.g., Schmid et al., 2014); pedagogical considerations for instruction within online and face-to-face modes, as well as across the two (e.g., Means et al., 2013); design of blended learning courses (e.g., Rowe et al., 2012); learner support (e.g., Landers, 2009); assessment in blended learning (e.g., McGee & Reis, 2012); instructor's role (e.g., Zhao et al., 2015) and so on. On the other hand, Siemens et al. (2015) proposed a framework for the fourth generation of information technology infrastructure, including the reflection and evaluation of different factors: (1) Control between learner and faculty/institution, including structured/unstructured learning activities; (2) Ownership of data and content—the learner or the institution; (3) Institutional integration—loosely coupled with data exchange happening through APIs and related industry standards or tightly connected with enterprise level systems; (4) Structure—centralized and decentralized teaching and learning approaches.

This research looked at the covid-19 scenario between February and June 2020, as well as the online learning environment at a local Hong Kong applied degree institute. The following were the study's research questions: (1) Were there any recurring themes in online learning and teaching? (2) Were there any disparities in perceptions of online learning and teaching between teaching staff and students?

The following is an outline of this study. The methodology was given in the next part. In the findings section, the qualitative data was evaluated. The discussion and implication would then take place. Finally, recommendations for institutional implementation of blended learning would be provided.

17.2 Method

17.2.1 Background

The Institute was a local applied degree education in Hong Kong. It offered 21 undergraduate programmes in design and environment, hospitality and management, and science and technology. Due to the impact of the coronavirus during Semester 2 (AY2019/2020), it resulted in the closure of the Institute's campuses for face-to-face teaching. The Institute shifted to online teaching. The Institute's President started an Institutional Research Project to investigate the experiences of students and teachers with online learning and teaching in the goal of continual improvement, and a Research Project Working Group was constituted in April 2020. The Institute's President chairs the Working Group, which comprises nominations from the Faculties/School, the Research Office, and the Learning Commons. The Learning Commons is in charge of the Institute's learning support. Where Learning Commons launched learning and information technology assistance throughout the online teaching period, teaching staff and faculty administrative staff continuously fixed challenges that arose from online teaching. This study was a part of the larger research project by the Working Group.

17.2.2 Subjects and Data Collection

Staff focus group interview: On the 26th and 7th of July, 2020, 18 teaching staff from 15 programs participated in four interview sessions, each lasting around 60 min. *Students focus group interview:* Similarly, 11 students from 7 programs participated in 6 interview sessions, each lasting either 60 min or 30 min and taking place between 26th of June and 16th of July, 2020.

17.2.3 Data Analysis

NVivo 12.0 was used to analyze the interview transcript. The autocode approach assisted in identifying emerging themes from the interview content. The themes and categories were examined. Repetitive content in many categories was eliminated or reorganized. Additional themes were established based on the content concepts. (1) Online learning experience; (2) Support; (3) Engagement; (4) Group work; (5) Time; and (6) Assessment are the concluding topics backed by quotations from the staff interview transcript. For analysis, the final themes and categories of student interviews were mapped with the results of the teaching staff findings.

17.3 Findings

17.3.1 Online Teaching and Learning Experience

This theme mirrored the teaching staff's and students' perceptions on online learning. It gathered teaching staff comprehension of the method of conducting online teaching as well as student perspectives on attending online classes. This presented a more complete picture from both perspectives, bridging our understanding of their perceptions and experiences about online learning.

Teaching Staff on online teaching experience.

Quite a few teaching staff had positive attitude towards online teaching. Some had experience before, some thought that it was effective, esp. for theoretical content. For some disciplines, there seemed no difference in teaching online or face-to-face. For example,

- Teacher K, "*So, I tried to use MS Teams, and I think that is quite effective in my class because of my students. I mean management students. They get used to all these tools, how to use it. So, I did not have too much difficulty to encourage them to use MS Teams.*"
- Teacher G, "*Honestly, I quite support the online learning but for the lab we work face-to-face in the laboratory. But for the theoretical part, very honestly, I support the online learning.*"

Learning experience to teach online

- Teacher C, "*for the first lessons we did not have online lesson. We only have narrated PowerPoint. And suddenly, one student suggested we (should) have the online teaching. So, the whole course every lecture started to have online teaching.*"
- Teacher P, "*by week 6, I think, so I just started straight away. I didn't wait for anything… They all have the app.*"

Lecture recording

A lot of comments on lecture recording were found. It was convenient to click a button to record the whole lecture though there maybe problem to send to students due to the file size. Most agreed that the lecture recording would benefit the students.

- Teacher Q, "*For the first time, I recorded the lecture… which last for 3 h in two episodes recorded in 2 files. And ultimately I found the files are too big to upload to the Moodle. And, I need to find another way to send to the students.*"
- Teacher M, "*This is one of the things may be that is good for some students if they really don't have time or they have a reason not to attend the class but later on, they make use of it, not to attend the real time lesson. But, they try to listen to the playback something like that.*"

  In addition to the lecture recording, some turned out preparing a list of video recording learning material for students to choose to learn from.
- Teacher N, "*I can record video on those statistical background, therefore students can simply click into the video, and then watch those video to learn the concept according to their need.*"

  Interestingly, some teaching staff also got benefit from self-reflection on teaching.
- Teacher P, "*You can go back and look at the classes and see the weaknesses. How can we improve? I watch back my lecture and look at the mistake that I made. For me, it is also useful for review(ing) my teaching practice.*"

Practical class teaching experience

The Institute offered applied degree education. Practical and laboratory class had an important portion in the curriculum design. A lot of comment was received from the teaching staff who did not prefer online teaching for practical classes and did not think that online teaching for practical class would be effective.

- Teacher F, "*for some lab-based lecture or experiment, this is quite limited by the online teaching because you really have to touch the apparatus, and how to make the solutions, so for them is quite difficult.*"
- Teacher A, "*so that's why some student find it difficult to make the concept. I mean creativity-related concept practical because they haven't had a chance of doing hands-on experience.*"

Students on Online Learning Experience

Previous online learning

Only very few had previous online learning experience,

- *Student A, "I have attended a few online classes during the middle school," and "When I went to tuition in middle school, sometimes I missed the class, so I would have make-up class online."*

Those who did not have online learning experience did have some rough perceptions,

- *Student B, "If it is really a regular curriculum, a degree course, if you use an online lecture, I think that may not be suitable for me. Maybe it is more suitable for a mass lecture, or a master's degree."*

How online learning was conducted?

Students reflected that there were great differences in online teaching practices. Some aligned after a few weeks though there were others not as expected throughout the whole semester.

- *Student C, "It is mainly narrated PowerPoint, as well as those with MS Teams for online class. But there are some subjects which only have narrated PowerPoint, there are no online class."*
- *Student D, "If we need to learn online, some lecturers use MS Teams while some use YouTube."*

Lecture recording

The majority of the students appreciated the lecture recording that they could benefit from. For example,

- *Student E, "I think it is all good, However, I prefer online learning where the lecturer will record the whole class," and "I might do a group project, if I have a project and I have something I do not know, I just need to return to the video recording."*
- *Student H, "With MS Teams, there is an advantage, because our faculty requires, my BSE lecturers, all have video recordings, that is, when you go to the classroom, you will record all the way."*

Practical class teaching online

Different from the point of view of the teaching staff, students thought that online learning worked equally well for laboratory or practical class. For example,

- *Student J, "No, it will not affect me much if I watch the demonstration video online."*

To summarize, all mandatory online teaching was unprecedented. Both the teaching staff and the students have to learn and adapt. It also demonstrated that teachers may have a different perspective on some areas of online learning than students, such as practical class online teaching.

17.3.2 Support

Online teaching and learning necessitated a unique set of abilities, equipment and technology, administrative support, and training, among other things. There were several difficulties at the start of the move to online learning because all of those prerequisites were not yet ready, available, or accessible.

Staff support on administration

Administrative process, administrative procedures, and the communication with the administrative teams seemed not a major concern of the participants. For example,

- Teacher G revealed that she did not "*need much administrative*" support. Most importantly, what teaching staff needed was "*technical people to help me to make the digital material to video to post to online Moodle*."

Facilities and equipment support

There was some basic equipment for online classes, e.g., camera and microphone where they were in lack of at the beginning. For example,

- Teacher J, "*students mentioned that they don't have any microphone or video camera from their desktop computer, and so we found we can only use the chat room for communication during the lecture sessions*."
- Teacher R, "*We have no problems doing everything online but only things that we may need more support on equipment because like the first teacher said that some of the students do not have microphone or camera at home. Same as us, we do not have any microphone or camera on our desktop office computer as well*."

They might have different experience in other institutions which, say, providing teaching staff with a whole set of equipment for online teaching, or preparing all equipment at a classroom for online teaching. For example,

- Teacher Q, "*So, I think for my case, it is helpful if the school can provide me a tablet, and also help me how to connect all those equipped hardware together to facilitate the language-based teaching*."
- Teacher C, "*I teach in another institute. They have a whole team of people. And, you can get the support by recording, with all the system setup already in the classroom*."

Technical support

As there was no choice but it required teaching staff to use technology to teach, it was no wonder that technical support was in great demand at the very first beginning. For example,

- Teacher J, "*when they find any technical issues, they may find very difficult to solve the problem because most all of the students are waiting for the response from the lecture, from the lecturer, and so they feel stressful about how to fix the technical issue during or before the lecture session.*"
- Teacher M, "*I want to address (post) the video on the Moodle and for the student to take a look at the playback... So, after that I want to delete because I don't want to keep so many video on the Moodle and I think that is quite difficult.*"

Training support

As online learning was new to the teaching staff, there would always be something for them to learn. Training was important. More would like to have just-in-time support to solve problems, in addition to regular workshops in general.

- Teacher U, "*For some part-time lecturers. These lecturers they are at middle age. They are not so having high confidence in using IT or computer*."
- Teacher F, "*I think the IT can provide some more simple illustration to encourage to middle age teaching staff to use new technology.*"
- Teacher P, "*I have to do the pilot for them, try with me. So, they can overcome the fear.*"

Software and application support

Conferencing applications were the core to conduct online class. In addition, other learning support systems were also important in the online learning period.

- Teacher E wondered, "*Do they have access to tools to do online editing?*" and, "*So, the main thing was if I'm going to be doing something like that online teaching and distance teaching. It's really important to teach them how to use these tools ahead of time.*"
- Teacher A, "*The students would easily mix-up where they should submit their assignments though we have already given the information on Moodle and we have already reminded them on online teaching.*"

Students on IT readiness

However, when the Institute switched to online learning, students were ready. Students had the equipment and facilities. They had also the software applications for online learning. Students evaluated themselves as having satisfactory IT skills and knowledge. For example,

- Student E, "Yes, I have the audio and video equipment needed."

IT skills and knowledge

After several months of personal experience in attending online class, the majority preferred training on video shooting and editing. For example,

- Student D, "Therefore, the students would not join online learning tools, for example, MS Teams, Zoom, YouTube because there is a workshop, I do not think there is a great motivation for the students to join the workshop."
- Student A, "But I personally prefer it to be video editing," and "I think the film editing skills is comparatively in need, than other programmes such as Word."

For the lecturers, students evaluated them differently. For example,

- *Student B, "Because at the beginning, it may be Professors or the Institute, who may not be familiar with online lecture."*
- *Student F, "The lecturers have no problem to provide support for basic online learning."*

Technical support and skills

The availability of the equipment and the setting of these devices require additional time, skills, and readiness. Sometimes, these devices just did not work as expected.

- *Student G, "For instance, with group project, it takes the whole group to upload to Moodle, and then each member needs to click the submit button…only then was the assignment submitted."*
- *Student K, "Sometimes… there was a time that I needed to start all the online test over again from the beginning."*

To summarize, the results highlighted the challenges and types of support required for both teaching professionals conducting online teaching classes and students participating in online learning. It may be necessary for the Institute to collect these opinions early on and plan to provide various support services.

17.3.3 Students' Engagement

One of the important problems was heavily debated in the students' interaction. While many teaching professionals believing that online instruction was a waste of time because students did not respond at all; several teaching staff saw advantages to engaging students in an online context.

Staff's view on low engagement

Many teaching staff complained that students were not engaging.

- Teacher K, "*But for the MS Teams, this is quite a little bit difficult to ask them to answer my questions…*"
- Teacher J, "*Really no ideas about how to motivate them to improve our interaction during the online teaching session.*"

- Teacher Q, "*Students did not respond proactively. Even though I ask them and encourage them to answer*."

Teaching staff were aware that students have concerns in online learning. For example,

- Teacher A, "*So, there will also be emotional concern that will be related to missed assignments*," and "*Sometimes we may even need to call a student. But at the same time, I would be worried about how the student perceives a call from the teacher. The student may think, 'Am I really a problematic student and that is why the teacher would call me*?'"
- Teacher J, "*We can only focus our PowerPoint materials but sometimes may miss the message from the chat room.*"

On the contrary, it was not all the disadvantages. There were also cases reported that students engaged more in online teaching.

- Teacher N, "*But now with online teaching, actually I spend much more time to have consultation with students with their projects, etc.,*" and, "*Some of the students, they may be shy or not to speak during the class. They will be much more reluctant to ask questions. But with the online mode, they are still shy, and therefore they will not turn on the microphone… But they will type on the comment box. I think it helps with this type of students for them to express more.*"
- Teacher F, "*In fact, the attendance rate is relatively higher than the physical classes, maybe the students can just dial in and then listen.*"
- Teacher J, "*But other students will not be able to see how I guide a particular student to solve the problem, but when we do it online, the student has no choice. He has to share his screen.*"

Possibly, there were creative ways to improve engagement. For example,

- Teacher D, "*We actually not just use Skype, we will use WhatsApp, Facebook messenger. Whatever ways that we can contact our students to attend the classes so that are what we have done during that period of time.*"
- Teacher E, "*I can just say okay you guys, just go click here and click there. And, this is where you will find sample speeches because I have been speaking this is where you will find links to other resources. This is where you find what I called builders which is just basically a Google Form that helps them walk through the processes of doing their assignments, ask them questions and lead them to building their speeches. And, so they have a very focused process that they would go through and it was all online anyway.*"

Students on interaction

Moreover, students had different experience when online learning was designed by different means. Students expected some interactions with the lecturers, instead of just the lecturers reading the material.

- *Student C, "Online class is better because if I have questions, I can ask the teacher right away, there's interaction. If it is only the narrated PowerPoint, you may have a question and you need to send email to ask, or WhatsApp the lecturer to ask to get an answer. You have to do this for what you don't know."*
- *Student H, "As a student, I really do not want to look at PowerPoint. If you go to MS Teams, Everyone, if you have any questions, you can talk about it."*

Mostly commented that online learning could not provide the ***support*** as in face-to-face teaching. For example,

- *Student A, "It is because for the face-to-face class, it is really the lecturer talking in front of you."*
- *Student D, in the face-to-face classes, lecturers would answer questions for a specific student and, "Then, the lecturer will talk to the whole class and remind the class not to fall into the same problem."*

Learning atmosphere

On the other hand, students mentioned about their feelings and emotions while attending online class. There is just a lack of motivation to learn, or the lack of learning together atmosphere,

- *Student F, "You may not really need a book, but you need to have a class atmosphere".*

  A student expressed his concern in the undergraduate education that networking, and communication was equal important to book knowledge. In the online environment, this was in lack of. For example,
- *Student B, "the university is a place, that you will develop a network or relationship. At the same time, we need to have a lot of soft skills,"* and "*Well, in fact, I think it will be a big impact, because classmates, if you are really unfamiliar… In fact, you have fewer opportunities to get to know people. I think it is a pity that you have missed so many opportunities.*"

  While the majority students appreciated the fact that students could ask any questions at any time during the face-to-face class in the past, it did not mean that they participated actively in the online classes. When the students were asked at the online classes,
- *Student M, "But it will be embarrassed, as there are really a large group of people listening all together."*

  Most students did not turn on their webcam during the online class. However, a student blamed the lecturers not to create such an atmosphere at the beginning of the semester,
- *Student B, "If it is an online lecture from a foreign country, it seems that their lecturer would compulsorily ask the students to show their faces," and "Because if you are compulsory to talk at the beginning, you must show up, maybe Everyone is used to it, that is, it is a rule, and Everyone must follow it."*

To summarize, higher education establishments could only adjust to the limits of online teaching using the technologies available at the time. However, there were a plethora of technologies on the market that could help add interactivity and interest students. If certain technologies did not fit all, other technologies may be sourced as a supplement.

17.4 Time

Participants spent a significant amount of time discussing the question of time. Students loved that it saved them a lot of time because they didn't have to go from their homes to campus. Although staff welcomed the flexibility of online teaching, it may not be necessary to save them time because they would need to spend more time preparing online teaching material and/or communicating with students.

Staff on time issue

Less travel time for students

- Teacher P, "*So, I think it's in the long run… they really prefer online because they don't have travel here.*"
- Teacher D, "*Especially for the traveling time because most of our students are staying quite far away from Chai Wan (the campus) so that is why it is good for them to use the online teaching mode.*"

While students did not need to travel to the campus for classes, teaching staff argued that online teaching made them even busier. However, more time is needed to prepare the students. For example,

- Teacher A, "*So, the main thing was if I'm going to be doing something like that online teaching and distance teaching, it is really important to teach them how to use these (online) tools ahead of time.*"

More preparation time for instructors. For example,

- Teacher G, "*It is just sometimes in the preparation of the lecture material,*" and "*Because it is in a week, we need to attend the class for two times each and with the tutorial classes, and sometimes with the live class with the students. So, like this, it is very difficult for us to manage the online issues.*"
- Teacher B, "*I found it very time-consuming for me to prepare the illustrations in advance, because when we are face-to-face meetings, I can actually illustrate right away using the whiteboard.*"

More time was needed to conduct an online class. For example,

- Teacher D, "*We have to research a long time for them to do the preparation because we have to wait them to share the file. And then, some of the time because of the* *network disconnection, and maybe there's some kind of delay of presentation and it would be out of our schedule.*"

It was found difficulty in time scheduling of online teaching classes. For example,

- Teacher J, "*But I still find very difficult to make arrangements with our students to have our final year project through Microsoft Teams, and under this experience, I also find some students may miss the lecture session even though I have followed the original timetable to conduct the lecture session.*"
- Teacher D, "*It is a bit challenging for us because normally we have lots of tutorial sessions.*"

Students on time issue

Arrangement and structure of classes

Well, because of the transition to online learning, original timetable classes were cancelled, and lecturers re-scheduled with individual class at the beginning that caused confusion. One student blamed that the timetabling arrangement should be more systematic and structured,

- *Student J, "Sometimes we got the notice from lecturers about a MS Teams class just the night before."*

Flexibility

Mostly, students appreciated the flexibility of online learning as compared to traditional face-to-face class teaching. For example, face-to-face classes have a full schedule in the timetable,

- *Student A, "It was because if I went to the face-to-face class, it would be scheduled fully in the timetable."*

Just the opposite, online learning is flexible. Most importantly, as many of them mentioned, students can save a lot of travelling time,

- *Student G, "The good thing is more time. It saves time for a ride. Taking classes a bit more flexible."*
- *Student H, "If you talk about the benefits of online learning, you do not need to go out early and return to campus," and "If I use Teams, I get up in the house and go to the class."*

To summarize, online classes gave flexibility. It saved a lot of time on travelling. However, this did not imply that there was less work to be done. Due to technological issues, both staff and students may lose time during the session. Teaching staff may also need to follow-up with students and spend extra time communicating with them.

17.4.1 Collaborative Group Work

One of the main focuses was group work. They didn't get to interact with their classmates. They struggled to form friendships and teams. Almost all modules, on the other hand, required some type of group project work. The issue was brought to the attention of the teaching staff. However, software solutions may have limits in terms of giving opportunities for small group engagement.

Staff on collaborative group work

Online teaching promoted peer learning that students worked in groups and learnt from each other. This was possible through some conferencing applications, such as Zoom. However, the Institute provided MS Teams which did provide such small group function at that time. Only those teaching staff who chose to use Zoom commented. For example,

- Teacher P familiarized students with the "*breakout rooms*" in online teaching class and "*I took a few weeks of pilot for them to try first before we actually used it, so at the end of it, they really enjoy(ed) it.*"
- Teacher E echoed that "*we did things like breakout rooms with Zoom, and that worked with pretty well, too. They (Students) pretty much know how to get around being on the zoom thing.*"

Although participants liked the idea, not every one of the them had this experience. For example,

- Teacher F reflected that "*I did not try out … to have some breakout sessions, or some kind of group discussions. I did not invest some time to explore how to make it.*"

In online teaching, promoting group work or collaboration would be a way to better engage students.

- Teacher C, "*I used to ask the students to use Google Doc for writing their group report. I also asked the students to include me into their group. So, if I was in their group, I would be able to notice who have written which parts. So, this is perhaps a way to make sure that there is no free rider.*"
- Teacher M, "*And I also think the group discussion is not that easy to facilitate. Sometime in classroom setting, I can just observe what they have discussed.*"

Students on team communication

A form of assessment is through group work. A student described how they did during the online learning period. This was not a cooperation, but a collaboration of teamwork,

- *Student C, "That is, for example, it is because we have a group project, if we do not have a face-to-face, I will share a Microsoft document and then work on it together."*

- *Student B, "For example, we need communication, and everyone at home is off camera, we listen to the sound, that is, when we do group assignment, it is really a division of labor, you are responsible for your part, I am responsible for my part, and finally everyone will do an integration. After that, you will hand in your homework."*

Under the online learning environment, students might not have much chance for communication.

- *Student J, "Yes, this classmate would attend face-to-face classes but disappear after changing to online learning."*

During the pandemic, there was the gathering restriction order. There was also the problem of coming out to meet,

- *Student A, "The result is that a group project requires everyone to come out to shoot together."*

Some tried their best to meet and to work together,

- *Student M, "All the group project members stay together. All stay together."*

On the contrary, if it was in the past, students might easily stay after face-to-face class to learn each other and to have group discussion,

- *Student G, "also, during face-to-face, if we have to do a group project, we can discuss a bit right away." and "But during online learning, we have to wait until after the class has finished, then we will need to form our own group to discuss."*
- *Student K, "If it is a group project, we can work on it together right after the face-to-face class."*

Online learning did not preclude students from communicating with one another after class through various means. As an example,

- *Student D, "We will discuss how to do the project. We will also use WhatsApp. WhatsApp itself has a group function."*
- *Student G, "In fact, it is the same during face-to-face classes because I usually return to home, then everyone turns on the Skype to do it together."*

To summarize, group work necessitated a bond between the members of the group as well as a level of trust. Students missed out on the opportunity to create such a bond and trust because the campus was physically closed for the whole semester. They found it challenging to work on. However, some students did use a variety of technologies and social media to engage with one another.

17.4.2 Assessment

Assessment was less discussed, despite the fact that there were still some concerns with assessment. Teaching staff were concerned about the format of a successful online assessment as well as issues of honesty. Students were aware of changes in evaluation standards, and they were concerned about the ambiguity.

Staff on assessment

Teaching staff had some different views on assessment. For example, to improve student engagement, the weight and format had been adjusted.

- Teacher A, "*As we cannot assess that in the classroom, we use a very traditional method. We gave students a weekly worksheet, not graded, we only use the performance of students on that worksheet to assess the students' class participation.*"

There were other concerns about assessment, such as integrity, cheating and plagiarism. For example,

- Teacher G, "*The other thing in the future, if we still use the online assessment, I prefer to have some sort of the face, to confirm the guy, to monitor the students to conduct the assessment, together with other things to check the cheating.*"

Students on Form of assessment and workload

Transitioned to online learning, there might be changes and adjustment to the form of assessments, the skills required and the workload. For example, a student described the changes,

- *Student E, "So, it is supposed to have only two individual assignments in this Module, and it may change to 3 or 4, because it will be added some more assignments which are originally a class assessment in face-to-face.*"

On the other hand, students seemed to welcome more of the online learning and the corresponding online assessment because of the open book examination setting,

- *Student K, "I am a bit concerned. For online learning, it will be an open book examination," but if it is face-to-face learning, "it will be closed book examination."*

Adjustment of rubric

There were also adjustments to the format and scoring criteria. For example,

- *Student E, "The assessment has become more important in terms of the video editing skill," but "There is no such video editing training in the Module." Student E, "It will add points if we have more skills in the video editing."*

Most students learned video shooting and editing skills by themselves at home. Some programmes had competitive advantage. For example,

- *Student D, "I have learned a lot of skills, editing films, shooting, and photography. Basically, I know everything," and "Will encounter different problems, especially the problems in film editing."*

To summarize, the Institute had no choice but to conduct online assessments. The students should be kept up to date on the changes, and the criteria should be made explicit. For example, continuous evaluation on project-based learning would be more appropriate for applied degree education while avoiding issues of integrity.

17.5 Discussion

The conversation that follows is based on the findings of the focus group interview with students and teaching staff. These contain learning and teaching experiences, opportunities and challenges, and future recommendations.

17.5.1 Key Findings

Online Teaching and Learning Experience

In general, students are positive about the delivery of online courses. They particularly value the online lecturers and the flexibility of online classes.

Interestingly, while students expected more interactions, a staff focus group discussion revealed that teaching staff were a little disappointed because students did not react much throughout the online lectures. Furthermore, the student focus group interview revealed several students' self-reflection that they lacked discipline and were easily side-tracked when taking online classes. Teaching staff can spend some time after class interacting with students to identify solutions that work best for everyone.

Lecture recording was discussed a lot in the student focus group interview. Many of the students loved having their online classes filmed and uploaded to Moodle for self-revision. This allows students to learn at their own speed. In some ways, this is preferable to a face-to-face class where specific parts of the lectures may be omitted. Some students also feel that video recordings of practical work demonstrations are equally beneficial to their learning.

It is proposed that, in the future, real-time broadcasts of online lectures, rather than merely self-learning materials uploaded to Moodle, be undertaken in order to attain a comparable efficiency of face-to-face teaching. It is also recommended that lecture recordings be provided whenever possible so that students can learn at their own pace or revisit anything they forget or don't understand. To avoid confusion, it is best to stick to the original timetable for real-time online lecture broadcasting. As a result, there is no requirement for faculty to schedule online classes with individual students.

Students, on the other hand, are more focused on practical, laboratory, and project work. According to the teaching staff focus group interview, some of the laboratory work could not be replaced by online classes, or that online classes could not be used to replace face-to-face because of professional body requirements, which necessitates better or contingency planning on how to deal with it. Possible alternatives include extending the semester with make-up practical classes, deferring the practical until the next semester, and so on. Both of these necessitate additional planning and scheduling. Video clips of practical demonstrations will help provide students with some prior experience before the practical class takes place as an immediate complement, but not as a replacement for practical lessons. Students perceive this as an effective addition.

Support

According to the various results, the bulk of users have online learning equipment and IT expertise. According to the student focus group interview, students rate their own and the teaching staff's IT abilities and knowledge as good to adequate.

It should be noted that only a small fraction of students require assistance. They have difficulty accessing online courses since they do not have safe Wi-Fi at home, nor do they have a desktop or laptop, and some must share their desktop or laptop with other family members. It is difficult for students to attend three hours of online lectures using their cell phones. It's also difficult for students to communicate with their online class classmates. This must be addressed in the future so that all students have access to online learning.

Engagement

According to the data, teaching staff were particularly concerned about students' involvement in online classes. They either do not show up or log in to the conferencing program and leave the room alone. There were no responses to the questions posed by the teaching staff. Students also believed that they lose some form of discipline. However, it was heartening to hear of accounts of increased engagement. Using interactive technologies, instructional professionals might collect student opinions and feedback more easily. Using collaborative writing tools, students can collaborate on writing tasks or projects over the same documents at the same time. As a result, it was suggested that training be provided to introduce teaching staff to a variety of interactive technology and collaborative writing tools. In addition to real-time broadcasting, communication between teaching staff and students, as well as engagement among students, should be encouraged.

Collaborative group work

Due to the nature of online courses, students have trouble learning from one another. They are having difficulty interacting with their groupmates. the move to online learning must be inconvenient in some way. However, there are various free programs accessible for students to interact with one another if they so desire. For example, some students were unaffected because they would communicate with their peers using technology means such as Skype or WhatsApp.

During online classes, it is encouraged that students communicate with one another at a variety of timestamps, such as small group talk, presentation, and/or group project time. It is much easier for students to work together in groups if they are familiar and comfortable with one another. It is also suggested that students use various forms of electronic communication to meet and discuss after class.

Time

The majority of students, according to student focus group interviews, believe that the benefits of online learning are related to time and convenience of use. They saved a lot of time traveling. However, it is unclear whether the students will work harder on their studies as a result of the time savings. The flexibility and time savings afforded by online classes are also appreciated by teaching staff. On the other hand, they reflected that they spent more time developing online teaching materials, communicating with students, and scheduling.

Assessment

The students' focus group interviews suggested that they were unsure about the assessment's requirements and rubrics. The switch to online assessment has also resulted in changes to the evaluation standards. For example, the majority of student participants listed IT abilities and video editing knowledge. Students lacked this skill, yet due to the change, they were required to shoot and edit their video project. More training or workshop planning has been required in the future to provide students with the necessary skills and knowledge.

It is important that the assessment criteria be clearly laid out. It is also important to ensure that learning outcomes are adequately measured. For example, if the assignment shifts from written to video, video filming and editing abilities will not be scored if they are not taught. Furthermore, regardless of whether or not students use alternative tools/machines/software programs, the assessment of learning outcomes should adhere to the original curriculum and content. For example, some students were able to access to 3-D printers for their design projects while others were not.

Empathy

It is proposed that teaching staff develop an online peer group community to provide emotional, instrumental, and social support as needed. In addition to digital gear and software and formal training courses, we can provide both students and teaching staff empathy.

17.5.2 Implications

This study contributes both theoretically and practically. This study's findings identified the main themes and discussion on the learning and teaching experience, which were supported by prior studies such as institutional adoption (e.g., Sharpe, Benfield, Roberts, & Francis, 2006), instructor's role (e.g., Zhao et al., 2015), technology use (e.g., Schmid et al., 2014), pedagogical considerations (e.g., Means et al., 2013), design (e.g., McGee & Reis, 2012). More importantly, this study supplied all of the rich knowledge regarding the method, the teaching staff's way of thinking, and the opposing opinions of students who got online learning. Previously, technology adoption theories and studies concentrated on individual, social, and technological variables (e.g., Ajzen, 1991; Ma et al., 2005; Venkatesh & Davis, 2000). Due to the covid-19 epidemic, technology did not appear to be a major worry in this study, as the technology offered by the institution for conducting online instruction was the same. It does offer us with a deeper grasp of the process of online teaching and learning through the human and social components of the teaching staff. Adoption of online learning was not an issue for the students.

This study, on the other hand, generated a lot of perspectives and opinions from both the teaching staff and the students. It meant that the earlier both parties supplied feedback to each other, the more effective the teaching and learning process. It was unfortunate that these viewpoints were only revealed at the end of the courses. Alternatively, in some courses, there was no mechanism in place to collect these thoughts at any time. The institute may also prepare better to supply the necessary equipment and facilities, application licenses, training, and to establish a supportive community. It was also debatable if more structured or unstructured learning activities, centralized or decentralized teaching and learning methodologies, and so on would be beneficial for the institution as a whole (Siemens et al., 2015). Higher education used to take a more loosely structured approach to its learning activities and teaching methodologies, delegating decisions to professors, departments, and programs. However, would the institute explore a more standardized and efficient method that would assist the students more during this unusual global pandemic situation?

17.5.3 Limitations and Further Studies

There are several limitations to this study. The sample size is small. The study did not include all of the programs. Varied disciplines may have different requirements and expectations, and the industry/professional organizations' contextual variables influenced the delivery of online classes. Furthermore, because the goal of this study was to compare and contrast the perspectives of the teaching staff and the students, similar themes were identified and studied. However, there could be other circumstances that just affected the teaching staff or the students. These aspects received less attention. Following up on the discussed themes, quantitative data analysis may be undertaken in the future to yield statistically significant findings (e.g., Ho, Cheong, & Weldon, 2021; Weldon et al., 2021). Furthermore, this study found several student concerns about online learning. More research should be done on the impact of motivation and emotion on students.

17.6 Conclusion

This online learning experience study was a part of the larger project completed during Semester 2 of the academic year 2019/2020. Rich quantitative and qualitative data were gathered to better understand both teaching staff and students' online learning experiences of the whole project. It serves as a reference point for the Institute and teaching staff in order to continuously improve students' learning experiences. Even if COVID-19 fades away in the near future, hybrid face-to-face and online learning will be a very viable and vital option for the future of learning.

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Chapter 18
Product Design Education in the Wake of COVID-19: New Technologies Enabling Experiential Learning Relevant to Future Practices

Anton Nemme, Berto Pandolfo, Roderick Walden, and Stefan Lie

Abstract World events in 2020 conspired to derail on-campus teaching and threaten how educators and students engage with each other. Particular to the field of Product Design, an online situation compromises learning as students cannot access fabrication workshops and develop crucial three-dimensional making skills. Educators and students alike now understand the deficiencies of teaching and learning exclusively online, however, success was observed in subjects that employed new digital processes. A future scenario in which Product Design practitioners will use software to algorithmically generate and optimise forms for advanced manufacturing is a proposition that has recently been tested. This chapter expands on the outcome of a university-industry collaboration (UIC) research project that led to the incorporation of computational generative design and topology optimisation processes in Product Design subjects. The case analysis identifies a convergence of innovative technologies; new ways to optimise student engagement and the development of future-ready skills.

Keywords Online learning · Generative design · Additive manufacturing · Product design · Action research

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18.1 Background

In 2017, the academic design practitioners from UTS's (University of Technology Sydney) Integrated Product Design Research (IPDR) conducted a direct funded university-industry collaboration (UIC) project with Street Furniture Australia (SFA) to explore the potential of 3D printing to replace current furniture manufacturing processes. The SFA project examined the potential for Additive Manufacturing (AM), see Sect. 18.2.3, to replace metal casting of structural components in outdoor furniture products such as benches and tables. It was found that certain types of AM technology may become viable for the production of specific parts designed to function within particular durability limits.

The project also found that the strategic adoption of generative design and topology optimisation software (discussed in Sect. 18.2.3), paired with the appropriate AM technology, can greatly support the organisation gradually transition to AM and a superior and more efficient production system.

The SFA UIC research project represents a form of action research that verified and articulated the current and emerging function of specific tools, technology, and techniques as it applies to industrial design practice. The knowledge gained through the SFA project led to a newly developed Generative Design elective subject to be part of the product design undergraduate course curriculum and an extension of research inspired teaching protocol. Generative Design will be discussed in detail in Sect. 18.2.3.

The SFA UIC project provided the genesis for the new subject development. The creation of teaching materials including lectures and studio exercises was informed by additional follow up action research conducted in the specific areas of topology optimisation and generative design. The follow-up research is focused on the development of a new product design, representative of a type of product that must balance engineering performance, design functionality and aesthetic styling in equal measure. This follow-up project—the design of a mountain bike (MTB) bicycle crank arm—further identified ways of integrating these new engineering-based tools with the values and practice of professional industrial design (Nemme & Walden, 2019).

After a period of development, the Generative Design Principles (GDP) subject launched in spring of 2019 implemented in the style of typical studio-based industrial design subjects. That situation involved face-to-face teaching delivery with both lecture and studio components. In minor contrast to the typical scenario was the design studio taking place on-campus within a computer lab; where the studio leader could both deliver software training and provide counsel on the progress of students' projects. And this arrangement enabled 2nd and 3rd year product design students to produce some novel and inspiring work.

In 2020, Covid-19 struck (see Fig. 18.1), which required all academic staff to pivot from an on-campus teaching mode in week 2 of the semester to an online mode (see Sect. 18.2.1) with the only preparation time being a university imposed non-teaching week. The shockwave of the Australia-wide lockdown was vast within tertiary education sector with the cancellation of all studio and workshop-based

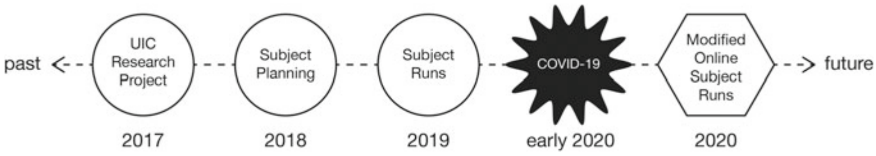

Fig. 18.1 A timeline to situate the impact of Covid-19

subjects (discussed in Sect. 18.2.1) and the preference given to subjects able to be converted to online delivery. Academic, technical and support staff were placed under intense pressure because of the necessity to immediately find ad-hoc solutions to the typical ways of teaching and working.

For the Generative Design Principles subject, the effect was resituating the typical 'live' lecture into a video conferencing situation paired with an online version of the computer lab class. Students were then faced with the necessity to manage their own unique software and hardware situations in addition to being part of a socially restricted learning environment. With expectations for learning in this period of lockdown being low, students were still able to engage and meet most of the learning objectives. In this paper we will argue that although studio-based face-to-face teaching is a superior environment for students to engage in learning the field of product design, that specific subjects can be taught successfully to 2nd and 3rd year students exclusively online supported by matched software tools and accessible Additive Manufacturing (AM) or 3D printing technology.

18.2 Literature Review

The reviewed literature is presented in three subsections, each addressing the pertinent aspects of this research. In Sect. 18.2.1 Learning Modes, both online and studio-based learning are defined, and their advantages and challenges discussed. Section 18.2.2 explains why *Research Inspired Teaching* is deemed important for undergraduate teaching in the Product Design Program at UTS and how research generated by Product Design academics through UIC projects is applied to teaching. Section 18.2.3 *Computational Design in Product Design,* covers the role computers play in the product design process and discusses the range of digital tools, both hardware and software, used for teaching product design at UTS. Hardware are tools, such as the computers used to create the digital artefacts of products, as well as Additive Manufacturing or 3D printing, the technology used to manufacture physical versions of the digital products. The software tools are discussed with the aim to provide clarity around the complexities of computational design by explaining what generative design is, how it can be used as a product design tool and the role that algorithms play in generative design.

18.2.1 Learning Modes

What is online learning?

Online learning is a term that was first used in 1995 when WebCT was developed as the first web-based Learning Management System (LMS) (Singh & Thurman, 2019, p. 289). Since then, teaching and learning institutions like universities from around the world have adopted the concept of online teaching and learning in various higher degree courses. Some are pursuing a partial or blended approach that includes traditional or face-to-face learning with some components of a course delivered online and others are delivering entire courses online. In the years since, online learning has adopted many different yet overlapping terms such as e-learning, blended learning, online education, web-based learning and computer-mediated learning. This chapter will use the term online learning.

Online learning is defined as education that is delivered in an online environment using the internet. Teaching material is delivered online and the teaching approach is suitable to both synchronous[1] and asynchronous[2] environments. Students can engage with online learning that is not dependent on where they are located (Singh & Thurman, 2019, p. 302).

18.2.1.1 What Are the Advantages of Online Learning?

Other terms to describe teaching and learning that does not take place in a traditional classroom include distance learning and distance education (Singh & Thurman, 2019, p. 295). During COVID-19 enforced lockdowns physical distancing demanded that teaching and learning make the change to an approach that was not reliant on where a student is physically located. Online learning enabled local and distantly located students the opportunity to continue their studies. Furthermore, extra flexibility is possible when the online learning systems are designed to allow students to access their learning material 'anywhere, anytime, in any rhythm, with any means' (Cojocariu et al., 2014, p. 1999). In pedagogical terms, a balanced online learning system using both synchronous and asynchronous approaches helps students establish active learning habits and increases the student's responsibility for learning (Lapitan et al., 2021, p. 126).

18.2.1.2 What Are the Problems Associated with Online Learning?

Students may have personal situations that can impact the ability to access technology, suitable internet connection or a quiet workspace (Lapitan et al., 2021, p. 119). Other

[1] A synchronous learning situation means students study together online at the same time.

[2] An asynchronous learning situation means students are free to log on and off a learning system to access learning material and the time of engagement is irrelevant to their learning process.

challenges include the perception that online learning was boring and unengaging and that the online content was theoretical, which does not allow students to practice and learn effectively (Dhawan, 2020, p. 8). Unique problems in online learning experienced during COVID-19 period in 2020 relate to the speed with which lockdown was enforced. The sudden implementation of stay-at-home-orders resulted in students leaving teaching related materials at university and teaching staff having to rapidly deliver classes from their homes (Lapitan et al., 2021, p. 119).

18.2.1.3 What is Studio-Based Learning?

The studio-based learning model of education involves active learning, project-based learning, and self-directed learning in an iterative process. It involves critical thinking and critical feedback sessions (Kari-Pekka et al., 2016) and are often designed to reflect activities experienced in professional practice (Brandt et al., 2013, p. 331). The studio has unique characteristics that are distinct from the traditional lecture and tutorial format of many academic courses. Product design education uses studio-based teaching and learning as a central part of its pedagogical practice (Shreeve, 2011). Design knowledge is difficult to understand or describe, it is also difficult to teach design using the traditional lecture pedagogy, however, design can be learned and understood through active engagement, 'learn by doing' (Chen & You, 2010, p. 153). The term 'studio' is understood as both a physical space where teaching activities are conducted (Crowther, 2013, p. 18) and, as a particular method of engaging in thinking (Maitland, 1991, as cited by Green & Bonollo, 2003, p. 269). Typically, a studio is a large informal space, furniture can be moved and there is sufficient space for students to work, often in groups. In product design where the subject matter often involves an object, studios are also conducted inside workshops. Product design students making mock-ups, models or prototypes in close proximity to materials, tools, machinery and workbenches allows students and staff to interact which supports the iterative aspect of design development in real-time.

18.2.1.4 What is Unique About a Studio-Based Learning in Product Design?

The type of work commonly conducted in studios are a distinguishing feature as they involve activities such as drawing, sketching and model making (McCarthy & Almeida, 2002). Students learn about design through applying design methods to address actual design problems. This way they accumulate experience and understanding of the design process in a context that is similar to professional practice. Another feature of the studio-based learning model is students are exposed to learning not only from the teaching staff but also from practicing professionals who are often invited to participate in studio projects (Brandt et al., 2013, p. 331) and workshop technicians when studios are conducted inside workshops (Zehner et al., 2009).

Apart from the similarities to professional practice, the studio-based model of learning provides significant social benefits to students. The community and social aspect of product design students working in close proximity to each other facilitates a sense of belonging (Gee , 2006, p. 10.7), it encourages students to develop peer to peer learning (Shreeve, 2011, p. 117) and is fundamental to the development of a community of practice (Wenger, 1998). Over the period of a project delivered in a studio-based environment students learn that their fellow students are a valuable resource to seek advice regarding their designs, they identify and use methods and vocabulary common to the field of product design and they begin to associate with members of the product design community (Brandt et al., 2013, p. 336).

18.2.1.5 What Are the Challenges of Studio-Based Learning?

Online learning is not able to 'provide a reliable tactile learning experience which is a form of intrinsic feedback' (Laurillard 2002, as cited in Crowther 2013, p. 23), where studio-based learning does. An advantage to online learning and a challenge to studio-based learning is the accommodation of technologies into studio activities that encourage a broader exposure to digital technologies (Crowther, 2013, p. 23). Design students acknowledge the importance of face-to-face interaction to support learning, a study showed that design students preferred face-to-face teaching rather than courses delivered online (Fleischmann, 2018, p. 49). However, the studio environment does challenge the inclusion of distantly located students, particularly in large expansive countries such as Australia.

18.2.2 Research Inspired Teaching

One of the strategic objectives at UTS is the concept of 'research inspired teaching' and there are clear benefits of research inspiring the teaching process and subsequently re-informing practice via graduates entering the field. Buchanan draws attention to the importance of being "alert to new developments and (to) prepare our students for a changing world-not only in technology but in the needs and expectations of the human beings whom we ultimately must serve" (1998, p. 64). In product design UIC projects, design-led research can be the central methodology. Design-led research actively incorporates and relies upon direct (design) intervention by the researcher and develops knowledge on the basis of what is learnt through that intervention (see Coyne, 2006). This approach can help ensure that design educators develop a combination of knowledge and technique in emerging fields of practice that can be incorporated into the teaching program. Buchanan provides the rationale for the partnership between education and practice in recognizing the "proper role of education in both discovering and disseminating new knowledge as part of the field of design" (1998, p. 65).

The subject matter in product design is delivered via project-based learning methods and the integration of theory and practice is a key aspect of the enquiry-based learning process. Stenhouse describes a situation where educators should share the learning experience with their students, "(us) learning the wisdom which we do not possess so that they can get into critical perspective the learning which we trust is ours" (2011, p. 122). The reason for this is that teaching cannot be regarded as a "static accomplishment like riding a bicycle" (Stenhouse, 2011, p. 131) and that the "nature of professional knowledge" is "provisional" and "created by research" (Stenhouse, 1983, p. 212). If the teacher is not "part of the research community…then research will not apply…" (Stenhouse, 1983, p. 212). Buchanan goes further "in the very process of teaching students how to design, the design educator is also investigating the nature of design, seeking to better understand its methods and principles" (1998, p. 65). In the process of undertaking academic research with industry partners (UIC projects) academics have the chance and opportunity to speculate, what "will (design) be in five years or in ten years" (Buchanan, 1998, p. 65).

18.2.3 Computational Design in Product Design

Computers as tools in the design process.

The use of computers as tools in the design process is not a new phenomenon. Digitalisation provided the opportunity to move from working at a drawing board to working inside a virtual drawing space on a computer screen via two-dimensional drawing software. The shift from the two-dimensional realm to three-dimensional computer-aided design systems (CAD) was a substantial leap forward for product design as a profession; as well as for the manufacturers involved with production of products that were the subjects of that design process. Three-dimensional CAD systems rapidly increased the accuracy and speed of product development providing a way for designers to build a pipeline of digital data which began with concept development and ended with production of a product in offshore destinations. In addition, software products that incorporated a 'feature tree' or parametric history of tool operations, provided the ability to iterate and document an evolving design representation with flexibility. This digital pipeline has been further enhanced by digital production opportunities, which provides designers the opportunity to manufacture their own products (be it for reasons of making a prototype or even a saleable consumer product) though fast and efficient access to a multitude of 3D printing services.

18.2.3.1 The Impact of Additive Manufacturing

Although additive manufacturing is said to comprise of only 0.1% of total manufacturing output (Wohlers et al., 2017) it is expected to grow by 24% annually (Hubs,

2021) which means that it “is forecasted to more than double in size over the next 5 years, reaching a value of $37.2bn in 2026” (Hubs, 2021). It can be said that with regards to the hype surrounding this technology we have passed the “slope of enlightenment” and are in the “plateau of productivity” (Hubs, 2021). Universities around the world are investing in additive manufacturing facilities and UTS has done so in their facility called Protospace which provides access to industrial 3D printing machinery for staff, students, and local industry alike.

As society is being faced with new and wicked environmental problems, additive manufacturing has potential to provide products in an on-demand situation (specialised products) from digital inventories (localising production reducing transport costs) and using only the amount of material required (minimising waste streams). The potential for materials to be varied and replaced at will, which is an affordance of extrusion-based FFF 3D printing processes, could herald a new age of environmental sensibility from the reprocessing of plastic waste through to introducing 3D printable bio-polymers generated from biological rather than petrochemical sources.

18.2.3.2 Computer as an Active Partner in Design Process

For the most part, in this typical design process a computer has operated as a passive partner and documentation tool of the designer, but we are now on the cusp of a shift in that normal relationship. The question that must be asked is, how can a designer’s current capability be extended? An answer to that question could be provided by new technology; being design-specific tools and processes. Archer defines technology as “humankind’s collected knowledge about tools of every sort; about the way they work; and about where and how to use them” (1992, p. 7). Archer’s concise definition of design being to “envision-what” (1992, p. 8) is greatly enhanced by the use of technology which provides the “knowing-how” (1992, p. 7) and in this coupling more sophisticated tools are the key to progress.

18.2.3.3 Computational Processes to Extend Designers’ Capabilities

Methods to expand design capability though computational processes have been discussed in literature published more than a decade ago, but the promise of these new techniques has taken considerable time to be implemented in slowly maturing commercial software products. As Norman and Verganti (2014, p. 94) stated “a technology is not enabling until it has reached the point at which it is available in a reliable, economical form”. These products need to be proven efficient and practical for designers prior to entering widespread usage and you can argue that until now these tools have not been enabling. The new techniques in question can be described as computational and to be more specific generative. In 2005, Shea, Aish & Gourtovaia explained that in the near future the design approach will evolve, “the next phase in digital design” will be when we embrace computers as “collaborative partners" that can "generate ideas and stimulate solutions" in response to a set of "conditions" (p. 253).

18.2.3.4 Defining Generative Design

The definition of what constitutes a 'Generative Design' process is not clear cut for readers of academic literature and in order to avoid a discussion of these nuances the authors will provide several descriptions which are not exclusive of other perspectives of Generative Design. Altair Engineering Inc. (2021) describes Generative Design as a "generic term for using computation in the design process"(p. 4) whereby something gets generated, but there is more to providing a wholistic definition. Soddu (2002) explains that Generative Design can produce events that are "unique and complex" (p. 294) and that those two concepts are strongly related. Janssen, Frazer and Ming-Xi state Generative Design provides the opportunity to "generate and explore (a multitude of) alternative design proposals" and also to "analyse and evaluate them" (2002, p. 119). Perhaps we can say that Generative Design "uses computation to actively assist in the design process in a way that would be difficult, if not impossible, for a human designer" (Altair Engineering Inc., 2021, p. 4).

18.2.3.5 Algorithms

Generative processes typically involve the use of algorithms some in common usage are "'L-systems', 'shape grammars', 'cellular automata', 'genetic algorithms' and 'swarm intelligence'" (Singh & Gu, 2012, p 185). The investigation and definition of these specific algorithms is beyond the scope of this paper, but an algorithm can be simply defined as a non-ambiguous set of instructions and an analogy can be drawn to a recipe or a set of street directions. If followed correctly, a set of directions only provides a single solution being the required destination but a recipe for a cake is more flexible. By modifying the ingredients and quantities (which we might view as conditions of that process) different results might be produced. If the expectation is a cake, a successful synthesis requires entering variables within a prescribed range; beyond that valid range may produce something other than a cake. However, for more ambitious bakers, the new foodstuff might be seen as a potential innovation. The creation of an algorithm gives a designer an opportunity to design the rules of the design process rather than the object by direct manipulation and blurs the lines between design intent and design by an autonomous software process.

18.2.3.6 Generative Design and Form Development

Darcy Thompson (2017/1917) stated, "the form of an object is a 'diagram of forces'" (p. 11) which is a wonderful recognition of the success and diversity found in natural structures. For designers, inspiration to produce form and structure has been assisted by some understanding of how nature solves problems (bio-mimetics, biomimicry). Sometimes this occurs purely from an aesthetic or structural standpoint (see Airbus Bionic Partition inspired by mammal bones and slime mould) and at other times in the concept of how a system might function (passively cooled buildings inspired by termite mounds). These design elements together with engineering principles and understanding of material performance has translated into all kinds of successful product and architectural designs.

Designing this way can be successful but it is defined by the limits of a human's skill and perception to envision what might be possible. McCormack and Dorin explain how the potential of Generative design exceeds this:

> *In traditional design...(there) is a direct relationship between the designer's intentions and that of the designed artefact. In contrast, design using generative methods involves the creation and modification of rules or systems that interact to generate the finished design autonomously. (2004)*

So, it is imaginable that in the future we might design by adjusting the rules and conditions of a process (or creating the underlying code) rather than by direct manipulation of objects in physical or virtual environments.

Product designers are concerned with the development of form and generative processes provide an opportunity to create "forms of exuberance" (Schumacher & Krish, 2010, p. 1). However, design solutions are not limited to this realm because "generative code can function as DNA does in nature" leading to a "multiplicity of possible artworks, artificial events, architectures and virtual environments" (Soddu, 2002, p. 291). Shea, Aish and Gourtovaia (2005) go on to state generative systems can be useful in "sparking new design ideas … solving difficult tasks …(which) extend designers' current capabilities" (p. 254). A key element in many definitions is the ability to produce a multiplicity of solutions. Figure 18.2 defines the range of approaches, styles, solution types and applications when using a computer as an assistive tool in the design process. Moving down the page marks a movement from a 'passive approach where the computer is used as a documentation tool to a

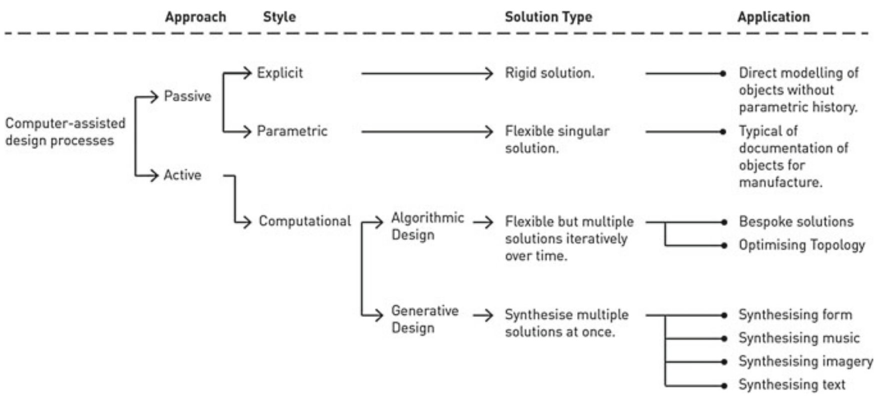

Fig. 18.2 A flowchart of computer-assisted design processes

more ‘active approach’ which includes extending designers’ capabilities providing increasingly flexible and multiple solution outputs. Furthermore, the solutions move from singular (top right of the diagram) to multiple (bottom right of the diagram).

18.2.3.7 Spectrum of Generative Strategies

Autodesk (2021) defines a range of strategies associated with the term Generative Design and they are: form-synthesis, lattice and surface optimisation, topology optimisation and trabecular structures. Here it is useful to draw attention to the processes enabling form development, form-synthesis and topology optimization; these are the processes that dominate the Generative Design Principles subject in the Product Design program at UTS. The authors offer brief explanations of those strategies later in the paper (See appendix).

Generative design processes based around form development are enabled by 3D printing and provide new opportunities for even more efficient, lighter (lowering material use) and better performing structures. Performance based industries were early adopters of additive manufacturing technologies and have become early adopters of generative design processes. In industries such as motorsport and aerospace the necessity to produce lighter and more efficient parts is never ending and a key driver of success. In this age of focus on environmental concerns, generative strategies can play a part in achieving better health outcomes, higher performing parts, material and energy efficiencies and coupled with newer more sustainable materials will provide substantial environmental benefits.

18.3 Research Question

Research indicates that there are parallel experiential learning pathways for understanding three-dimensional form and structure via physical model-making, and via generative design processes when coupled with 3D printing capabilities. Software tools have now matured and can enable designers to effectively utilise generative design processes, which are set to become key technologies for product design into the future. With those conditions explained, the authors pose the question:

> *To what extent can a project-based tertiary level product design subject that teaches generative design be delivered exclusively online satisfy the same learning objectives conventionally met through face-to-face teaching?*

18.4 Methodology

18.4.1 Description of Authors Perspective

The authors operate as academic design practitioners in the field of industrial design within a university environment. Within that context, the specific concern is advancing the professional practice of industrial design through three modes of practice. These modes have differing emphases but are strategically formulated so that knowledge can transfer between them. The three modes of practice are (design-led / practice-based) research, teaching, and industry engagement (UIC). To improve our capacity as academic design practitioners to advance the industrial design profession it is necessary to improve our capabilities across all three types of engagements. In each situation our purpose and our involvement are the common factor. As academic design practitioners (Walden et al., 2015) a key aspect is to develop a curriculum that is informed by both ratified and emerging practices. In this way new skills and perspectives are encountered which feed into the curriculum of theory and skills which recent graduates take into practice.

18.4.2 Description of Action Research

A typical design process is described by Milton and Rodgers (2013) in this way: opportunity identification, brief and specification, concept design, design development detail design and production. The staged nature of this process can involve multiple iterative cycles. Iterative processes enable designers to constantly learn from direct feedback by reflecting on their implemented design methods, but for product designers the knowledge gained provides a means to produce an artefact and is not explicitly communicable. This could be viewed as a situation which has several elements of an action research methodology. Swann argues that action research "bears a strong resemblance to the design process (of) problem/research–analysis–synthesis–evaluation" (2002, p. 53) (in action research it is plan, act, observe and reflect, see Fig. 18.4). Swann goes further explaining that design can be seen as an action process centred around synthesis, but the output is not recognised as research quality because it is invisible (2002, p. 55) whereas action research can provide validity to that research process. Swann suggests that action research and design are "so close that it would require only a few words to be substituted for the theoretical frameworks of action research to make it applicable to design (2002, p. 56). To better understand this close alignment of action research and design, it is necessary to highlight some key concepts from action research literature.

Heigham and Croker explain that the goal of action research is to find out "what is going on in your own local context in order to change or improve current practice in that situation (2009, p. 115). Robson makes the claim that in the process of finding out there is "a process of learning from experience, a dialectical interplay between practice, reflection and learning" (2016, p. 13) and Kemmis and McTaggart (1988) produced a diagram which explains this 'interplay' of stages (see Fig. 18.3).

Action research can be said to offer an alternative to traditional social science research in that it is "practical" and "participative and collaborative" (Zuber-Skerritt, 1992). It is a strategy in which "research may inform practice and lead to action" with "a spiral of cycles consisting of four major moments: plan, act observe and reflect" (Zuber-Skerritt, 1992). Here there is an echo of Kolb's learning cycle (1984) of experience, reflection, abstraction, and experimentation.

Robson makes several claims which help define action research more accurately being that it is "a kind of self-reflective practice" which can be undertaken by "people in any context, regardless of their status or position" and it is a way of "researching your own learning" in effect, "an enquiry by the self into the self, undertaken in company with others acting as research participants and critical learning partners" (2016, p. 15).

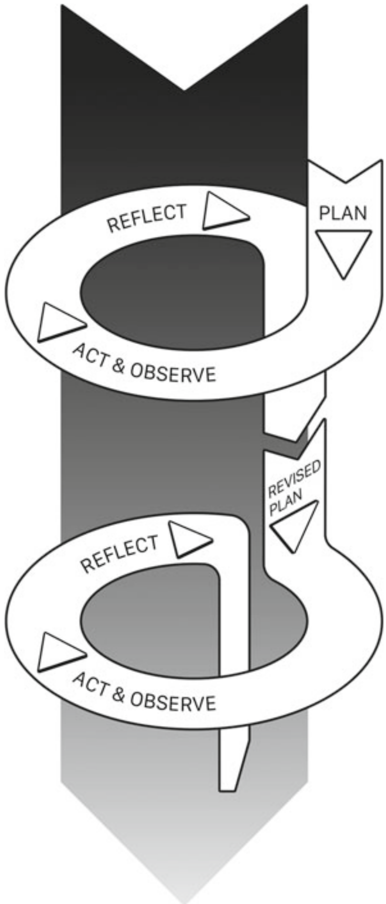

Fig. 18.3 Double cycle action research diagram (adapted from Kemmis & McTaggart, 1988)

Zuber-Skerrit explains the process for implementing action research:

> *The plan includes problem analysis and a strategic plan; action refers to the implementation of the strategic plan; observation includes an evaluation of the action by appropriate methods and techniques; and reflection means reflecting on the result of the evaluation and on the whole action and research process, which may lead to the identification of a new problem or problems and hence a new cycle of planning, acting, observing and reflecting.* (1992)

In considering the reflection stage in an action research cycle a parallel can be drawn with Schön's concept of 'reflection on action' (1983) which serves to define the way we can build a theoretical understanding of a completed situation or process.

18.4.3 An Example of UIC

Street Furniture Australia is a manufacturer of high-quality street furniture solutions. In early 2017, they approached IPDR to conduct some contract research concerning the viability of additive manufacturing as a method for commercial outdoor furniture production, this was the genesis of the authors' interest in Generative Design processes being applicable to product design. The researchers in this contract research project are both educators and participants with interest in educating the industry partner and themselves. Additionally, there is a focus to improve the UIC research process, to expand on new tools and techniques and to transfer novel and practical techniques to students in the form of a diverse and relevant curriculum and increasing our standing as academic design practitioners.

Action research can serve as a suitable methodological lens to observe the implementation of a new research-inspired elective subject. Figure 18.4 is a diagram which aligns each research phase with an action research cycle. In the first cycle, the authors are working with an industry partner in a University Industry Collaboration (UIC) project as design researchers which (at the time) was explicitly understood by the researchers as an action research process. After generating the research theme, research questions were explored in a participatory process with the industry partner. This led to a project focus and finally the production of a report and two research papers (Walden & Nemme, 2021; Walden et al., 2020). The circumstances of that engagement were finite, such that there was no opportunity to continue work on those themes through another cycle of research.

In the second action research cycle the authors are working as researchers on a self-initiated project to employ the tools and processes of generative design to produce artefacts. This enabled the development of teaching materials to be used later and provided the data for a research paper (Nemme & Walden, 2019). In cycle three we are working with students as their teachers in a studio-based learning situation which is typical of the product design education is delivered and applying the teaching materials developed within cycle 2.

The three cycles can be stabilised in the following way: the technology involved in each cycle is the same, our roles as academic design practitioners remain the same, and UIC, academic research and teaching, are all knowledge transfer activities.

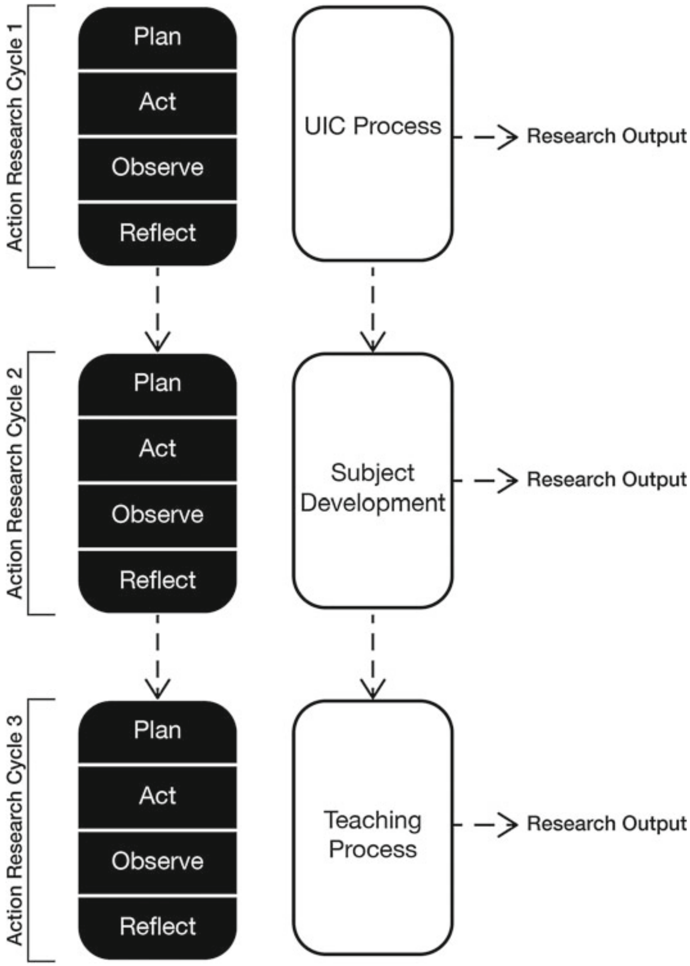

Fig. 18.4 A comparison of action research cycles with phases of developing and implementing the Generative Design subject

18.5 Results

The first two action research cycles have the benefit of pre-dating the turmoil unleashed on the participants by COVID-19. Here, cycle one is presented as a diagram (Fig. 18.5) to explore the design-led process in an unpacked presentation showing alignment with each action research feature of plan, act, observe and reflect (see Appendix, Fig. 18.11, for the full presentation of the 3 stage diagram). To consider this as a complete action research cycle, the authors provide evidence of two research papers that were generated from the first cycle (Walden & Nemme, 2021; Walden et al., 2020). The UIC project with SFA produced an encounter with Generative

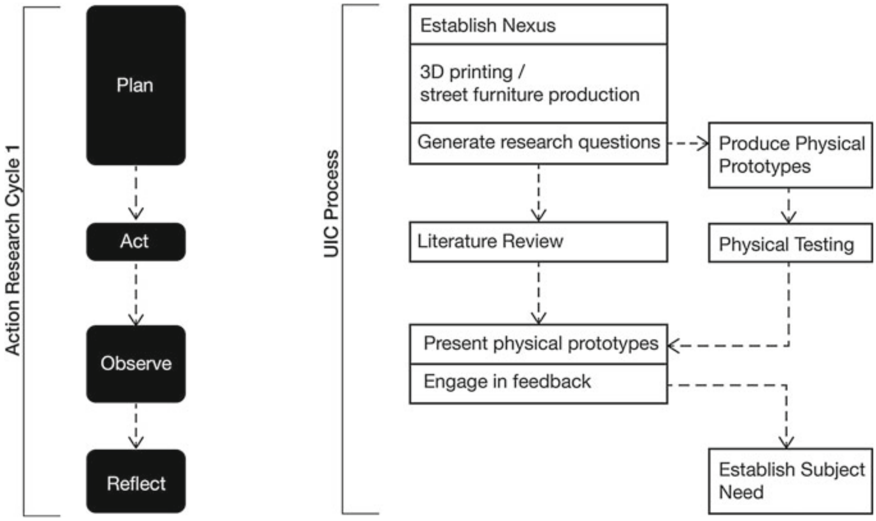

Fig. 18.5 Unpacking cycle 1 of the action research process

Design tools and techniques which provided impetus to create a novel product design subject.

In cycle 2 (see Fig. 18.6), the researchers were aware of the need to produce teaching materials including lectures and exemplars with only a conceptual understanding of the various generative design processes. The knowledge would have to become 'know-how' built through a 'reflection in action' process (Schön, 1983). This necessitated the plan for a self-initiated project for the generative design of a bicycle component. To complete the action research process task of reflection, the participants produced a research paper (Nemme & Walden, 2019) documenting the nuances of how generative processes can modify and enable product design practice.

In cycle 3 (see Fig. 18.7) of the action research process, the teaching process is unpacked. Here the structure of the subject is presented which documents the plan and act action research tasks. The structure of the Generative Design Elective is typical of many of the project-based elective studies in the product design program which focus on the theoretical side of new methods and the acquisition of practical skills. Within a twelve-week six credit point programme the subject format is three hours per week including a one-hour lecture paired with a two-hour design studio taking place inside a computer lab. In that environment the students have access to software unavailable in core studies and utilise it to experiment with hybrid digital workflows. The initial project focus is the lightweighting an object chosen by the student followed by a more difficult and specialised project which introduces them to topology optimisation and form synthesis; both can be considered as processes under the umbrella term of Generative Design.

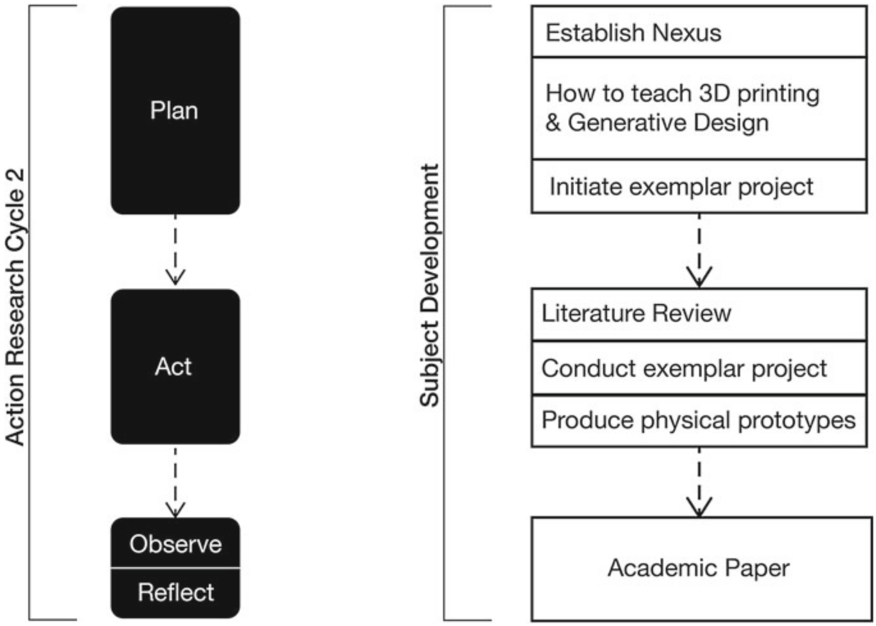

Fig. 18.6 Unpacking cycle 2 of the action research process

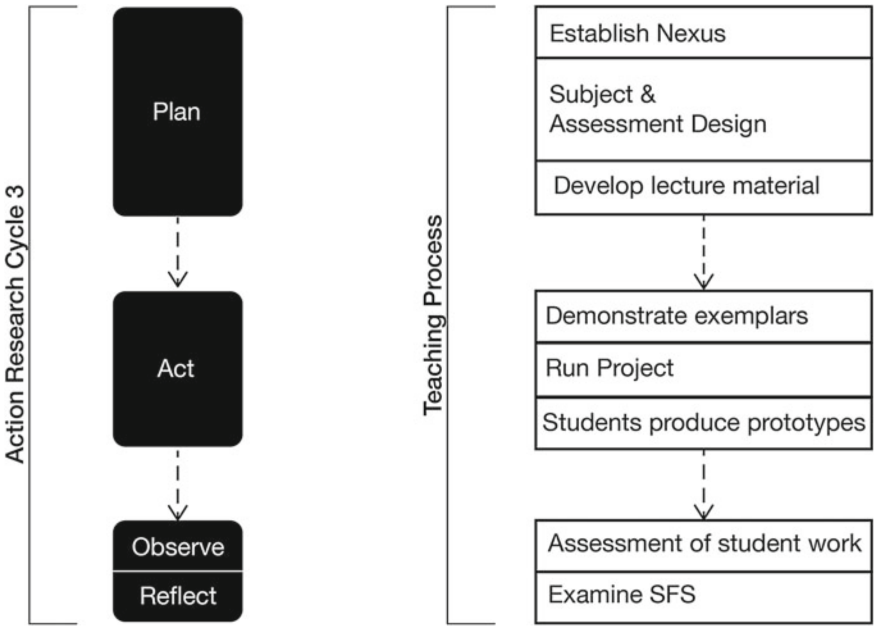

Fig. 18.7 Unpacking cycle 3 of the action research process

Fig. 18.8 Rendering of a putter head that incorporates a variable lattice structure designed by Thomas Alder (2020)

To address the observe and reflect stages of the action research cycle, evidence of the work produced by the students during the modified teaching program of COVID-19 and student feedback surveys is now presented. There was an assumption that the students would have been vastly impacted by the modified online teaching process and that this impact would be visible in the produced work, however, the submitted work was of a high standard. Students were required to produce renderings of their finalised designs along with a matching 3D printed object which fulfil the necessity in typical product design subjects for a model. Figure 18.8 depicts a rendering of a golf club putter head produced on the theme of 'lattice and surface optimisation'. It is important to notice the falloff in the size and frequency of the cut away areas which is difficult to produce in a typical mechanical CAD application. Figure 18.9 depicts the before and after result of a project that concerns the theme of 'topology optimisation' undertaken on a car brake pedal. Here the key issue to notice is the amount material saved in the optimised version versus the original while maintaining similar performance characteristics.

Fig. 18.9 Rendering of two versions of a car brake pedal, the closest to the viewer having gone through a topology optimisation process by Adelaide Kohlmann (2020)

Lattice structures are a typical design element employed in a lightweighting process; in this case it provided a unique aesthetic quality for the putter head. The object was created in a two-stage process with Solidworks employed to produce the shape envelope and NTopology software employed to install the lattice structure.

For the car brake pedal example, the object was first accurately modelled in Solidworks based on the existing article, and then optimised by way of the 'shape study' feature in Solidworks.

Student access to 3D printing services

With social distancing restrictions in place, it is important to address how the students were able to advance their projects and this was done by a combination of CAD processes and producing 3D printed versions of their designs. UTS Protospace's web-based portal provided the opportunity for students to access a quoting system that provided price and material volume calculations based on an uploaded digital CAD file (STL). From that application students could select the most appropriate additive manufacturing technology (and specific machinery) to manufacture their project. Once the 3D prints were produced, the students were notified, and they were able to collect the objects from lockers located within the facility. Furthermore, advice from Protospace staff was provided to students through digital channels, which mitigated any non-essential face-to-face contact.

To complete the cycle of action research, the teaching staff explored the responses from the student feedback surveys with the expectation that there would be a high degree of negativity to the modified online learning process. This assumption proved to be incorrect, and the student responses were positive and proved they had engaged and absorbed the important concepts from the subject. The student feedback responses serve as a good record of what was achieved:

> *The uniqueness of this subject has taught me new ways to envision future projects, which I doubt I would have ever learnt otherwise. (respondent 1, 2020)*
>
> *The concept of generative design is fascinating and interesting. I didn't know about it until I started this subject and it has informed me of the generative design principles and the ways to get an outcome that you would like, I liked the lectures and how well they worked with the subject matter. (respondent 2, 2020)*
>
> *Overall, I am satisfied with how this staff member facilitated my learning "4.8" (out of 5.0) (respondent 3, 2020)*

18.6 Discussion

The evolving nature of Product Design Education

A typical design process (Milton & Rodgers, 2013) might be described this way: opportunity identification, brief and specification, concept design, design development, detail design and production. And for a tertiary student project in product design the production phase concerns the creation of a prototype; being a model of a specific level of fidelity. Low fidelity models are sketch models or form studies, and higher fidelity models are experience prototypes, functional prototypes, and appearance models. It is noteworthy that different model types have different functional applications which might be operational (as vehicles for learning) or to mimic reality (in the case of an appearance prototype).

Within the design process, Milton and Rodgers (2013) refer to iterative cycles of design and development as being comprised of four distinct stages: understand, observe, visualise, and review. These stages are supported by prototyping as a core research method and are either repeated (to gather more data) or become satisfied and the designer moves onto the next stage of the design process. With less opportunity for students to enter the workshop to work on their design projects in a three-dimensional hands-on way the opportunity to visualise, observe and understand was heavily impacted by Covid-19.

For the generative design subject, on-screen review of student projects in a CAD environment coupled with the ability to produce 3D printed models at earlier stages in the design process supported the iterative process the students undertook. Because there was less direct interaction by the studio leaders with the designed objects, students assumed responsibility to review the ergonomic and structural issues of their designs by their own interaction with the 3D printed outputs. Any shortcomings of the objects could be demonstrated to the studio leaders in a screen-based video-conferencing situation.

UTS prides itself on producing work ready graduates and research inspired teaching can add value to this goal. New subjects being integrated into the product design program must provide industry relevant skills and knowledge. Generative Design and Topology Optimisation have been investigated by the researchers in terms of its relevancy to the industrial design profession based on a self-initiated project by the researchers (Nemme & Walden, 2019) The findings of that research paper concluded that Generative Design and Topology Optimisation tools should not be exclusively be the domain of engineering design work and ought to be understood and utilised by the industrial design profession for reasons including that they can provide creative opportunities to generate and understand new structural solutions regardless of the production techniques available. It is important to consider that there are mitigating factors; depending on the software chosen, topologically optimised forms can be blocky, unappealing and require refinement for market appeal. This refinement process can be managed if the industrial designer is enabled by the software tools to build an iterative structural understanding of the design in questions rather than being constrained by an engineering specification alone. By reflecting on the value of new tools and techniques encountered in that research process it was decided that they should be situated within their own newly formed subject—this dictated the subject need. To achieve this, the authors needed to undertake additional primary research to explore the software tools, develop the know-how and produce suitable examples.

18.6.1 Methods to Build Structural Understanding

For inexperienced (novice) designers, methods to gain insight and understanding of structural principles could be highly beneficial in the early stages of project. Typically processes such as finite element analysis (FEA) are the domain of structural and mechanical engineers and FEA is applied to validate potential design solutions. In processes such as topology optimisation and form-synthesis students must first learn to set up and apply a load case within a simulation environment and through this process they begin to theoretically understand how forces may operate on their own designs. The validation for this comes when physical testing is conducted on the 3D printed versions of the designs they have created.

18.6.2 Limitations of Teaching Exclusively Online

Mitigating the positive aspects of teaching exclusively online both in terms of outcomes produced by students and student feedback scores, it was evident that there are limitations to teaching generative design principles this way. For some students the necessity to be completely self-reliant and responsible for their own learning was a difficult aspect. Some found the learning environment to be socially isolating, slow-paced which prevented them from participating in the spontaneity available in face-to-face teaching. The concept of collateral learning, applied in this case, by viewing the work of more adept students, was hampered by an exclusively online arrangement.

The fact that students did not need to attend workshops to undertake model-making was convenient for this subject. The opportunity to interact and explore three-dimensional form development was made possible through CAD processes coupled with 3D printing as the method to produce prototypes. Within this situation it was found that students were slow to make iterations of their projects possibly due to the speed at which a 3D printed prototypes were returned either from the bureau service or their own equipment. It can be argued that a more agile 'reflection in action' process is available to students with physical modelmaking (which fuels iteration) and CAD and 3D printing being used in place of this process operates more slowly and more in the vain of 'reflection on action'.

Some of the designs created by the students through generative processes had a high degree of complexity and fine areas of geometry; these could not be accurately represented by 3D prints made on inexpensive FFF (extrusion-based) 3D printers and hence many of these designs produced print failures. Students that were able to access industrial scale 3D printers (particularly with powder-based technology) produced larger and accurate representations of their work.

The issues discussed highlight the potential benefits of generative design processes to product design practice when coupled with fast and efficient access to additive manufacturing facilities. The implementation of this subject demonstrates that there are some positive opportunities to develop high quality educational content for industrial design in an exclusively online situation. As universities locally and internationally are under threat financially due to the collateral effects of COVID-19, this method of teaching could be suitable for the introduction of short courses for recent graduates if the teachers and students are aware of the limitations of the exclusive online teaching arrangement.

18.7 Conclusion

UIC Research is a useful way to inspire the generation of new subject matter. Through an action research lens, research inspired teaching has been validated as a successful strategy in this paper and the authors' findings are consistent with Stenhouse (1983, 2012) and Buchanan (1998) who have explored the 'teacher as researcher' theme years ago. Furthermore, research inspired teaching is a principle already in place and part of the UTS strategic plan.

Fortunately, given the authors' commitments to research and industry engagement we were able to explore the potential of computational modelling and additive manufacturing in an industry context much earlier in 2017. These insights provided a certain level of confidence that an online subject around generative design processes could and should be delivered as part of a product design degree study programme in the future.

The situation of COVID-19 impacting teaching in early 2020 was unforeseen and sudden for staff and students of the university alike. Social distancing measures forced a movement to an exclusively online arrangement and the authors knew this would be difficult because product design teaching is historically tied to an enquiry-based face-to-face studio environment. Interplay between workshop and studio environments are key for students to develop and iterate their understanding of three-dimensional forms and exclusively online arrangements by definition compromise this learning situation.

The authors have learnt that exclusively online learning might suit subjects with a high degree of digital content and involvement including those that require both the introduction of new design strategies and software training; which covers a substantial number of processes implemented in product design education. Notwithstanding that positive outlook, face-to-face teaching remains superior to a purely online learning arrangements particularly via methods that allow students to appreciate the physical form of artefacts first hand and by extension learn from the work of each other directly which is difficult in an online situation.

Issues of spatial understanding which can be solved by physical modelmaking still persist when conducting design processes in purely digital ways. The use of three-dimensional CAD software and experience of the designer goes some distance along the path to mitigate the effects of not being able to access workshops but they are not a perfect solution. To produce the 'reflection in action' (Schön, 1983) feedback loop that is present in a physical modelmaking process, students must have fast and efficient access to 3d printing facilities to produce their own prototypes and support a deeper iterative design process. Industrial 3D printing is preferred over desktop equipment for the benefit of higher fidelity prototypes, particularly available from powder-based 3D printing processes. These 3D printed artefacts can then be evaluated by the student to improve and adjust their own design processes.

The researchers were able to reflect and build upon experiences in new ways to construct the generative design principles subject. The arrival of COVID-19 was an unusual circumstance which accelerated the potential of online learning. It enabled the evaluation of the nature of an exclusively online subject, which without COVID-19, would not have ever been investigated. Product design students responded positively to this new elective subject matter as it was different to what they experience in core studies and already had a high degree of integrated digital learning content. As such, subjects of a similar nature can successfully be taught in this way.

Appendix

Definitions of generative design strategies

Topology Optimisation (see Fig. 18.10) concerns weight and material efficiency of parts, providing the opportunity to minimise the weight of a component (by a percentage) but maximise its stiffness based on a starting shape and applied forces; it provides a singular outcome. This is particularly useful in the redesign of existing parts when an efficiency improvement is required; say, reducing the weight of assembled components on a racing bicycle.

Form-synthesis alternatively does not require a starting shape but only applied forces and contact points within a software simulation which provide the framework for the software to 'grow' geometry between those contact points producing typically complex and mammal bone-like forms; it also provides a multiplicity of solutions in a single process. In any exploration of objects that have been 'generatively designed' form synthesis is the process behind the most complex, exuberant, and biological forms. This form complexity does create a conundrum for a designer interested in manufacturing and dictates that without rationalisation of those forms production must be via additive methods (3D printing) rather than subtractive (CNC machining) or formative methods (injection moulding).

Lattice and Surface Optimisation (see Fig. 18.10) is a key strategy in creating lightweight parts and several software tools can be used to cut away areas of solid material and replace them with more efficient and lighter lattice structures. Lightweighting can be undertaken with or without consideration of forces applied to a component and so in this process the resulting object could be structurally compromised and perform worse than the original object. Conversely, for skilled individuals with a structural understanding the results can be lighter objects that absorb fewer material resources. The process of lightweighting when successfully applied can achieve more fuel-efficient aircraft and motor vehicles by reducing the total weight of assembled parts.

Trabecular Structures (see Fig. 18.10) are forms that belong to the field of medicine. Here, 3D printing is being used to improve the clinical outcomes of many patients via the production of tailored implants. Surgeons can pre-order a bespoke implant designed by a technician based around three-dimensional data of the injured patient rather than relying on a drawer full of sized spare parts. One of the issues under consideration for 3D printed implants is the integration of these objects with existing healthy bone structures. CAD software is available to generate tiny porous geometries

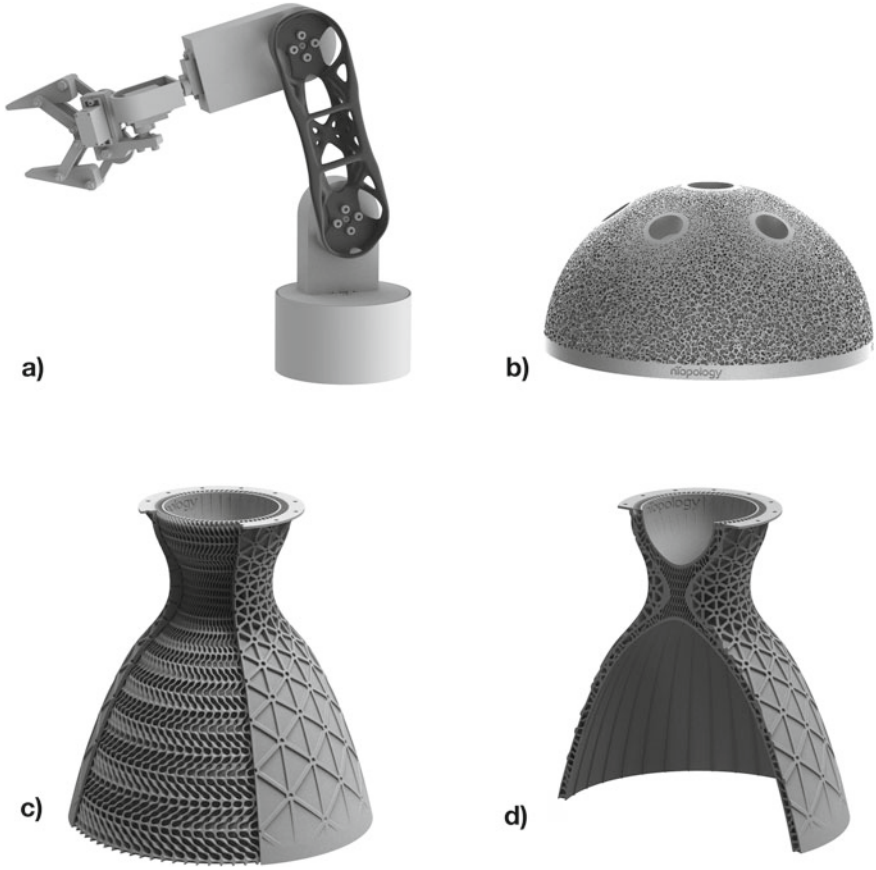

Fig. 18.10 Applications of diverse Generative Design techniques possible in nTopology. Clockwise from top left: **a** robotic arm with a topology optimised component, **b** acetabular cup with trabecular features, **c** & **d** cut-away views of a rocket engine nozzle with integrated lattice structures (nTopology, 2021)

(trabecular structures) throughout the geometric envelope of the implant which will encourage the body to rapidly and efficiently integrate the implant (Fig. 18.11).

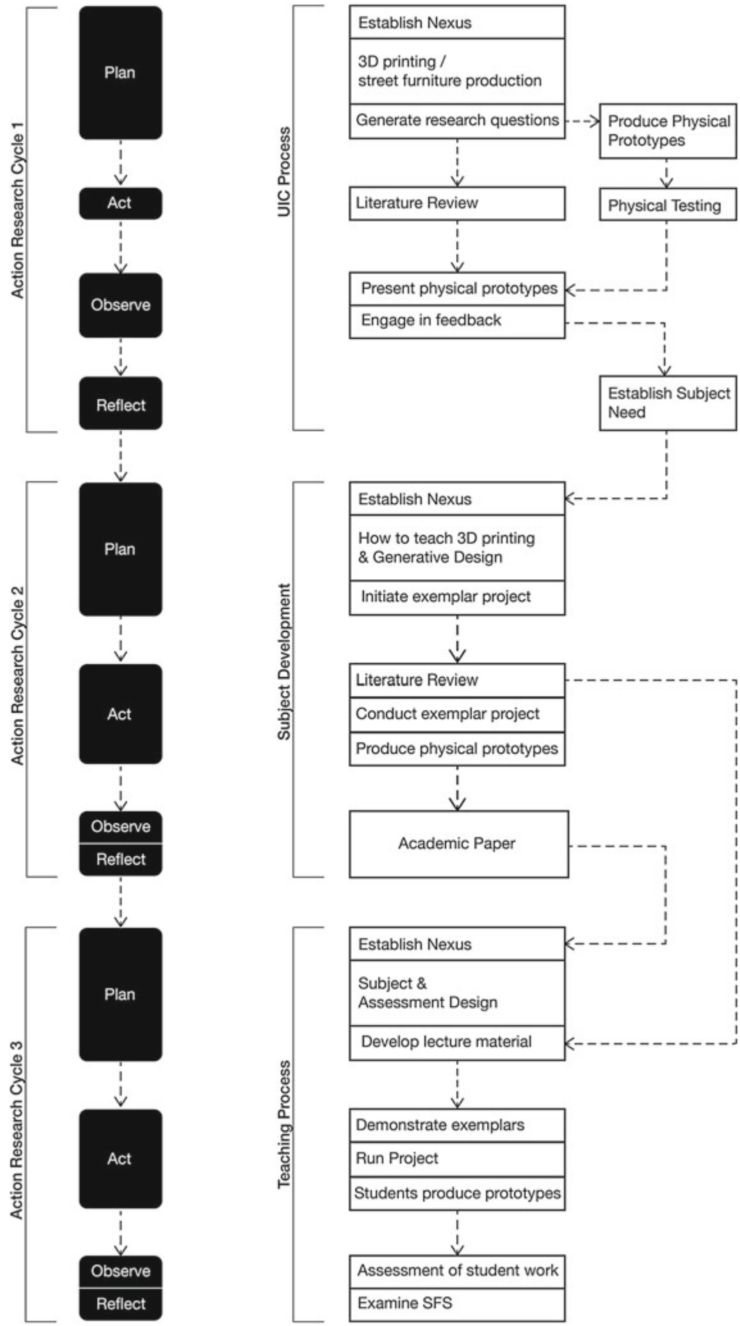

Fig. 18.11 Complete 3 stage action research diagram showing the stages of UIC, subject development and teaching process

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Roderick Walden is focused on the development of knowledge-driven industrial design practice that situates prototyping as a central research device. His academic design practice reflects the changing nature of professional industrial design in which conventional patterns of product distribution and supply are changing. He has contributed to university-industry collaboration projects and academic publications that investigate opportunities for industrial designers to advance their practice, to critically research meaningful and responsible design interventions beyond the immediate concerns of manufacturing.

Dr Stefan Lie is a product designer and academic working at the intersection of product interaction and sustainable design. His research emphasises the relationship between humans, materials, and their resulting contribution to cultures of overconsumption and waste. He has a particular interest in small-batch and on-demand 3D printing and the use of next-generation bio-derived polymers as an alternative to petrochemicals. Lie is a co-director of the Material Ecologies Design Lab at UTS, which develops new materials sourced from regenerative systems.

Chapter 19
How Do Moroccan Higher Education Students Behave During the Remote Education in Time of COVID-19?

Lalla Fatima Zohra Alami Talbi and Saadeddine Igamane

Abstract This paper aims to assess how did Moroccan higher education students behave during the transition from face-to-face education to a complete remote education triggered by Covid-19 pandemic. Hence, we could accordingly deduce even a first conclusion if they are ready and accept education 4.0. For that purpose, a survey is carried out for 1030 students from different Moroccan universities. Results show that students are not satisfactory of remote learning mainly because of the lack of connection means and the interaction with teachers and classmates. However, students and teachers surveyed are convinced of the utility of digital educational tools and are ready to use them. Thus, we can conclude of their readiness for education 4.0 revolution that will accompany the Bachelor reform.

Keywords Continuity of distance higher education · Covid-19 · Student engagement · Digital educational tools · Moroccan higher education

19.1 Introduction

COVID-19 pandemic has been an occasion to make policy makers and education actors more aware of the industrial revolution 4.0 and the need to accelerate the implementation of education 4.0 to prepare the future workforce. Moreover, it reveals many opportunities in modalities of teaching and learning thanks to which pedagogical continuity was ensured when distancing measures and social constraints were applied. Higher Education Institutions (HEIs) have been leaded to occur the unprepared and sudden shift from face-to-face towards online teaching and learning. This

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later remains the only solution to ensure the continuity of education from distance to the best extent possible; although, it may not guarantee the same level of quality compared to face-to-face education.

Indeed, the use of remote educational tools in large scale to ensure continuity of education in time of university closure was a deep preparation to pass the transition to education 4.0 and also an opportunity to convince the most reluctant actors of the importance of those educational tools for the future of learning. Therefore, a deep change in mindset has occurred as reported by the International Association of Universities survey (Marinoni et al., 2020). Hence, educator staffs are more ready to change modalities of teaching in order to propose more flexible learning possibilities based on blended learning i.e., a mixed of synchronous and asynchronous education tools. Thus, they can open up to lifelong learning opportunities. This experience has in fact opened a new horizon of opportunities for teaching and learning. To build on this experience, it is compulsory to review the examination approaches and to digitalize the administrative processes and the access to the library's resources and documents. This experience will ultimately, enhance the institutions crisis management readiness and their resilience and agility to deal with other or similar unforeseen crises in the future.

Alongside these opportunities, HEIs have to cope with the disruption of teaching and learning activities by managing teaching continuity, foreseeing exams and planning the next academic year. According to the International Association of Universities survey that concerns 424 HEIs based in 109 countries from 4 regions (Africa, Americas, Asia and Pacific and Europe), the disruption caused by Covid-19 has affected teaching and learning activities at almost all HEIs (Marinoni et al., 2020, p. 23). 67% of surveyed HEIs have replaced classroom teaching by distance teaching and learning; while 7% have cancelled teaching activities and 24% have suspended most activities meanwhile they are working on developing solutions to continue teaching and learning through digital or self-study means. Teaching cancelled in Africa reached 24% HEIs, while it does not exceed 3% in others regions. Moreover, African HEIs that were able to quickly move teaching and learning online represent only 29% compared to 85% of HEIs in Europe. In other words, two-thirds of African HEIs were not prepared to move teaching online and when they closed their campuses, they had to suspend teaching.

The results of this survey are obviously hard to generalize for all HEIs in the world, as there might be an implicit bias of self-selection in the respondents of the survey, nevertheless, these results show the impact of Covid-19 disruption depends to a large extent on the readiness and preparedness of HEIs to deal with remote learning. Moreover, 2% of surveyed HEIs are not impacted by Covid-19 disruption mostly because they are virtual universities.

Regarding the management of exams 45% of the surveyed HEIs were planning at the moment of the survey to carry out exams for the semester as planned but through new measures, 6% as usual, while 24% intended to postpone exams or to put it on hold. 80% of surveyed European HEIs and 62% of Asian & Pacific HEIs and 69% of American HEIs have planned to carry out exams for the semester, while only 32% of African surveyed HEIs have planned to do so (Marinoni et al., 2020).

It is true that the sudden shift to online teaching and learning was a solution to ensure the continuity of teaching and learning when the lockdown became effective. However, it has reinforced inequalities between student that get access to learning because they have a computer or tablet and internet access, and those who do not, mainly in countries of mid and low incomes. These later are the hardest hit by the educational disruption. Noteworthy, discrepancies exist even in countries with good internet penetration.

Despite the efforts made by several actors, the quality of teaching and learning has been affected by comparison with face-to-face teaching. First, the lack of training in remote teaching pedagogies leads many teachers to learn by doing or imitate what would have been the face-to-face way of proceeding. Second, owing to the need of some study fields to practice on laboratories or in instruments which cannot be performed well when working from home. Therefore, teaching has often been limited to the theoretical aspects of the curriculum what led to a deficit in learners' achievements.

This paper tackles about the Moroccan university transition triggered by COVID-19 circumstances and lockdown from the face-to-face education to wholly remote education based on digital education tools which are one of the pillars of education 4.0. Despite the exceptional conditions of the implementation of the remote learning, however, the students' behaviour and their feedbacks could let us know about their readiness and acceptance of education 4.0 and then, their adherence to remote university project and Bachelor's degree reform. Thus, this paper attempts to answer the following questions:

How do Moroccan universities behave towards COVID-19 disruption? What are the students' perceptions about the use of digital education tools? Do they accept the transition to the online learning and use of digital education learning? Are they ready to get involved in education 4.0 to answer the future labour needs enacted by industry 4.0?

Fist, this paper presents the foundations and the scope of education 4.0, in addition to the main initiatives of Moroccan university. Second, the paper describes the students' methodology survey and sample. Finally, results are discussed according to theory and a previous teachers survey.

19.2 Education 4.0: Scope and Overview

19.2.1 Industry 4.0 and the Need for Education Revolution

The meaningful change in the industry business model, commonly called Industrial Revolution, leads to a wide disruption. First, in job supply to the point to occur a deep change in the job market face. Many jobs will be destroyed when others will be created in response to the new industry needs. Accordingly, workers dismissals will increase because they are replaced by a machine or an artificial intelligence which is the case of the current fourth revolution. Second, the unemployed workers will be exposed to precariousness and poverty which might lead to a social crisis. Third, education system is asked to solve a part of this social crisis by ensuring in emergency more fit-for-purpose out comes in preparing students for the workplace otherwise, it will be accused of being responsible for the increase in the unemployment rate and the decline in the country's competitiveness.

Industrial revolution 4.0 consists of automation jobs by applying connected machines, robots and artificial intelligence to replace many tasks currently done by the workforce. Thus, companies will be able to reduce costs, increase business productivity and competitiveness.

This industrial revolution is very specific and disruptive. First, it occurs in a very critical period marked by a global economic contraction owing to COVID-19 pandemic-induced lockdowns and the most severe crisis for job market since the Great Depression of the 1930s (International Labor Organization, 2021, p. 20)."Working-hour losses in 2020 were approximately four times greater than during the global financial crisis in 2009" (International Labor Organization, 2021, p. 1). They are equivalent to 255 million full-time jobs, moreover, labour market recovery is uneven and modest. In these circumstances, businesses (84% of interviewed employers) are convinced to accelerate the digitalization of work processes, the remote work, as well as the automation of tasks to strengthen their resilience in the face of further health crisis. Second, it will transform tasks, jobs and skills (World Economic Forum, 2020a). The surveyed companies by the Forum's Future of Jobs that plan to introduce further automation indicate that 55% of them set out by 2025 to modify the composition of their value chain and 43% expect to reduce their current workforce, while 41% plan to expand their use of contractors for task-specialized work and 34% plan to expand their workforce (World Economic Forum, 2020a, pp. 27, 29).Moreover, by 2025 15% of estimated time workforce in 2020 will be replaced by machines. Thus, the estimated time spent by humans at work based on 2020 tasks is on average an equal parity on the time spent by machines for the overall tasks (World Economic Forum, 2020a, pp. 28–29). Machines and artificial intelligence will mainly focus on redundant tasks which will be likely the declining jobs (Table 19.1). These jobs (processing information and data, administrative tasks and some aspects of traditional manual labour) representing 15.4% of the workforce are expected to decline by 2025 to 9% (6.4% decline), and that emerging professions will grow from 7.8% to 13.5% (5.7% growth) of the total employee base of company respondents to the Future of Jobs Survey (World Economic Forum, 2020a, p. 29;33). However, tasks of managing, advising, decision-making, reasoning, communicating and interacting are expected to continue to be carried on by humans (World Economic Forum, 2020a, p. 29).

Overall, the shift in the division of labour between humans and machines may likely displace 85 million jobs by 2025, while new jobs estimated at 97 million would be more adapted to the new division of labour between humans, machines and algorithms may emerge (World Economic Forum, 2020a, p. 29).

These important shifts concern mainly non-emerging roles (among others 75% in Sales, 72% in content roles and 67% of Engineering roles) and require a labour force reallocation which is already underway.

Table 19.1 identified top 20 emerging jobs that are consistently growing in demand among 99 recognized by Future of Jobs Survey (2020) across 20 economies, in addition to the other declining in demand.

The *World Economic Forum's Jobs Report* expects that the number of jobs destroyed will be exceeded by the number of 'jobs of tomorrow' created. These

Table 19.1 The Jobs Landscape in 2025 /Top 20 job roles in increasing and decreasing demand across industries

TOP 20 emerging jobs		TOP 20 declining jobs	
1	Data analysts and scientists	1	Data entry clerks
2	AI and machine learning specialists	2	Administrative and executive secretaries
3	Big data specialists	3	Accounting, bookkeeping and payroll clerks
4	Digital marketing and strategy specialists	4	Accountants and Auditors
5	Process automation specialists	5	Assembly and factory workers
6	Business development professionals	6	Business services and administration managers
7	digital transformation specialists	7	Client information and customer service workers
8	Information security analysts	8	General and operations managers
9	Software and applications developers	9	Mechanics and machinery repairers
10	Internet of things specialists	10	Material-recording and stock-keeping clerks
11	Project managers	11	Financial analysts
12	Business services and administration managers	12	Postal service clerks
13	Database and network professionals	13	Sales Rep., Wholesale and Manuf., Tech. and Sci.Products
14	Robotics engineers	14	Relationship managers
15	Strategic advisors	15	Bank tellers and related clerks
16	Management and organization analysts	16	Door-to-door sales, news and street vendors
17	FinTech engineers	17	Electronics and telecoms installers and repairers
18	Mechanics and machinery repairers	18	Human resources specialists
19	Organizational development specialists	19	Training and development specialists
20	Risk management specialists	20	Construction Laborers

Source Future of Jobs Survey, World Economic Forum (2020a) later will be wholly new occupations, or existing occupations undergoing significant transformations in terms of their content and skills requirements.

However, job creation is slowing while job destruction accelerates which would not fail to increase unemployment rate and social pressure. Thereby, expanding social protection, including support for retraining to displaced and at-risk workers are more than necessary to mitigate the social impact. Moreover, public policy should focus efforts on supporting and retraining displaced worker by improving the access to reskilling and upskilling to insure their professional integration.

Finally, an education revolution should take place to prepare future workforce for 'jobs of tomorrow'.

19.2.2 Scope of Education 4.0

University face big challenges to ensure an educational revolution while the number of students increases considerably (by 70 million in lead up 2035compared to 2017) mainly in Asia (63.3%) and Africa (26.5%) (Boudjelloul, 2021).

The artificial intelligence and the increasing automation processes triggered by industry 4.0 need new workforce skills requirements that machines cannot offer. These skills are collaborative, socio-emotional and transversal. Thereby, they form the comparative advantage of the future workforce namely the main component of employability in addition to the core skills that university should focus on in educating students. The World Economic Forum (2020a) identifies in Table 19.2 the main 15

Table 19.2 Top 15 skills for 2025

1	Analytical thinking and innovation
2	Active learning and learning strategies
3	Complex problem-solving
4	Critical thinking and analysis
5	Creativity, originality and initiative
6	Leadership and social influence
7	Technology use, monitoring and control
8	Technology design and programming
9	Resilience, stress tolerance and flexibility
10	Reasoning, problem-solving and ideation
11	Emotional intelligence
12	Troubleshooting and user experience
13	Service orientation
14	Systems analysis and evaluation
15	Persuasion and negotiation

Source Future of Jobs Survey, World Economic Forum (2020a) required skills namely critical thinking and analysis as well as problem-solving, and skills in self-management such as active learning, resilience, stress tolerance and flexibility.

To acquire these skills for students, it is necessary to change both *learning content* and *learning experiences or mechanisms*(World Economic Forum, 2020b, pp. 7–10). *The change in learning content* aims to improve basic fundamental skills and the integrated adaptation of curricula to the demands of the labour market in order to prepare students to become both productive contributors and responsible citizens. In addition, the design of competency-based programs requires the participation of public and private sector employers alongside the university to ensure the training employment match.

The WFE (2020b) establishes a framework proposal for Education 4.0 based on the following 4 key skillsets to be broken down into curricula (Fig. 19.1).

The transition to education 4.0 will also require a deep shifting on *learning mechanisms* based on vetted innovative teaching pedagogy and new learning technologies (virtual reality, MOOCs, SPOCs, remote learning, …) to closely mirror the future of work, and thus, meet labour market requirements. Moreover, organizing training in eco-systems to best simulate real working conditions allows students to put into practice and develop the 4 key content learning skillsets.

Indeed, the shift in learning content could not manifest without a shift in learning mechanisms. These latter depend on 4 principals:

1. **Personalized and self-paced learning:** in fact, education 4.0 offers a flexible learning mechanism to enable each learner to progress at his own pace likewise it takes into consideration the individual needs of each learner. Thus, each student should have a professional personal project in bachelor's degree. Contrary to

1.Global citizenship skills: Include content that focuses on building awareness about the wider world, sustainability and playing an active role in the global community.
2. Innovation and creativity skills: Include content that fosters skills required for innovation, including complex problem-solving, analytical thinking, creativity and systems analysis.
3. Technology skills: Include content that is based on developing digital skills, including programming, digital responsibility and the use of technology.
4. Interpersonal skills: Include content that focuses on interpersonal emotional intelligence, including empathy, cooperation, negotiation, leadership and social awareness.

Fig. 19.1 Schools of the future: defining new models of education for the fourth industrial revolution. *Source* World Economic Forum (2020b) the period of industry 1.0 and 2.0 when educative system offers standardized training to perform standard and uniform tasks.

2. **Accessible and inclusive learning:** the new learning technologies make learning accessible anywhere that allows students from isolated and disadvantaged backgrounds to get access to learning.
3. **Problem-based and collaborative learning:** this learning pedagogy aims to get closer and simulate future working conditions. It is requiring peer collaboration what is an opportunity to put into practice Global citizenship skills, Innovation and creativity skills, Technology skills, and Interpersonal skills. Moreover, this innovative pedagogy makes education playful, experiential, computational and even embodied.
4. **Lifelong and student-driven learning:** it is important to educate students in self-education to make them able to update themselves and adapt to new changes in working conditions. Flexibility and the ability to adapt to changes are the key factors for sustainable employment.

19.2.3 Overview of Education 4.0 in Moroccan University

Education 4.0 was introduced in Moroccan university long before COVID-19. Thanks to institutional initiatives of universities and the ministry on one hand, and to personal initiatives of teachers convinced of the positive effect of technology on student learning on the other hand. Some disciplines had commonly used online platforms such as Classroom, Moodle since 2015. Nevertheless, the use of these digital educational tools remains on the whole, unusual in Moroccan university particularly in the humanities and social sciences faculties.

Indeed, COVID-19 conditions have forced the use of digital educational tools at a large scale to ensure the continuity of learning while the HEIs closure. It has been in fact an upgrade occasion for teachers and students.

Before COVID-19, many initiatives have been undertaken first, to acquire laptops or computers for students and teachers as well. Nafida is a program for teachers of higher education and primary and secondary schools that grants a subsidy of 2,000 MAD (200 USD) to 150 000 beneficiaries to acquire computers or laptops, in addition to a discount of 25% in internet costs. The second edition of this program has started the 10th June 2021 with the same specifications.

Injaz is a program for students that offers computers at a reduced price next to an internet subscription for one year. Nearly 138,500 students have benefited from this offer.

Second, the Ministry in charge of Higher Education has strengthened through E-Sup program, the capacity of the university network and established the Digital network environment in terms of Educational Resources and E-learning. Also, the E-Sup program has encouraged the technological development and innovation activities in the use of ICT in education.

Furthermore, the Net-U project has aimed to deploy an outdoor Wi-Fi network within universities, faculties and university campuses, i.e., 108 sites.

The e-learning centres were implemented in each university to produce MOOCs in partnership between the Ministry of Higher Education and the group «GIP FUN-MOOC» and offer training on the use of digital educational tools to teachers. The Moocs produced are available in the national platform "Maroc Université Numérique (www.mun.ma)" (digital Moroccan university) since, July 2019.

During COVID-19, the Ministry of Education, in partnership with the French Embassy in Morocco, has launched a call for projects to strengthen distance education in the Moroccan university and hence support the launch of the Bachelor's cycle planned for the academic year 2021-2022. The call for projects concerns mainly modules and softs skills programmed in the first year of the Bachelor's cycle, and teacher training in online teaching and assessment.

Furthermore, to solve the student connectivity problem, Moroccan universities have implemented at the start of the school year (2020-2021) Moodle Platform to allow students to remote learning without needing internet credit. Also, they decided to set up in each HEIs an e-learning center to record courses.

19.3 Methodology and Sample Presentation

19.3.1 Methodology

In order to assess whether Moroccan higher education students accept and are ready for the education 4.0 based on both digital and pedagogical innovation, this paper study the students' behaviours in the use of digital educational tools during the containment period, and their engagement degree.

To this end, an online survey was disseminated via an email campaign in addition to social networks in French and Arabic from 05 August to 24 September. During this period, several reminders were made to improve the response rate and expand the sample. Finally, 1030 Moroccan higher education students responded to the survey. It must be emphasized that the mode of questionnaire administration adopted "online" although the best suited to the health crisis, however, it introduces a selection bias for respondents which immediately excludes students who do not have access to online education. This does not affect the quality of the study, since the objective is to study first, the behaviour of students in distance education in times of COVID-19 and second, their feedback on using the digital educational tools to check the possibility of integrating them into their future customs and habits within the framework of education 4.0.

It is true that the sample is made up of students coming from all the universities of the kingdom and studying in different disciplines, however, it is not representative in the same proportions as the basic population. Thus, the sample is defined on the basis of a voluntary sampling based on the students who agreed to complete the online questionnaire.

The questionnaire consists of 64 questions spread over 5 axes: institutional communication about the use of digital educational tools; the use of digital educational tools before and during the containment; student engagement during the containment; exams and supervision in carrying out research work (dissertations, doctoral theses); the assessment of the digital learning experience; and finally, the perspectives of the future of learning; in addition to the profile of respondents.

This survey was administered in parallel to the teachers' survey that obtained 202 responses. Some results of this survey will be used to discuss the results of the students' survey.

19.3.2 Sample Presentation

The surveyed students were mainly women (55.1%). The vast majority of respondents (79.3%) are aged between 17 to 25 years old. They study in bachelor's degree (38.25%), in engineering (34.56%), and in master's degree (21.17%). 59% of surveyed students are from all Moroccan universities, while 41% are from public and private higher education schools. 41% of students study Law, Economics and Management, while 19% study Arts and Humanities, and 40% Sciences. The language of instruction is primarily French (74.1%), followed to a lesser extent by Arabic, then both Arabic and French (7%), and French and English (5,8%).

Moreover, 57.9% of surveyed students declared having a good mastery of Information and Communication Technologies (ICTs), while 36.1% have a little knowledge, and 6% no mastery. 75% of the students surveyed have the required tools for remote learning, namely internet (WIFI, 4G, fiber optic) and digital tool (computer, tablet, Smartphone). These characteristics of the sample can not be generalized to all Moroccan students regarding the choice to administrate the survey online. However, they seem close in a certain extent to the data of the International Telecommunication Union (ITU) of 2019 that shows that 94% of Moroccan own an individual mobile phone and 99% are covered by at least a 4G mobile Network. Moreover, 81% of households have internet access at home and 60% a computer at home. Regarding the ICT skills, 49% of individuals have basic skills, 34% standard skills, and 9% advanced skills.

19.4 Results and Discussion

19.4.1 How Do Moroccan University Students' Study During the Remote Learning?

Remote learning during the lockdown period

To support students' learning in the lockdown period when face-to-face teaching is suspended, Morocco used a variety of tools to broadcast educational resources to reach the largest proportion of students mainly those who do not have access to connectivity, namely radio, television and online educational resources. Nevertheless, broadcasts can be limited to covering only a few subjects due to the short amount of time devoted to TV and radio programmes.

Moreover, many HEIs have decided in the first weeks of their closure to post on their website their teachers' course materials mainly in pdf or ppt format, besides audio and video resources. Indeed, the Mohamed V University of Rabat, the Cadi Ayad University of Marrakech and the Hassan I University of Oujda have distributed more than 10,000 online course materials in Word, PDF or PPT format. Video and audio media is used at the second level primarily by the Sultan Moulay Slimane University in Beni Mellal that broadcasted the most with 4566 videos and audios (El Mendili, Saaidi, 2020, pp. 86–87). Moreover, live resources (videoconferences) were mainly used by teachers of the Chouaib Doukkali University of El Jadida, the Mohamed V University of Rabat, the Abdelmalek Essaadi University of Tangier and the Ibnou Zohr University of Agadir. In addition to this, personal efforts have been made by teachers to make courses available to students via other platforms (Classroom, etc.) or even the most used social networks in Morocco namely WhatsApp and Facebook.

In the OECD and partner countries, online platforms were the most popular tool used during the lockdown (Andreas, 2020, p. 15). Online platforms were used in nearly all OECD and partner countries. Online learning tools ranged from educational content which students could explore at their own discretion and conducted at their own pace, to real-time courses led by their teachers using virtual meeting platforms. Moreover, TV broadcast was also a popular learning arrangement to reach students without remote learning means.

Table 19.3 shows that 71% of surveyed students have received the course material from their teachers in pdf or ppt format and have benefited from remote education using synchronous (videoconference) or asynchronous (audio or video recording) tools. Nevertheless, 10% of surveyed students reported to have received the course material only, while 3% their teachers have not kept in touch with them and thus, they did not continue their learning remotely.

Hence, all surveyed students have a priori the required tools to get access to remote learning. This observation is due in large part to the forced choice of administering the survey online given the health crisis and social distancing measures. Therefore, we should take into consideration this selection bias. In other words, the method

Table 19.3 The way that remote learning is kept by surveyed Moroccan Higher Education students

The way that remote learning is kept	%
No remote learning	3
Course material only in pdf or ppt format	10
Use of synchronous or asynchronous tools without course material	16
Course material and use of synchronous or asynchronous tools	71

Source Survey Data

Table 19.4 Tools used in remote learning by surveyed Moroccan Higher Education students

Tools used in remote learning	%
Virtual meeting platforms (Meet, Teams, Zoom, Webex, skype)	56
Online platforms (classroom, Moodle, Edmodo)	31
Social network (Facebook, WhatsApp)	13

Source Survey Data

of administering the questionnaire has systematically excluded students who do not have the required connectivity tools. Also, the lack of statistics on students with ICTs at national level does not allow us to weigh and put these results into perspective. 77% of surveyed student have a personal computer and 10% a tablet, 90% a smartphone and 86% access to internet. It is true that the sample consists of students coming from all the universities of the kingdom, however, it is not representative of the proportions of the basic population. Moreover, it is important to note that 57.5% of surveyed students have already used digital education tools before COVID-19.

Table 19.4 reports that the main tools used in remote learning by surveyed Moroccan Higher Education students (56%) during the university closure are virtual meeting platforms allowing videoconferences and so an interaction with teachers simulating face-to-face teaching as much as possible. They used primarily Meet (40%), followed by Teams (30%) and Zoom (29%), and to a lesser extent by Webex and Skype. In addition, roughly 31% of students reports having used online platforms. They used mainly Classroom followed to a lesser extent by Moodle and Edmodo (1%). Some students have used social network to continue their education remotely by Facebook and mainly by WhatsApp.

Overall, surveyed students preferred the most Classroom, followed by Meet, Teams and Zoom.

In addition to these tools used in remote learning, it is worth noting that Moroccan universities have produced before COVID-19 e-learning courses available on line. Unfortunately, only 58% of surveyed students have visited it and solely 11.5% have known about the e-learning courses produced by all Moroccan universities available at Maroc Université Numérique (digital Moroccan university) web site (www.mun.ma).

Dissertations remote supervision

33% of surveyed students concerned by dissertation declared having benefited from a supervision during the university closure and are well satisfied, while 32% seem to be not really satisfied, and 35% report did not benefit from any supervision.

Supervision was provided mainly via mail and videoconferences. During the university closure the libraries were also closed. Thus, students have found difficulties to get access to references to prepare their dissertations. To overcome this, university presidents have set up a commission to facilitate access to national and international digital libraries. In addition, the Moroccan Institute of Scientific and Technical Information has provided an e-resources platform. However, 57% of PhD students surveyed were not informed.

Furthermore, only 21% of surveyed students preparing their dissertation of master degree have defended it.

Remote Exams

Moroccan universities have decided to take the spring semester exam at the next academic year (2020–2021), unlike the majority of engineering and business schools. However, some universities have scheduled Master degree exam of retake autumn session remotely. Those of Bachelor degree were carried out before HEIs closure.

Thus, 21% of surveyed students concerned by the retake session have taken their exam remotely.

19.4.2 Student Engagement During the Lockdown Period

40% of surveyed teachers consider that the number of students attending classes has decreased compared to face-to-face teaching, mainly (according to 75% of teachers) by lack of means.

22% of surveyed students report having no barriers to follow-up their learning remotely during the lockdown period. However, the other students attribute their lack or weak involvement to many reasons. Primarily, the lack of internet access and its high price that represents 3.9% of the Gross National Income (GNI) per capita, while it is equivalent to 1.7% in Spain, 1.2% in France and 0.9% in Switzerland (International Telecommunication Union, 2021). They also evoke the lack of motivation, the interaction need with their teacher and classmates, the lack of organization, self-discipline, skill to manage time, and the need to devote more time and effort than face-to-face. Indeed, distance learning requires self-control skills what is lacking in Moroccan students who have never been empowered to be autonomous and to self-learn. To a lesser extent, some students have experienced depression and boredom triggered by the constraints of social distancing and limitation of transport. Among the barrier to remote learning some students have mentioned, the family income problems due to covid-19 and that home is not a favorable environment for studying.

Of course, teachers' engagement is decisive in students' involvement. There is a divergence in teachers' involvement regarding the delivery of online courses. 37.4% of surveyed students reported having benefited from more than 10 online courses, i.e. practically all the curricula courses. Only 4.4% of students did not report having any course remotely during the HEIs closure.

Furthermore, 78.7% of teachers have tried to involve students by asking them homework, presentations, etc. Likewise, they have ensured tutorials as usual. However, that were complicated to manage mainly for some disciplines that need experience and practice with instruments in laboratories. 70% of students concerned by tutorials have benefited.

63% of surveyed students reported having interacted with their teachers, unlike 19% of students. The rest of student have not really benefited from an interaction with their teachers. Indeed, the lack of interaction and commitment of students as well as teachers surveyed might limited significantly the learning operation. Thus, these actors could not project themselves in the learning operation to the point of considering virtual space as a real space. Therefore, the theory of the learning community (Rourke, Anderson, Garrison et al., 2001; Swan, 2019) is not applicable to the context studied, just as the connectivism theory. This latter advocates that interactivity and community engagement allow knowledge-generating interactions (Jung, 2001). Indeed, the learning did not come from the collective effort of the community, the teacher was to a larger extent the only producer and transmitter of knowledge. Students can only interact by the chat during videoconferencing, mainly in open access establishments characterized by massification, which was of course insufficient and far from being considered a real interaction. Consequently, 29.1% of surveyed students are not satisfied from the involvement of their teachers in the period of HEIs closure, while 27% are satisfied, and 43.9% are not really satisfied.

19.4.3 Assessment Remote Education Experience

The assessment of the remote education experience in time of covid-19 will be made from the perspective of the students and possibly supplemented by the teachers' point of view.

Roughly 40% of surveyed students are not satisfied and also not really satisfied, while only one student out of four is satisfied (Table 19.5).

HEIs Management Assessment

Table 19.6 shows that the majority of surveyed students (73%) found the management of the continuity of distance education by their institution unsatisfactory or not at all satisfactory. Only a quarter of surveyed students ranked it satisfactory to very satisfactory.

Indeed, Moroccan HEIs especially those with open access characterized by the massification did not set up any measure to help deprived students to get access to the connectivity in order to keep up their learning right remotely and keep in touch

Table 19.5 Students' satisfaction about the remote learning experience

	Frequency	%
Not satisfied	407	39,5
Satisfied	195	18,9
Not really	428	41,6
Total	1030	100,0

Source Survey Data

Table 19.6 Students' satisfaction with the management of their institution during the distance learning continuity period

	Frequency	%
Not at all satisfied	296	28.7
Unsatisfied	452	43.9
Satisfied	242	23.5
Very satisfied	40	3.9
Total	1030	100.0

Source Survey Data

with their teachers. They have felt left out. In some countries, among other Canada, Luxembourg and Mexico (OECD, 2020) mentoring services have been offered to students. In Morocco, some business schools and engineering schools have beard to the deprived students the internet connection costs (an internet package of 200 MAD (20 USD) per month) that have allowed them to pursue their study and exams remotely. Unfortunately, students from rural isolated areas did not benefit from this support because of the lack of internet network coverage and digital device. Consequently, they did not continue their learning remotely with their teachers.

At the start of the school year, a special exam session was scheduled for these students. In addition, for the sake of fairness, some HEIs have planned two tests for each subject, one covering the entire program and the other only the part carried out before HEIs closure. We can wonder about the relevance of this measure and to what extent it contributes to reinforce the learning deficit. Moreover, at the start of the school year, some HEIs have also created online learning platforms to guaranty free internet access to their students and that after signing an agreement with the National Telecommunications Regulatory Agency (ANRT).

However, we can note a lack of communication from HEIs regarding the e-learning platform (www.mun.ma) set up before COVID-19 (only 11.5% of surveyed students are informed) and the IMIST e-resources platform.

Teachers Engagement

Table 19.7 reports that student satisfaction with the experience of remote education depends largely on the student's appreciation of teacher involvement.

Thus, 57% of dissatisfied students are also dissatisfied with the involvement of their teachers, and 74% of those who are satisfied are also satisfied with the involvement of their teachers.

Table 19.7 Students satisfaction with the teacher involvement during the distance learning continuity period

		Satisfaction of your remote learning experience		
		No (%)	Yes (%)	Not really (%)
Satisfaction degree of teacher involvement	No	57	7	13
	Yes	11	74	21
	Not really	32	19	66
	Total	100	100	100

Source Survey Data

Table 19.8 Relationship between the use of the digital education tool and quality of learning and motivation according to the own experience of surveyed students during the remote learning

	Effect on	
	learning quality (%)	Motivation (%)
I do not know	4.4	4.2
No	26.6	35.1
Yes	24.8	27.1
Not really	44.3	33.6
Total	100.0	100.0

Source Survey Data

Feedback about the Use of Digital Educational Tools

According to the experience of distance learning, ¼ of our sample believes that the digital tool improves the quality of learning, and 27% think that its use has a positive effect on the student's motivation to learn (Table 19.8).

Surveyed students appreciate the digital education tool mainly for the ease of access to teaching, flexibility and more autonomy, the possibility of working in parallel or saving transportation money. This last reason is shared by 21% of students, and a priori by 22%.

Just over half of the students believe that distance learning provides lower performance compared to face-to-face teaching. For the 34.9% of the sample, comparison between the two teaching methods is not possible (Table 19.9).

Therefore, 43.3% of the students surveyed are for the integration of digital teaching tools in their courses, while 38% are against and 18.7% are undecided. However, 64.9% of surveyed teachers are convinced that digital education tools can contribute to the learning performance of students. Moreover, 85.6% are ready to use digital educational tools starting from the next academic year (2020–2021).

This position of the students can be understood regarding the pandemic context when actors were not prepared for a remote learning besides, the lack of interaction between learners and teachers, since the majority of courses were distributed in PDF, PPT or Word format.

Table 19.9 Face-to-face teaching and distance-learning comparison based on learning performance

	Frequency	%
Equal	84	8.2
Lower	525	51.0
Comparison is not possible	359	34.9
Superior	62	6.0
Total	1030	100.0

Source Survey Data

Table 19.10 Face-to-face teaching and distance-learning comparison based on a learning performance

	Frequency	%
Equal	84	8.2
Lower	525	51.0
Comparison is not possible	359	34.9
Superior	62	6.0
Total	1030	100.0

Source Survey Data

Future of Education 4.0 in Moroccan University

Just over half of the students believe that distance learning provides lower learning performance compared to face-to-face teaching. For the 34.9% of the sample, comparison between the two teaching methods is not possible (Table 19.10).

Despite the possibilities of interaction that can be ensured by videoconferences and chats, more than half of the sample (53%) considers that distance learning can in no way replace face-to-face teaching, while 19.1% of students think the opposite, and 27.9% are not quite convinced.

The students surveyed do not see distance learning as a solution to learning the mass (only one out of three students was “for”). Moreover, they do not consider it to be reserved for selected students (only one student out of five was “for”) or a substitute for face-to-face teaching (only 5.5% of the sample was “for”). However, 49.6% of surveyed students are favorable to face-to-face learning supplemented by remote learning, and 17.7% a remote learning supplemented by face-to-face learning while, only 27.8% prefer the face-to-face learning exclusively.

According to the teachers’ survey, 88.60% of them consider that distance learning can only be a complement to face-to-face teaching and cannot in any case replace face-to-face teaching. A minority that does not exceed 2.5% considers that distance learning can be an alternative to face-to-face education. And 85.6% of teachers are ready to use digital teaching tools at the next academic year (2020–2021). According to Sosin et al. (2004), hybrid education combining the two modes of teaching strengthens the involvement and learning performance of students. However, technological innovation taken alone is not the guarantee of student learning performance according to Talley (2005). It must be accompanied by educational innovation.

This dual technological and educational innovation requires according to Navarro (2000), the commitment of the faculty to carry out these time-consuming investments, compared to a traditional course, and a change in habits and routines.

In addition, the benefits of the digital learning mode should be qualified by taking into account several parameters, among others, teaching methods, student profiles and their previous courses (Hoskins and Van Hooff (2005)), Navarro (2000), Dutton et al. (2002), etc.).

The positive attitude of teachers towards the use of digital teaching tools, expressed before the confinement, is largely explained by the fact that 55% of teachers had benefited from training in these tools. Consequently, the prior knowledge of these teachers is responsible in large extent for their involvement in distance education.

19.5 Conclusion

It is true that the sudden shift to online teaching and learning were very challenging to occur for all educative stakeholders. Nevertheless, it was compulsory to ensure learning continuity when the lockdown became effective. This transition is well managed and has a low disruption impact first, if technical tools and accessibility are available for teachers and students as well. Second, if competences in distance pedagogies for teachers and distance learning for students are well mastered, because they have benefited from prior training or experience. However, remote learning is not very suitable for some fields that depends on practice either in laboratories or on instruments.

Surveyed students have pursued their learning remotely primarily by the mean of videoconferences. Despite, the efforts undertaken by the ministry in charge of education, the HEIs and teachers, only one student out of four are satisfied from the experience of remote learning. The unsatisfactory of 40% students is mainly due to the lack of support to get access to remote learning and the lack of interaction with teachers and classmates. It is true that the majority of teachers and students surveyed accept the idea of distance education, but not to the extent of replacing face-to-face teaching. They rather prefer blended learning and are convinced of the utility to use the digital educational tools.

Overall, the main educational stakeholders seem to be ready to implement education 4.0 revolution, at least in its digital part. It remains to accompany the digital shift with the educational reform based on skills learning approach and problem-based learning to simulate at best the work conditions and prepare workforce to the industry 4.0 needs. Indeed, this is what advocates the reform of Bachelor scheduled to come into force at the start of the academic year 2021–2022. To make this reform a successful one, policymakers should ensure training for teachers and the right of connectivity for all students to make this education inclusive. Henceforth, the trivialized use of distance education tools makes lifelong learning possible. Moreover, the ministry of education is ambitious to set up a digital university.

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Chapter 20
Technology-Enhanced Student-Centric Learning in Information and Multimedia Technologies in the New Normal Era

Wing Yan Jasman Pang and Yun Aileen Hou

Abstract Information and multimedia technologies (IMT) teaching requires theoretical and practical sessions. The practical sessions are essential for students to build an in-depth understanding of the principles and theories. Unlike some other areas where practical sessions require completely face-to-face teaching. Information and multimedia technologies area is unique such that practical sessions can be delivered in online mode via innovative approaches, thereby the overall purely face-to-face contents can be reduced. The purpose of this study proposes decomposed teaching strategy with virtualized practical sessions as the innovative approaches in the new normal era. The proposed strategy is composed of two phases: (1) decompose of the teaching content into theoretical sessions and software and hardware related practical sessions. (2) deliver the software and hardware related part via virtualization tools to maximize the understanding of the practical implementation. A pilot study of 31 IMT students for 14 weeks is conducted to find out the effectiveness of the proposed strategy.

Keywords Technology-enhanced learning · Student-centric learning · Innovative pedagogies · Information and multimedia technologies · COVID-19 · Vocational higher education

20.1 Introduction

Face-to-face learning has been disrupted in order to support students' well-being in the COVID-19 pandemic, maintaining traditional learning has become a core challenge for the entire education community. Due to the outbreak of COVID-19, Hong

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Kong government announced school suspension and institutions were unable to carry out their teaching activities in norm. At that time, most institutions adopt a remote teaching mode to continue the teaching and learning. In higher education, theoretical learning and practical learning are generally covered in their course outline. Particularly, learning in Information and Multimedia Technologies (IMT) has a high weight in practical learning, because the practical sessions in IMT are important for students to build an in-depth understanding of the principles and theories. So, teachers in IMT programmes face a challenge in the practical sessions on how to assure the teaching and learning quality in remote mode.

These unpredictable conditions suddenly caused further changes in various sectors, particular across educational community. Rahiem (2020) reported some studies that some universities selected hybrid learning model which is a combination of face-to-face learning and online learning as the fully implementation in the new norm. However, even with the integration of educational methods into an hybrid learning model, it is still very challenging to achieve the learning outcomes through learning activities that require intensive interaction between students, teachers and learning resources, e.g., peer project works, hardware and software applications etc.

In this article, we first describe the teaching and learning patterns before and during COVID-19 pandemic in order to elaborate on the problems of suspended face-to-face teaching and learning environments. We then introduce a hybrid teaching model, which can be a contingency plan to the changes in the recent teaching and learning due to the Pandemic. However, the implementation of the hybrid teaching model in IMT mode would encounter problems due to plenty of practical sessions. These practical sessions are usually delivered by tutorials, including software-involved or hardware-involved class works, group works, and quizzes. The problems emerged in the hybrid teaching practical sessions are discussed followed with a literature review. Then, a decomposed teaching strategy with virtualized practical sessions for IMT is proposed as an innovative pedagogy to solve the problems. The teaching strategy is student-centric and technology-enhanced. Finally, a pilot study is conducted to collect the student feedback on the proposed decomposition teaching method and the results of the pilot study is presented followed with the conclusion.

20.1.1 Problems

It is no doubt that teaching IMT is different from other disciplines because it employs various types of disciplines such as computing, communication, and multimedia in their course unit. Even remote learning or virtual learning model generally applies combined technologies and multimedia to formulate the teaching and learning materials. IMT area is such a unique discipline such that the teachers are skillful on those technology applications to deliver the knowledge effectively no matter in the theoretical and practical session. Shamir-Inbal and Blau (2021) illustrated, that effective virtual learning during emergency events is based on the relevant skills that teachers and students have developed during conventional learning. In this uncertain pandemic, teachers and students will bear their stress, fear, and anxiety emotions. (Cheng and Lam 2021). They are worried about the supportive difference between remote learning and normal learning mode and so on suffering from long-term disadvantages for them compared to those who studied normally. Thereby, some extra arrangements for learning mode will be necessary according to Daniel (2020). Providing practical training to students through a virtual learning model is possible but needs to have special arrangements. Therefore, we explore the innovative methods for further application in the recent circumstances. This pilot study aims to examine the proposed technology-enhanced learning as the innovative approach in the new era. The following two research questions guided the study:

1. To what extent the learning outcomes of IMT higher education is affected by remote teaching?
2. Are virtualization tools recommended to be used to improve the teaching and learning for the practical sessions in the new normal?

In vocational higher education, the teaching model in IMT is composed of lectures with theoretical learning and tutorial with practical learning with 14 weeks, practical learning lessons are accounted for more than half of the whole teaching mode. Theoretical learning offers students an in-depth understanding of a concept in various contexts, in contrast, practical learning provides students appropriate training with software or hardware. Large-scale, national efforts to utilise technology in support of remote learning, distance education, and online learning during the COVID-19 pandemic are emerging and evolving quickly (Ali, 2020).

During the COVID-19, some institutions use the hybrid teaching model, to allow students to have dual learning modes: face-to-face learning and virtual learning in both practical and theoretical sessions. Most IMT teachers have prepared as usual, and uploaded all learning materials online in advance for the theoretical session. At the class, teachers transmit the video streams digitally and record the live class that students can retake the lectures from anywhere at any time. They usually use Video Conferencing Platforms (VCP), such as Microsoft Teams, Zoom, Skype, as their virtual learning platform, with various education-oriented embedded functions, such as online assignment, quiz, chat room, recorder, and whiteboard. Teachers would use the VCPs in real-time lectures, i.e., theoretical sessions, as a regular teaching model for IMT students, where they can then interact with the teachers in real-time, like both parties can engage with each other at the same time and same space via the virtual communication. It seems to have a good arrangement for those students, by using traditional methods and by integrating technologies that combine a conventional synchronous and asynchronous learning mode, to enrich students in learning. In conventional practical sessions, teachers usually demonstrate the usage of the software or hardware and require the students to repeat or develop new functions. The practice sessions in IMT mainly aim at the development of students' technical competence on hardware, and training students' ability to use the professional software. IMT students are engaged in extensive group or individual learning project work where are supported by practice sessions.

Although switching to remote learning is a contingency plan under the pandemic, advantages of virtual learning has been reported in the literature in the past decades. For example, Latchman (1999) stated, "the powerful communication and information technologies have opened the way for enhancing traditional teaching and learning in both conventional and remote education by synchronous and asynchronous tools." The notion of asynchronous tools included recorded video/audio, appointed written materials posted online in advance to provide an access for students, to obtain those instructional materials at any time and any convenient location. There is not a tremendous change of theoretical learning in hybrid mode for joining a class in real-time from a remote location. In contrast, students in practical learning perhaps face difficulties for the hardware demonstration and software installation or even the problems on using both. Remote education also demonstrated its disadvantages including the extensive preparation for the delivery materials and reduced of interaction and access between the students, teachers and the resources, especially when the preparation period for the online mode is limited. Therefore, it is still an open question for vocational education, where practical skills is one of the major learning outcome, to what extent the students can achieve the learning outcomes through online teaching mode. In our pilot study conducted, some tools were used to enhance the accessibility of teaching personnel and teaching resources for the students in the online teaching and the results of the pilot study will be presented in the later part of this article.

20.2 Literature Review

Continuous schooling has rapidly become a major challenge in our education systems due to the COVID-19 pandemic has been continuously spreading across the world for nearly two years (Kong, 2020). Suspension of all face-to-face teaching in all schoolings was the only solution at the beginning. However, the Education Bureau in Hong Kong (The Government of the Hong Kong Special Administrative Region, 2020) has enacted diversified modes of teaching to facilitate students to keep continuous schooling on virtual platforms. Institutions have implemented these measures to inform, reassure and maintain the teaching and learning relationship with students, thereby this emergency arrangement has being delivered over the past year. In higher education, the teaching and learning process is equipped with theoretical learning and practical learning. Before the pandemic, teachers generally use Learning Management Systems, such as Moodle where teaching schedule, materials can be uploaded and online quizzes can be conducted, in IMT to implement an online learning community. Assignment, peer project work, and examinations as the assessment system measure the students whether achieve the program's learning outcomes. However, over the past two year's pandemic period, there has been a drastic development in the teaching and learning methodologies around the world. In the following, we summarize the selected literature in terms of:

- Remote teaching and learning,
- Virtual learning in practical session,
- and Curricula and assessment.

20.2.1 Remote Teaching and Learning

The remote teaching and learning contain two key elements, namely the learning environment and the satisfaction level with remote learning. Students' learning environment in COVID-19 are the most common to be discussed in the literature. The main change in learning environment is that the venue generally changed from schools to students' homes. Students have their own space to study, which is not much affected by the remote learning. In contrast, they would reduce the travelling time and get well-prepared for remote learning as providing the comfortable and convenient environment to them. The circumstance is similarly to Earthman (2002) demonstrated that complex or crowed places such as schools or classroom may create different problems, easily to distract students' learning behaviour thereby influence students' academic achievement. On the other hand, Daniel (2020) stated that the creating a digital classroom could provide more room to breathe for teachers and students. Zhang et al. (2002) pointed that the remote learning focuses on web-based teaching learning and instructional design in synchronous and asynchronous environments and raises a variety of new requirements related to technology operation, teaching skills and management. To enhance the quality of teaching and learning, teachers get much effort to develop the hybrid teaching mode for synchronous and asynchronous online learning model thereby the courses are decomposed into theoretical in remote learning sessions and virtual practical sessions. Shamir-Inbal and Blau (2021) stated that the model of the synchronous and asynchronous online learning mode from various scholars that can be an effective way to engage students to be active participants in the learning process.

20.2.2 Virtual Learning in Practical Session

Virtual learning, in general, can be categorized into "for content" or "for student-centered" (Stiles, 2007). It is not surprising to apply the categorization to the practical sessions. According to Dillenbourg, Schneider and Synteta (2002) defined that virtual learning does not refer to any educational web site, however, it is a better understanding of the functional relationship between how information is structured and represented and how it can be used in learning activities and interactions. On the other hand, the definition of "practice" that is the act or the process of doing something, performance or action, in a space. Teachers designed the virtual learning in practical session based on how the learned theories could apply in practical directly. Wrenn and Wrenn (2009) explained that teachers, as educators who are in professional or service-related fields, desire their students not only to learn theory and understand why theories are important but also to learn how to apply the theoretical frameworks in practice. Therefore, we do hope that the practical session could focus on the drill and practice environment even when students are learning from home. This can be achieved with aid from simulated or emulated platforms that provide an authentic environment to students. In IMT courses, it is preferred to provide virtual space, a virtual device or an emulator that allows students keep learning and practising in a simulated environment.

20.2.3 Curricula and Assessment

Does the institution change the entire curriculum as a contingency plan that suitable for using in remote learning during COVID-19. We do believe that the answer is "it doesn't". Factually, it is not easy to change or even tune some of curriculum contents to fit for remote learning, because any major changes need to go through the quality assurance procedures, which may take time. However, the teachers adjust their teaching plan and materials, which are the most core adjustments, to fit for remote teaching. Therefore, Daniel (2020) recommended for teachers are better to keep two objectives in their mind as the general advice, i.e., to aim at students-centered learning whatever in remote learning or conventional learning, and to aim at the assessments via varied assignments or end-of-year examinations run in the virtual platforms.

To summarise the literature review, many studies focus on aspects during the pandemic such as students' learning environment, teaching strategies, and remote teaching and learning, for both theoretical and practical sessions. The practical sessions are the most core teaching strategies in vocational education, particularly IMT programme. However, there is few study on teaching strategies on practical sessions, which is a gap for this pilot study as investigation.

20.3 Decomposed Teaching Strategy with Virtualized Practical Sessions

The Pandemic brings challenges in all aspects of education, such that online teaching, learning and assessments must be adopted. However, unlike some other disciplines where practical sessions are conducted in the face-to-face way, IMT learning does not require all learning to be conducted physically on site or face to face with the teacher. The nature of the IMT learning, where majority of contents are computer based, allows more room to use remote tools to teach and assess the students. Also, the skills developed by IMT teachers and students through conventional education enable the teacher to adopt more contemporary tools to virtualize the practical sessions, in a way that the obstacles brought by the online mode is minimized. Therefore, a decomposition of the teaching contents into categories that are theory-focused, software and hardware-involved becomes crucial to course adaptation for the online mode in IMT discipline. In the following, the decomposition is elaborated using IMT examples followed by proposed virtualization solutions for the example modules.

Students, teachers, resources and their interaction are the core aspect to consider when re-designing the teaching and learning for the new normal. According to the levels of physical interaction needed among students, teacher and resources, we propose to decompose the IMT teaching materials and assessments as follows:

- Theoretical sessions
- Software and hardware involved practical sessions

20.3.1 Theoretical Sessions

This is the session involving students and teachers only, without requiring any software or hardware resources. This category includes teaching sessions as well as theoretical assessment sessions. In the face-to-face mode, the teacher will deliver the lectures with interaction with students. Students interact with the teacher and with the other students through in person Q&A. Students are not required to use any external resources to achieve any learning objectives. In The Technological and Higher Education Institute of Hong Kong (THEi), this is called as "lecture" sessions where the theoretical concepts and principles are delivered by the teacher. The majority activities in a theoretical session can be implemented by online sessions using video conferencing technology. Among all the theoretical activities, one of the most challenging part of a theoretical session via live streaming is how to ensure student group discussion. Using MS Team. Toward this goal, the meeting host can create "channels" to allocate students into channels such that all the students in one channel can chat to each other while their conversions cannot be heard by other channels/groups.

20.3.2 Software and Hardware Involved Practical Sessions

This is the session where not only students and teacher are involved, but also software tools and hardware devices are needed to achieve certain learning objectives. In IMT, a majority number of the courses contain such practical sessions, including programming courses, networking courses, and multimedia courses. Following are examples for the practical session procedures in the conventional teaching.

In programming courses provided in our institute without online teaching, the laboratory sessions require students to follow the steps stated in the laboratory notes to write computer programmes. At the end of the session or when the student finishes the task, the tutor validates the student's programming running result and give a score to the student. **In networking courses**, network simulators are used to illustrate the routing and networking algorithms to the students. In laboratory sessions, IMT student are required to use the simulator to configure the visualized networks devices. At the end of the session, the tutor validates the student's configuration and simulation results to assess the students' performance. **In multimedia courses**, students are required to follow the steps in learning media production. The cinematography emulators are used to develop the production planning and configure the applied equipment types. At the end of the session or after they have finished the task, the tutor validates the student's works whether fulfilling the standard to assess their performance.

In the following, we take software practical sessions as an example to compare the differences between face-to-face and online teaching. We first decompose the teaching and learning of one session into the mini steps as shown in Table 20.1 to facilitate an analysis on their handling method in two modes. Disadvantages of the online teaching in each step are provided in the last column in Table 20.1. Then, we propose solutions to the disadvantage through virtualization platforms.

In Table 20.1, it is noticeable that more preparation, in step 1 and 2, is needed at the student side before the programming task can be started in an online session. The installation error may be due to non-academic-related issues concerning operation systems, computer environment as well as the computer performance. In order to solve this issue, our proposal is to use online environment as much as possible. For example, in information technology students in THEi, we switch to codingroom.com from traditional local machine java environment to teach the course "Data Structure and Algorithms". The students can use cloud platform to run their Java code without any installation. The unclear task and project files may be another issue where remote students miss the briefing part of the project, and he/she gets no peer students to ask immediately. In this case, the students may need to wait for the tutor to clarify about the preparation. To solve this problem, the tutor may open a common cloud project in online platforms, such as codingroom.com or Google Colab, and the students may work on the base project through shared links without manually creating any project. Take another example of multimedia and technology students in THEi, celtx.com is online pre-production tool which helps students have a practical experience to work as a group for the entire pre-production project. Students can directly share their project to obtain tutor's comments. In our one-year experience online teaching, the online virtual platforms solve most of the problems occurring in step 1 and 2. With such virtualization student performance degradation due to lack of interaction with teacher is expected to be minimised.

In the practical session execution stage in steps 3 and 4, the students face similar issues in the practical session that no matter they are having a physical session or online session, as these steps require individual activities most of the time. In the hardware-practical session, the students generally face the issue of borrow equipment on campus, as these steps require group activities most of the time thereby it may more or less influence their learning procedure. Therefore, the hardware-practical sessions are re-scheduled, to put them as multiple practical sessions aims to reduce the face-to-face learning mode. Meanwhile, adopting production emulators can be

Table 20.1 The online teaching in each step with pros and cons

	Face to face mode	Online mode	Disadvantages and observations for online mode
Step 1: Install the software	The tutor/school prepared. The students do not need to install the software	The students need to install the software. Errors may occur where the students may need tutors' help	Extra help from the tutor, e.g., shared screen, may be intensively needed
Step 2: Create project or load the project file	The students create and load the project from the lab materials Clarifications are occasionally needed from the teacher in the classroom	The students will create and load the project from the lab materials Clarifications are usually needed from the teacher through the online teaching meeting tools	More help is needed from teacher on declarations of the materials and setup of the project due to the fact that students may not always focus on the task briefing
Step 3: Practical for the tasks	The students work for the task such as write code or operate production tools	The students work for the task such as write code or operate production tools	Nil
Step 4: Deal with the errors	The student who encounters errors will raise hand and get tutor's help. The tutor will check the student's practical works	The student who encounters errors will either type in the chat box or raise hand and get tutor's help online. The tutor will respond to the chat box or check the student's practical work via shared screen	Students cannot get face-to-face help from the tutor. Student are more willing to ask questions
Step 5: Validate the result	The tutor goes to the student and validate its works	The student uses screen capture or shared screen or weekly self-evaluation report to show the teacher	It is harder to know if the work is actually accomplished by the student. Auto-testing is possible through online platforms

anywhere in a simultaneous and distributed way. Thus students are required to have individual activities rather than group works. Some students surprisingly may not affect by using production emulator, in contrast to enhance their media production knowledge of working with it. In our experience, we found that in an online session, the number of questions students raised is actually more than those seen in a physical session because some shy students are more active in the virtual environment. This is because students are willing to use the handy chat box to leave or voice out a message to a teacher more than ask the teacher in person.

For the validation stage step 5, the online mode has an advantage such that the student can send their screen captures or share the link to the teacher to get validation in a quicker manner because they can send their results simultaneously. In the information and technology course, some well-designed online coding platform supports auto verification of a project, where the students can verify their code by pre-configured test cases designed by the teacher. However, it is harder for the teacher to know if the student does the work in an honest manner. Unlikely in the classroom, the tutor may supervise the students on-site so the tutor gets clearer idea about whether a student is doing his/her own work. However, an online coding platform, such as codingroom.com, can record the students' coding steps and replay for the tutor at the validation stage may help the tutor in this stage. In multimedia and technology course, teachers have the same problems of the honest manner that cannot verify their works whether are done by themselves. However, the weekly self-evaluation report can help the tutor to validate their work.

20.4 Pilot Study Results

20.4.1 Data Collection

A total of 31 IMT students from vocational higher education were invited to complete the online questionnaire survey in this pilot study. The questionnaires are covered two main sections, i.e., the hybrid learning mode and the virtualization of the tutorial. A questionnaire survey was administered using an online survey tool—Google Forms as the data collection tool and shares out a link to all participants. And the self-report methodology was conducted for the analysis and discussion after data collection. Participants are from two groups, there are 21 students from information and computer technology, and 10 students from multimedia and innovation technology. The pilot study was implemented in 3 h per lesson, in a total of 14 weeks, with theoretical and practical sessions during covid-19 using the proposed decomposed teaching strategy with virtualization tools. After that, participants conducted the online surveys in the end of the semester.

20.5 Discussion

20.5.1 Findings Towards the Research Questions

RQ1: To what extent the learning outcomes of IMT for vocational higher education is affected by remote teaching?

Participants were asked questions about the influence of remote teaching mode, support from the tutor in hybrid learning mode, and virtual learning environment for practical sessions. The data report referred to the satisfaction level for student learning in remote mode and improvement in teaching and learning by virtual tools was analysed. The data indicated that less than 50% of students reported they are not any affected by remote learning. However, the report revealed 64.5% of students think that the lectures on theoretical knowledge and principles by the remote teaching mode are enhanced compared with conventional learning. This is attributed to the asynchronous learning manner such that the lecture videos can be re-visited at any time anywhere.

Comparing the theoretical, practical and assessment sessions, students feedback that theoretical sessions are the least affected by the online mode as shown in Fig. 20.1. Only 1 student thinks it strongly degraded by the online teaching, while 2 students think the theoretical sessions are strongly improved. The software and hardware sessions are not affected too much as expected in the analysis, as it is noted that their impact level distribution are similar to theoretical sessions, i.e., 40% degraded vs 30% improved. It shows that the proposed virtualization helps in alleviating the negative impact brought by the online teaching in practical session for IMT.

In all programming courses, most students reported satisfaction for the support provided by the tutor in hybrid learning mode. Students pointed out that they only need to have occasional support no matter in face-to-face learning and online learning. In addition, among five types of supports provided by the tutor in programming tutorials or assignments, namely (1) clarification of questions; (2) installation errors; (3) compilation errors; (4) running errors, and (5) validation of the program, the last two types—running error and validation of the program are the most frequently asked for help in programming tutorial. In this pilot study, teachers used online

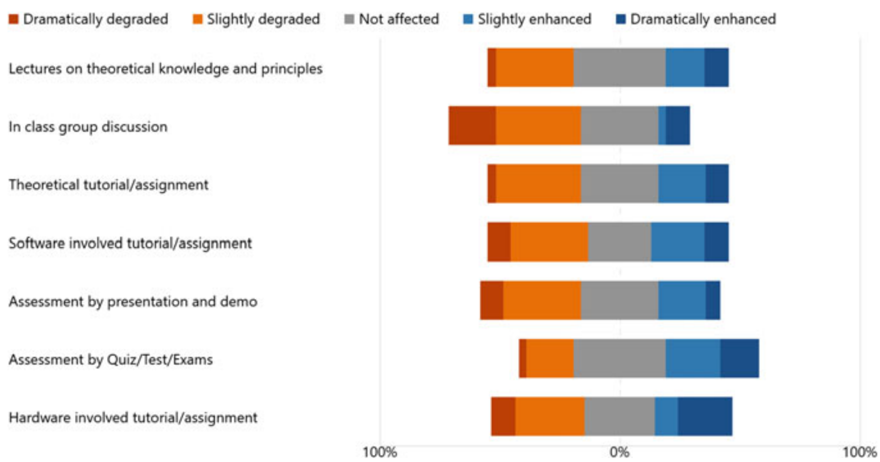


Fig. 20.1 Question: Which of the following types of contents are affected by the online teaching mode?

virtualization platform to mimic a real coding environment, i.e., codingroom.com, as the virtual learning platform in practical sessions.

As shown in Fig. 20.2, more than 50% of students agreed the platform improves the learning efficiency and effectiveness when the face-to-face class is cancelled in all five aspects, especially it is easy to start programming online without downloading any material where in total 66% of students vote for improvement. This figure verifies the analysis that was mentioned in previous section.

On the other hand, as shown in Fig. 20.3 with the network simulators and multimedia emulators adopted in the virtual tutorial, 80% of students reported that they both can be practised anytime, and it is useful for revision. Furthermore, using the simulator and emulators at anytime anywhere enable the students to keep their learning interest and habit, which is always one of biggest challenges faced by the students in the conventional study.

RQ2: Are virtual tools recommended to be used to improve the teaching and learning in the new normal?

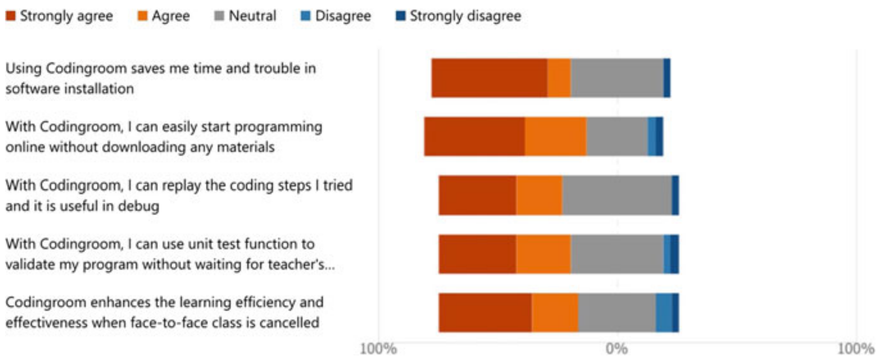


Fig. 20.2 Question: With codingroom.com, do you agree with the following items?

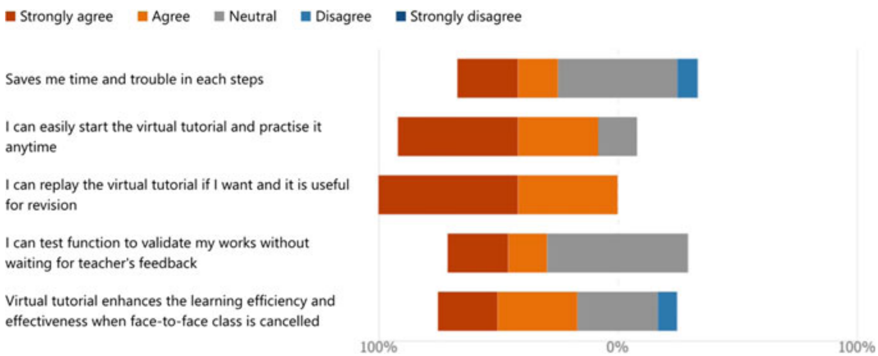
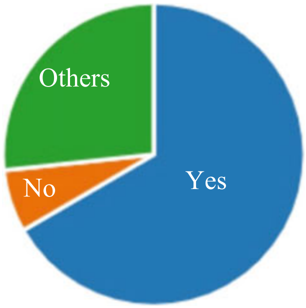


Fig. 20.3 Question: with virtual tutorial do you agree with the following items?

Fig. 20.4 Question: Will you recommend the institute to keep a virtual tutorial in future practical lessons, even face-to-face is resumed?



In order to provide a well-prepared remote tutorial, teachers sought some simulators and emulators for students, to develop an authentic environment as the virtual tutorial for instance, "codingroom.com" and "Google Colab" were applied in programming class, and "celtx.com" and cinematography emulators were applied in multimedia class. The online survey revealed 90% students are willing continuously to use these virtual tools in the future even when the face-to-face learning mode is resumed. Students responded the survey that once teachers demonstrated the virtual tools in the remote learning platform, they do not need to ask for supporting in the virtual tutorial as often as they did in conventional study. As mentioned previously, students can replay those devices for their revision, to achieve the learning outcomes.

In question "Will you recommend the institute to keep a virtual tutorial in future practical lessons, even face-to-face is resumed?", students show appreciation of the use of virtualization tools as demonstrated in Fig. 20.4. It is important to notice that the contingency measures taken in the pandemic are actually beneficial to student's learning in the non-pandemic cases.

20.6 Conclusion

This study proposes technology-enhanced learning as a innovative approach in the new normal era. The study was conducted as a pilot study for the exploration of benefits of hybrid learning and challenges of utilizing the effectiveness technology in remote learning for theoretical sessions, and using simulators or emulators for virtual tools in practical session during the COVID-19. The survey results show that proposed decomposed teaching strategy with virtualized practical sessions as an innovative approach is successful to adopt technology-enhanced learning to reach student-centered learning. The self-report methodology is the main limitation of this pilot study thereby an analysis of the online activities is necessary to be conduct in the future research. It is important to notice that the contingency measures, such as decomposed teaching strategy and virtualization of the practical session, are actually beneficial to student's learning in the non-pandemic cases.

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Chapter 21
Enhancements of Vocational Students' Engagement of Workplace Learning in the Industry-University Collaboration Learning Environment: A Case Study in the Greater Bay Area

Yanmin Zhao and James Ko

Abstract A close collaboration between vocational institutions and industrial workplaces becomes imperative to ensure students' opportunities to collaborate with other people and get familiar with the workplace environments. This case study of a higher vocational institution in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) investigated vocational students' engagement in work-based learning from an industry-university collaboration perspective in enhancing students' professional skills in dynamic situational work contexts. Ten internship reports and four in-depth interviews on vocational graduates were analysed to reveal students' participation in work-based learning in an industry-university collaboration. The findings suggested that applying the collaborative model to the vocational institutions can reveal students' learning in tandem with work-based teaching pedagogies. First, industrial enterprises' involvement ensures students' early acquisition of occupational skills to adapt to new industry fields. Second, vocational education with strong industry orientation can adopt new teaching and learning methods to orient students to real-work environments.

Keywords Student engagement · Industry-university collaboration · Workplace learning · Learning environment · Application-oriented education

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21.1 Introduction

Globalisation has rapidly imposed changing demands in the labour market that only job-ready graduates with advanced skill sets in the workplace can survive. The changing character of students' learning and the acknowledgement of work-based learning has been growing in recent decades (Fuller & Unwin, 2011; Illeris, 2003). The application-oriented teaching and learning, internship, work-oriented learning, and apprenticeship have attracted people's attention in vocational institutions. Furthermore, the close collaboration between vocational institutions and industrial workplaces provides students practical opportunities to participate in different learning communities (Guile & Griffiths, 2001). Furthermore, to facilitate vocational students' learning, researchers have demonstrated that collaboration among students, workplaces, and vocational institutions influences pedagogical practices of guiding workplace learning (Guile & Griffiths, 2001; Mikkonen et al., 2017).

Shi (2013) indicates that Chinese higher vocational education faces several issues and challenges, such as difficulties in combining students' study with workplace training and difficulties in a long commitment to collaboration between enterprises and vocational institutions. However, there has been a noticeable change from the traditional style of vocational teaching and training. In tandem with the demand for enhanced future workplaces, research should focus on application-oriented degree education, which encourages career-oriented and practical work-integrated learning (Hong & Ma, 2020). Concerning the development of higher vocational education in promoting industry-university partnership in mainland China, the demand of labour market force and skilled personnel are pushing changes in teaching and learning from all perspectives, particularly in students' work-based learning and occupational competence development (Pan et al., 2016; Shi, 2013).

Workplace or work-based learning and practical skills training are the main forms of cooperation in the current situation of industry-institution collaboration. An empirical study conducted by (Guan et al., 2016) found that government support on industry-university collaboration sped up cooperation, which vocational organisation leaders and teachers gave sufficient attention to the innovation and knowledge transfers on the perspective of engaging students' workplace learning. In particular, cities in Guangdong province are leading the new establishment of an industry-university collaboration model to improve the connections between work-integrated teaching and the local industry at the provincial level (Liu, 2016). Therefore, this chapter focuses on analysing how industry-university collaboration enhances students' workplace learning engagement in application-oriented universities and develops professional skills with industrial enterprises' involvement.

21.2 Theoretical Backgrounds

21.2.1 Industry-University Collaboration Perspectives

University and industry are two important sectors that play an essential role in social development and progress. Although the collaboration between university and industry can be traced back to a century ago, redefining the university's role in collaborating with industry has been intensified in the twenty-first century (Zha et al., 2016). Chinese vocational schools have a long history of full-time academic training, preventing students from practical workplace training (Shi, 2013). Combining with practical work experience has been changing the traditional patterns of classroom-based vocational education. Industry-university collaboration as a part of cooperative education aims to provide students with experiential learning advantages and help them get familiar with the transition from school to work (Shi, 2013; Zha et al., 2016).

The practice for industry-university collaboration has a substantive impact on the connection of the university research to the enterprise and the cross-boundary knowledge transfer between the university research team and the enterprise management personnel (Po et al., 2016). Integrating the industry and university is also a powerful way to put forward the co-construction of knowledge in work-integrated learning (Hattinger & Eriksson, 2018). Rybnicek and Königsgruber (2019) systematically analysed the interrelationship of determinants on the collaboration between industry and universities. They identified that institutional factors such as resources that a partner can offer and the structure of organisations impact the implementation of such a partnership. Therefore, collaborations between industry and university linked the regional innovation network and resources to more diversified connections with local enterprises (Lyu et al., 2019). Furthermore, the collaboration between the university and the private sector highlighted the critical features of workplace learning and workplace development expertise concerning the needs of developing and retaining a professional workforce (Slotte & Tynjälä, 2003; Tynjälä, 2008).

On the nature of collaboration, the degree of enterprise involvement to invest in skill improvements and the degree of government in encouraging vocational training are two main dimensions to enhance application-oriented teaching and learning (Po et al., 2016). The model of industry-university-government relations (Etzkowitz & Leydesdorff, 2000) indicates that the collaboration between universities and enterprises is under the supervision of the government. The university also closely connects with the industrial world, while governmental support provides enterprises incentives and encourages vocational institutions. Khorsheed and Al-Fawzan (2014) proposed that an industry-university collaboration model functions as a platform for private industries such as small- and medium-sized companies and research universities to lower barriers for educating a capable workforce in technology innovation. Cai and Liu (2015) have observed that Chinese higher vocational institutions are approaching a collaboration on vocational education where students from a partner university can work for the company. Based on the collaboration experiences in Guangdong province of the Greater Bay Area, the practice has proven that effective interactions among enterprises, universities and government institutes promote the transformation of cooperation mechanisms and have an impact on innovation of pedagogical practice and vocation-oriented learning (Liu, 2016; Lyu et al., 2019; Zha et al., 2016).

21.2.2 Workplace Learning and Community of Practice

Workplace learning plays an essential role in vocational training or application-oriented teaching and learning in leading pedagogical changes and promoting students' community of practice in the workplace and their learning within educational institutions (Siebert et al., 2009; Zhao & Ko, 2018). The topic of workplace learning lies in the well-documented findings in the literature in which most researchers indicate that workplace learning contributes both to the improvement of vocational programs and the changing structure of application-oriented institutions (Aarkrog, 2005; Velde & Cooper, 2000). Workplace learning, in particular, allows students to develop their professional skills in the working environment and helps prepare skilled workers, thereby further improving the efficacy of vocational schools (Pineda-Herrero et al., 2015). Therefore, workplace learning is the key term that includes formal training activities and informal learning activities that involve interactions between individuals and their working environments.

In distingusihing workplace and school-based education, Illeris (2003) argued that learning for competence development in workplaces is very different from learning at schools and educational institutions. Fundamentally, workplace learning occurs in dynamic relation to the learning environment and learners' learning potentials (Illeris, 2003, 2011). Billett (2004) proposes that workplace learning is a form of participatory practice, where community settings or educational institutions function like workplaces, in which learning is generative of social practice when individual students engage in thinking and acting. Fuller and Unwin (2011) argue that learning environments concerning the participatory dimensions offer communities of practice at the workplace and pursue expansive learning environments for personal and organisational development. Thus, workplace learning engagement is a central concern for a workplace pedagogy for doing work-related participation practices.

Lave and Wenger (1991) theory of communities of practice and the career concept in the community of practice (Wenger, 2010) has often been used to analyse vocational students' workplace engagement. For example, their theory was employed as an analytical tool to illustrate workplace learning through peripheral participation as communities of practice in a vocation-oriented learning program (Aarkrog, 2005). Similarly, Siebert et al. (2009) also declared Lave and Wenger's theoretical model as essential for learning by participation and learning as doing. More specifically, they focused on students' experience of workplace learning from the communities of practice at work and their perceptions of work-based learning from individualised perspectives. Workplace learning provides links between individuals and their environments, referring to the learners' involvement in activities in correspondence with real learning environments (Illeris, 2004; Tynjälä, 2008, 2013). By investigating students' perspectives of workplace learning and the teacher's perspective of guiding students' vocational learning, the changing style of teaching and learning would greatly improve students' professional skills development through workplace learning and a combination between school-based and school-based work-based learning environments.

Learning at work is an important issue for vocation-oriented students, and vocational institutions and enterprises are actively encouraging re-engaging in learning in their workplaces in order to achieve competitive employees. Research shows that workplace guidance on vocational students strongly relates to their prospects of developing expertise in future training workplaces (Mikkonen et al., 2017; Zhao & Ko, 2020). As mentioned, research on industry-university collaboration in Chinese higher vocational education has been increasing in recent years. However, such studies mainly focused on collaborative models, implications on economic improvement, cooperative mechanisms, and other aspects. Few studies emphasise this collaboration that transforms vocational students' learning and enhances their workplace learning experiences. In addition, the change of collaborative teaching and learning environments is another aspect to explore vocational teachers' practices about vocational students' learning.

21.3 Methods

A small case study was conducted to explore students' work-based learning engagement, in particular, to understand their intentions, knowledge, and actions related to the industry-institution collaboration. Case studies are methodological approaches employed in many social science fields, which are relevant to vocational education research that researchers attempt to perceive participants' actual job requirements in its organisational environment (Fischer et al., 2014). However, a case study is more concerned with participants' living work experiences and covers most investigations of real-world settings and several data collection methods such as document analysis, observations, interviews, and surveys (Creswell, 2013; Merriam, 2009; Yin, 2015). Therefore, a case study approach offers specific advantages to surface deep issues about enhancing students' work-based learning and the engagement of work-integrated learning under the collaboration between the industry and universities.

21.3.1 Context and Participants

In the context of the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), the foreign trade industry has huge employment needs, private application-oriented universities or colleges are meeting the current demands for foreign trade companies in Guangdong province. Participants are from one application-oriented university located in Dongguan city, the core area of the GBA and the Pearl River Delta economic zone. The main features of the economic structure in this area are the processing and manufacturing industry and the small and medium-sized enterprises with flexible management and employment systems and various products and services. Local universities play an essential role in training professionals to carry out international trade, daily corporation management, and the emerging cross-border e-commerce business. The "3+1" model (students spend three years for specialised courses on campus and a one-year internship in the enterprise with a collaboration partnership with the university) was implemented to build a better bond between local universities and the industry in the GBA area. The training model for students majoring in Business English and International Trade (BEIT) focuses on cultivating students' English application skills for the export-oriented enterprises, which matches the characteristics of local economic development in collaboration with enterprises and education.

Ten students who completed a one-year internship training and four graduates working in the local enterprises participated in the study. All participants are from the BEIT subject with a four-year program, and students in the fourth year of study are required to do internship in the local collaborating business companies. During the second term of the third year, students are assigned to the company in line with their specialities, and they need to write an internship training report in fulfilling the training requirements. The selected student participants gave consent for all of their written internship training reports to be used as data, and four previous graduates who already worked in different companies for more than one year agreed to participate in the semi-structured interviews. The collected work-based training reports combined with the interview data from previous graduates were analysed to explore the improvement of students' vocation-oriented and work-integrated learning in the context of industry-university collaboration.

21.3.2 Data Analysis

Thematic analysis was adopted in the study as a method for identifying patterns of key findings. According to Dawson (2007), the thematic analysis starts with data collection and continues simultaneously in the analytic process. Braun and Clarke (2006) define that "thematic analysis is a method for identifying, analysing and reporting patterns (themes) with data" (p.6), which serves as a guide to identifying some key themes that emerged from interviews and the written reports. "Themes in qualitative research (also called categories) are broad units of information that consist of several codes aggregated to form a common idea" (Creswell, 2013, p.194). Analysis of workplace learning report materials and interview transcripts were intended to discover how industry-institution collaboration enhances vocational students' learning and deepens students' learning in the workplace. Therefore, we highlighted four critical themes summarised from a series of common codes based on internship training materials and interview transcripts: industry-university collaboration reframed students' workplace learning, the involvement of students' work-based learning, the "dual tutor" system, and the "prospective employee" plan.

21.4 Findings and Discussion

21.4.1 Industry-University Collaboration Reframed Students' Workplace Learning

The scheme of industry-university collaboration among application-oriented colleges and universities encouraged students' workplace learning and improved their professional skills through internship activities. Both local application-oriented universities and enterprises jointly design the curriculum to meet the actual needs of students in improving their off-class practice in the workplace learning environment and to develop an enterprise-based training platform for facilitating students' occupational skills in the industry. For example, relying on the collaborated platforms, the characteristics of co-cultivating cross-border e-commerce professionals have become a highlight of the subject of BEIT in local application-oriented universities. In addition, the link between vocational teaching and the prospective employees for local enterprises has enabled the involvement of the work-based learning environment.

Students' workplace learning was reframed through industry-university collaboration influenced by the changing environment of engaging the vocational institutions. Vocational student participants engaged in their workplace learning in their study of the final year, and they came to understand their internship at the workplace as a part of professional learning. Through ongoing cycles of learning and training at the workplaces, student participants identified the importance of workplace learning experiences, which provided an opportunity for students to improve their employability skills. For example, one student participant indicated:

> When I was looking back on my internship experiences, I needed to learn practical skills for the future job, and I regarded it as the transition period before I started my career. However, it also gave me a chance to know it is like in professional work and how the bank operates and the daily business of working in the bank because my field is finance (Dave).

He recognised that learning at companies makes him understand the different learning styles. He spoke about workplace learning extending beyond not only the classroom but beyond the school through collaborative learning of practical knowledge, and he realised that learning in real situations enhance his professional expertise as he told me in an interview:

> What I have learned in college gave me a chance to apply it in the practical workplace, and I think the knowledge learned in college is quite different from what I have learned in the internship. In internship learning, it is like learning through doing, but in college, I just

> absorb the theoretical knowledge without thinking about how to apply it to real working situations (Eric).

These findings speak to a fundamental reframing of learning at the workplace, demonstrating the benefits that the enterprises offered to vocational students. However, technical knowledge requires new forms of learning, and continuously changing the environment of the industrial field needs the integration of theory and practice within the collaboration of industry and university (Liu, 2016; Shi, 2013).

21.4.2 The Involvement of Students' Work-Based Learning

Students can directly obtain the most cutting-edge industry knowledge and master the skills needed in the actual work and obtain salaries not lower than similar interns, which can be described as multi-tasking. The second important theme was that industry-university collaboration showed students' workplace learning in implementing and sustaining change. Industry-university collaboration implemented in vocational institutions encourages students' continuous workplace learning that requires students to complete the internship in their final year of study as one student participant implies that:

> I got two chances for the internship, one was in my third year study in the winter vacation for one month, and another was the last term of the fourth year, and the internship in the fourth year was the compulsory one with two months because I need write a report about the internship experience (Lisa).

The cross-border e-commerce training report suggests that work-based activities encourage students' mutual engagement in learning activities through the enterprise-collaborating training platform. In addition, the collaborative work-based learning environments engage students in group-based activities. These are consistent with the view that a flexible classroom setting in the vocational learning environment promotes stimulating work-related learning and allows teachers to adjust pre-designed class activities to suit students' learning requirements (Dillenbourg, 2013; Zhao & Ko, 2020).

The data also showed that vocational students have the flexibilities to choose the internship enterprises, and they do not have to stick to the companies that partner with their university. A student participant who found his workplace mentioned that:

> The college did not assign my internship; in fact, there are two kinds of the internship. If students cannot find one, the college would help them assign one with a collaborative relationship with the college. If I can find a place to have my internship in line with my speciality, it is ok to do it (Lucy).

As Kuijpers et al. (2011) stated, the flexible work-based learning environment fosters the development of students' career competencies, and students' vocational skills are emphasised in their personalised learning environment through collaborating with other students in the workplace (Valtonen et al., 2012).

21.4.3 The "Dual Tutor" System and the "Prospective Employee" Plan

Implementing the "dual tutor" system and the "prospective employee" plan in the cross-border e-commerce innovation class encouraged students' work-based learning. The enterprises coordinated the operation and management process with the teaching process. As a result, higher vocational education teachers have experienced a remarkable transformation of guiding students and transitioning from school-based teaching to integrating theory and practice. Therefore, vocational teachers learnt to have a stronger innovative mindset to update their practical knowledge structure (Deed et al., 2019; Guan et al., 2016) while visiting their students in different companies. In addition, vocational teachers can obtain a realistic understanding of the trends of talent training and the demands of local industries and enterprises through industry-university collaboration.

The data also supported the idea that the guidance provided by workplace tutors had a positive association with the vocational students' professional skills development, which helped students develop their ideas and improve work performance. Vocational teachers adjust their collaborative teaching based on materials or training platforms in specialised vocational subjects and give students flexible time to complete their training reports and classroom activities (Zhao & Ko, 2018). It was evident that collaborative teaching was characterised by the flexible nature of the learning environment and teaching and learning in work-based settings (Deed et al., 2019; Zhao et al., 2013). The literature has shown that interacting with senior workers while learning at work can contribute to students' overall feelings of teamwork development, which implies that research should consider the viewpoints of workplace instructors regarding vocational students' skill development (Metso & Kianto, 2014).

21.5 Conclusion and Implications

This study may be limited to one higher vocational institution to identify students' learning engagement and their understanding of learning at the workplace in Guangdong province of GBA. The practice of industry-university collaboration is constantly exploring new channels of integrating students' work-based training and technological innovation. Although the collaboration between industry and university may not result in a complete change in schooling, what is clear is that it can affect students' professional expertise that sustains change of workplace learning in profound ways. Findings imply that the improvement of students' workplace learning should be grounded in the close cooperation of industries and universities. Other studies have demonstrated that successful collaboration can improve the development of on-job and work-related training and applied learning through integrating the real-work environments (Kairisto-Mertanen & Keinänen, 2020; Leach & Zepke, 2005).

By exploring students' perspectives of workplace learning, the findings have great implications for improving students' professional skills development through workplace learning and collaboration between school-based and work-based learning environments. The study also provides practical foundations for designing effective workplace learning programs and integrating classroom and industrial settings. Other studies suggest that vocational students may benefit from work-based learning in students' skill development and learning efficacy (Aarkrog, 2005; Siebert et al., 2009). In connection with application-oriented education with solid industry orientation, the key findings highlight the involvement of students' workplace learning in collaboration with enterprises.

The study has practical implications for workplace learning that vocation-oriented universities should consider how to cooperate closely with companies and how to tailor students' needs for training in the workplace. Teachers and company managers should carefully carry out the curriculum-based workplace learning plan to better prepare students' potential for the labour force. For example, a careful matching curriculum with workplace learning setting and school is helpful to improve students' learning in practice (Aarkrog, 2005). Regarding the implications for further research in the workplace, building industry partnerships to link the work-based environment with the classroom help support students' expertise in applied learning.

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Chapter 22
Engaging Students Through Technology-Enhanced Interactive Activities Outside the Classroom

Pauli P. Y. Lai

Abstract Technological advancement has enabled the migration of the education arena to an online mode as the 'new normal' ever since COVID-19 swept the world over. To engage students outside the classroom, we devised different technology-enhanced interactive activities in a database subject. Supplementing the online classes, flipped classrooms were arranged so that students could have more in-depth reviews. While live presentations became impossible during the pandemic time, video assignments were used as a replacement. Students were asked to submit the initial version, which their peers would view and comment on. After receiving the peers' constructive feedback, students submitted a revised version by incorporating their peers' comments. Furthermore, an online SQL Challenge Game was established where students could challenge their peers by answering SQL questions. With the adoption of these activities, students were engaged out of class. The results showed that their communication skills and academic performance were enhanced.

Keywords Game-based learning · SQL · Peer learning · Flipped classroom · Video assignment · Out-of-class interactive activities

22.1 Introduction

The COVID-19 pandemic has resulted in social distancing and hence online classes in the education arena. It posed challenges to the educational arena for both teachers and students. In fact, over the past 30 years, university education and traditional lectures, in particular, have been strongly criticised. The main criticism has cast light on the following: students are passive in traditional lectures due to the lack of mechanisms that ensure intellectual engagement with the material, student's attention wanes quickly, the pace of the lectures is not adapted to all learners needs, and traditional lectures are not suited for teaching higher-order skills such as application

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and analysis (Cashin (1985); Bonwell (1996) & Young et al. (2009); cited by Nouri (2016)).

Meanwhile, with the pandemic starting in 2020, face-to-face teaching was switched to the online mode. Online learning increased the learners' ability to learn with convenience; however, the physical separation from their peers and instructors that online learning involved might result in a lack of communication and interaction, and a weaker sense of belonging to a classroom community (Chaiprasurt & Esichaikul, 2013). Thus, students' engagement became an issue because student engagement was critical to student learning, particularly in the online environment, where students could often feel isolated and disconnected (Dixson, 2015).

Research in the past indicates that the communicative events considered important for engineers are: teleconferencing, networking for contacts and advice, and presenting new ideas and alternative strategies. Fluency in the English language is seen as an opportunity in the engineering field to advance towards becoming a global engineer. The pedagogical implications of the findings indicate that module design and development should consider incorporating workplace scenarios as the basis for activities. (Kassim & Ali, 2010). As engineering educators charged with the mission of carrying the torch of education to the next generation, we do not just pass on knowledge. We also care about the presentation skills of students in English.

While a wide range of proposed solutions attempts to address the apparent deficiencies in current educational models, a growing body of literature consistently points to the need to rethink the traditional in-class, lecture-based course model. One such proposal is the flipped classroom, in which content is offloaded for students to learn on their own while class time is dedicated to engaging students in student-centred learning activities, such as problem-based learning and inquiry-oriented strategies (McLaughlin et al., 2014).

In our case, when the pandemic hits, our students were given pre-recorded short video lectures on a subject called 'Database Systems', which they could view anytime they liked. Then, during the online class hours, they would be asked questions regarding the included topics for in-depth discussions. The flipped classroom was well-received, as it allowed for flexibilities in the study time, and the students could learn at their own pace.

To help students learn SQL, an online game-based learning platform called SQL Challenge Game was established as part of the subject 'Database Systems'. In this case, SQL Challenge Game introduced an approach that used games' elements and dynamics to inspire students to learn with more effort. Thus, understanding whether gamification can effectively engage students and improve their academic learning outcomes is a relevant and pragmatic issue (Hamari, Koivisto, & Sarsa, 2014).

In view of the importance of English, one of the subject learning outcomes is that students would communicate effectively. To achieve this learning outcome, we introduced a video assignment to this database subject as a new assessment item that allowed students to practise both verbal and written communication skills. First, students were asked to choose a database-related topic and conduct research on their own to practise their self-learning skills. With the help of professional English teachers, guidance was given to each student, who then had to record a short video of fewer than 5 min for their presentation on the chosen topic and upload it to a video platform. The initial uploaded video would be viewed and commented on by their peers in addition to the teacher's assessment. Following the peers' feedback, students submitted their revised version by incorporating their peers' comments into their video presentations. Finally, the teacher compared the revised version against the initial version to determine whether improvements were made. The whole assignment enabled students to practise their self-learning skills by conducting research and watching peers' videos, verbal communication skills through recording presentation, and written communication skills through providing feedback. In general, improvement in presentations was noted for over 70% of the students.

We have referred to previous research on flipped classrooms with the integration of game-based learning platforms. We have also considered research on video assignments. However, we have not yet found literature on any attempt to integrate all three in one course. In our case, students played the SQL Challenge Game and watched the flipped videos outside of their online classes. Hence, it was of interest for us to dwell on how it worked out for our students. It turned out that these three features had positive correlations with the total academic performance, with the magnitude ranging from moderate to strong correlations. Further, most students liked this learning mode using SQL Challenge Game, Video Assignment, and Flipped Classroom.

22.2 Literature Review

22.2.1 Attention Decline in Classes

A growing body of literature consistently points to the need to rethink what is taking place in the classroom. Research has shown that students' attention declines substantially and steadily after the first 10 min of class (Hartley & Cameron, 1967; MacManaway, 1970).

22.2.2 Flipped Classroom as a Way to Motivate Students

The flipped classroom, an innovative model with extensive use of technology for education, is a prevalent teaching model in the United States (Railean, Walker, Elçi, & Jackson, 2015). In recent years, the flipped classroom has become prevalent in many educational settings. The flipped classroom adopts a pedagogical model in which short video lectures are viewed by students at home before class so that the teacher can lead students to participate in activities, problem-solving, and discussions (Shyr & Chen, 2018). Some empirical research has been conducted to show the effectiveness of the flipped classroom. For instance, pharmacy students' experiences with flipped classroom courses were analysed in a study. It was reported that students prefer to go through the learning content before class and use the class time for applied learning (McLaughlin et al., 2013, 2014). Students who learned through a flipped-classroom approach considered themselves more engaged than students who attended traditional classes (Nouri, 2016). Following the onset of the pandemic, opinions have been strengthened in favour of the flipped classroom methodology, which has been shown to be a powerful methodological alternative compatible with online teaching. Therefore, educational authorities must strengthen the technological tools as well as the teacher skills needed to develop capacities related to the rapid response to the current and future teaching challenges (Izagirre-Olaizola & Morandeira-Arca, 2020).

22.2.3 Motivation to Study Outside Classroom

In the online environment, students can often feel isolated and disconnected (Dixson, 2015). There is potential to significantly increase student engagement by gamifying online courses (Soflano et al., 2015). Therefore, the online classes considered in this study were similar to distance learning as students could not gather inside of classrooms. The motivation of students to learn from a distance was a problem. A study on the correlation between students' distance education motivation levels and their online experiences and satisfaction shows a significant correlation between the two. When it comes to the reasons for their satisfaction and dissatisfaction, students with low- and medium-level motivation levels stated that their dissatisfaction was due to a lack of interaction and negative perceptions and their dependence on conventional education (Cakir et al., 2018).

22.2.4 Existing Tools for Learning SQL

Learning SQL can be surprisingly tricky, given the relative simplicity of its syntax. Automated tools for teaching and assessing SQL have existed for over two decades. Early tools were only designed for teaching and offered increased feedback and personalised learning, but not summative assessment. More recently, however, the trend has turned towards automated assessment, with learning as a side-effect (Kleerekoper & Schofield, 2018). Currently, rich and interactive eLearning tools receive considerable attention from both practitioners and researchers.

22.2.5 Gamification in Education for Engagement

Many studies have shown that the gamification of learning environments can enhance learners' motivation to use learning environments (Lavoue et al., 2019). Meanwhile, the success of gamification in education depends on its potential to engage students in learning activities. The engagement has been proven to be positively correlated with student success outcomes, including satisfaction, persistence, and academic achievements (Krause & Coates, 2008). In addition, it has been suggested that when perceived as informational, gamification elements, such as points, levels, and leaderboards, may afford the feelings of competence and hence enhance intrinsic motivation and promote performance gains (Mekler et al., 2017).

22.2.6 Need for English Presentation Skills with Peer Evaluation

Effective learning has many different disciplines. One of them is improving students' soft skills, including different abilities, such as presentation, communication, teamwork, time/project management, and effective writing (Masoud & Al Muhtaseb, 2021). However, despite the long-term and intensive English learning education they have received, Chinese college students struggle to make even a 2 min professional English presentation (Zhu, 2019). Meanwhile, engineering students devote most of their time to learning maths and science, and they do not pay much attention to building their communication skills (Masoud & Al Muhtaseb, 2021). The need for our students to have excellent presentation skills have prompted teachers to conduct specific experiments (Balaban-Sali, 2008). Feedback and assessment play an essential role in teaching and learning (Dixson, 2015). With careful planning and training, peer assessment is a viable alternative assessment in higher education (Schunk & Zimmerman, 2008). Past research reflects the very positive attitude of the students towards peer assessment as a relevant source of external feedback (De Grez, Valcke & Roozen, 2012). Past findings also suggest that using students to assess and evaluate each other's presentations leads to enhanced performance (Ho, 2020).

22.3 Research Method

22.3.1 Research Tools

We used a mixed research approach (Larry, 2003) in this study. The mixed research approach is a legitimate, stand-alone research design in engineering education that combines the strengths of both qualitative and quantitative research (Service, 2009).

In the quantitative phase, quantifiable data about the background and students' preferences were collected via the Entrance and Exit Surveys. Scores from the tests and the quizzes were also obtained. These data were then analysed statistically with the use of parametric techniques such as Pearson's correlation.

For the qualitative phase, surveys with open-ended and closed-ended questions and online interviews were administered and then analysed to shed light on the numerical results.

22.3.2 Research Participants

The course 'Database Systems' had 148 students from the Department of Electronic and Information Engineering. Some of them were from the Higher Diploma program, and some were from the Degree program.

22.3.3 Quantitative Phase of Survey

In the beginning, an online entrance survey regarding the Flipped Classroom, Video Assignments, and SQL Challenge Game was carried out. The survey contained more than 40 questions covering the students' background, such as their education and gender, their expectations from this course, and their proclivity towards various areas of this course.

After the end of the course, an exit survey was carried out to check whether the expectations of the students were achieved. The responses from the entrance survey were compared with those to the exit survey.

Further, we analysed such data as the scores from SQL quizzes, knowledge-check quizzes, video assignment scores, SQL Challenge Game scores, and the total academic scores to check whether there were any correlations between them and the magnitudes of such correlations. Looking forward, we intend to devise better measures to help students learn with enhanced motivation and interactions and equip themselves with better presentation skills for subject-related topics.

22.3.4 Qualitative Phase of Survey

Open-ended questions, in addition to the other questions, were included in the exit survey. The students were asked to express their opinions. Online interviews were also arranged with the available students to collect information about the students' views and explore valuable information that we might have lost sight of.

22.4 Implementation

22.4.1 Implementation of Flipped Classroom

Teachers pre-recorded the short videos with interactive activities, knowledge check quizzes, and the content flow for the selected flipped classes. These learning materials are put onto Blackboard, the Learning Management System, from where students could download for viewing at any time.

22.4.2 Implementation of SQL Challenge Game

22.4.2.1 Objectives of SQL Challenge Game

Students played SQL Challenge Game by answering questions with the writing of syntax for the desired output. By doing so, the students familiarised themselves with the syntax for rendering different outputs. With the availability of the solo mode and the challenge mode, students could either play independently or compete with their classmates. The feature of the ranking page let the students know the top ten players to provide them with an incentive to play and surpass the other students. We hoped that during the pandemic, with the social distancing measures in place, SQL Challenge Game would induce students to engage in their studies outside of the classroom, and the Game itself would help them practice syntax writing.

22.4.2.2 Playing of Game

Solo Game Mode

The Game was set against the background of the growth of a bull from childhood to adulthood with the need to be fed with hay as food. The students were required to answer questions related to SQL for the baby bull to be rewarded with food to grow up into adulthood in five stages/levels. Students could play the Solo Game and Challenge Game.

In the Solo Game Mode, students attempted the SQL questions independently by inputting the SQL statement based on the ERD, which would be prompted by clicking the "Show ERD" button. Before submitting the answer, students were advised to click the "Check Query" button to check if their answer/output matched the question (Figs. 22.1 and 22.2). The correct answer would be rewarded with food for the baby bull to grow up.

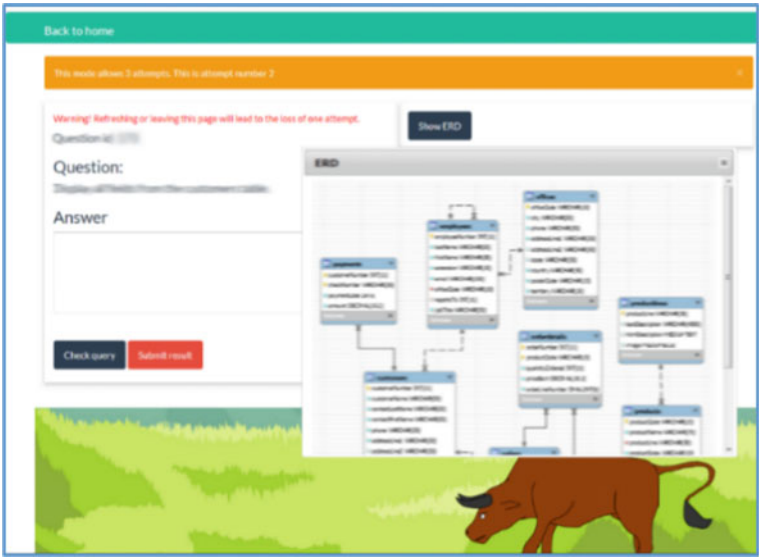


Fig. 22.1 Question page on Solo mode. ERD is shown on clicking the "Show ERD" button

Fig. 22.2 SQL result is shown on clicking the "Check query" button. Then, by clicking the "Submit Result" button, students can submit their answer for processing

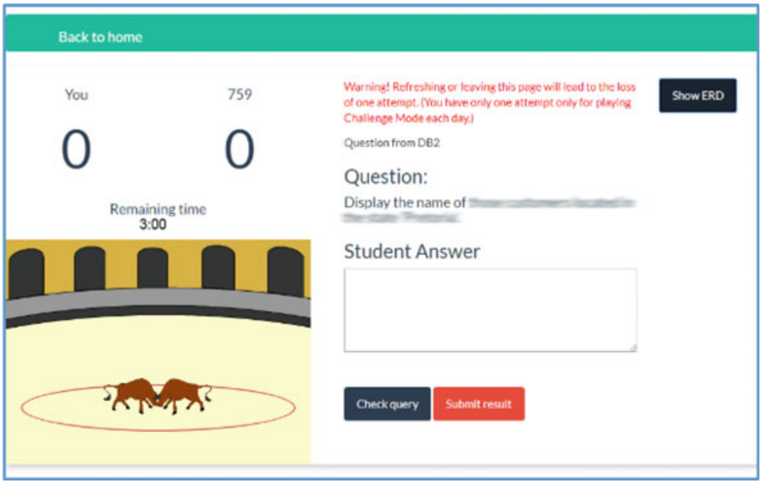


Fig. 22.3 In Challenge Mode, two students raced to answer the SQL questions. A correct answer would be rewarded with a move forward

Challenge Game Mode

In the Challenge Game Mode, the Game was set against the background of an arena for bullfighting when the baby bull had grown up. Each student should find a classmate as the opponent, and they raced to answer the SQL questions. Players of the Game should aim at pushing the opponent out of the circle. Each move is reciprocal in the Challenge Game Mode. A correct answer would be rewarded with a move forward, which is equivalent to a move backwards by the opponent. It takes three steps forward for a student to push the opponent out of the circle and win, given that no step has been taken by the opponent (Figs. 22.3 and 22.4).

22.4.2.3 Gaming Period

The online SQL Challenge Game was launched in Week 3 of the Spring Semester of 2019–2020. The students had 11 weeks to play the Game.

22.4.2.4 Ranking Page/Leaderboard

A ranking page was available for students to check their own rankings as well as those of the top ten players by clicking on the 'Ranking' button on the menu bar. The individual ranking of the student was listed as 'Self ranking'. The names of the top players on the ranking page were the nicknames chosen by the students themselves, which protected the privacy of the leading players and added to the fun element.

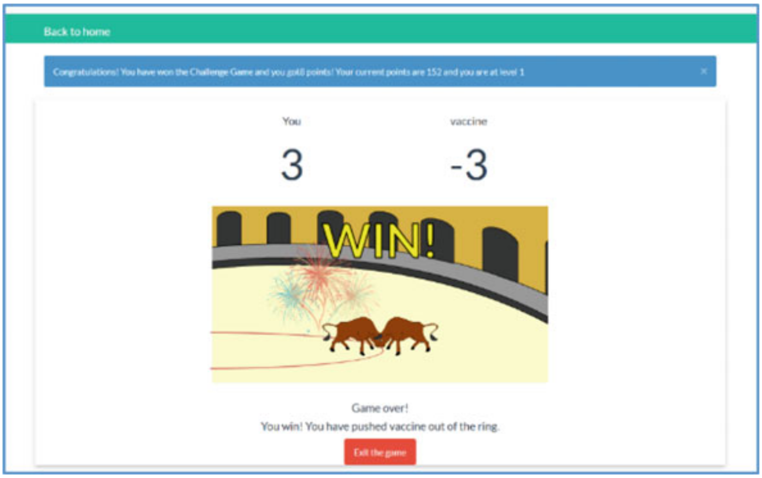


Fig. 22.4 It takes three moves forward for a student to push the opponent out of the circle and win

22.4.3 Implementation of Video Assignments

22.4.3.1 Intended Subject Learning Outcomes

Upon completion of the subject, students will have acquired the following skills:

Category A: Professional/academic knowledge and skills

1. Database design and development.
2. Database management and database security.
3. Data warehousing and data analysis.

Category B: Attributes for all-roundedness

4. Communicate effectively.

To help students achieve the Intended Learning Outcome 4 ‘Communicate effectively’, we introduced a video presentation assignment with details as follows:

- Students are required to submit individual video presentations on selected topics.
- The first submission is the initial version that the peer group members evaluate by providing concrete comments.
- The second submission is a revised version based on the comments given by their peers.
- Presentation must be done in English with Microsoft PowerPoint.
- Each video shall last for no more than 5 min.
- The video must show the presenter such that eye contacts and gestures, etc. can be spotted.
- The presenter should ensure that the voice could be heard clearly to assess clarity and vocal variety.

The major areas covered in this video assignment include:

- Data Warehouse.
- Data Mining and Big Data Analytics.
- Database Security.

Samples in line with the three major areas of this video assignment were given to the students for their reference in working out their presentations. Students may propose a topic other than those listed.

The video assignments consisted of the initial version and the final version. The initial version was evaluated and given peer feedback, based on which the revised version was produced.

The submission of the first assignment was due in early March 2020. Students then had to view the videos of their peer members and give feedback to their groupmates by filling in Part I of the Peer Feedback Form (Fig. 22.5), where students were advised to provide concrete comments. According to our sample in Fig. 22.5, the peer comments suggested eye contact.

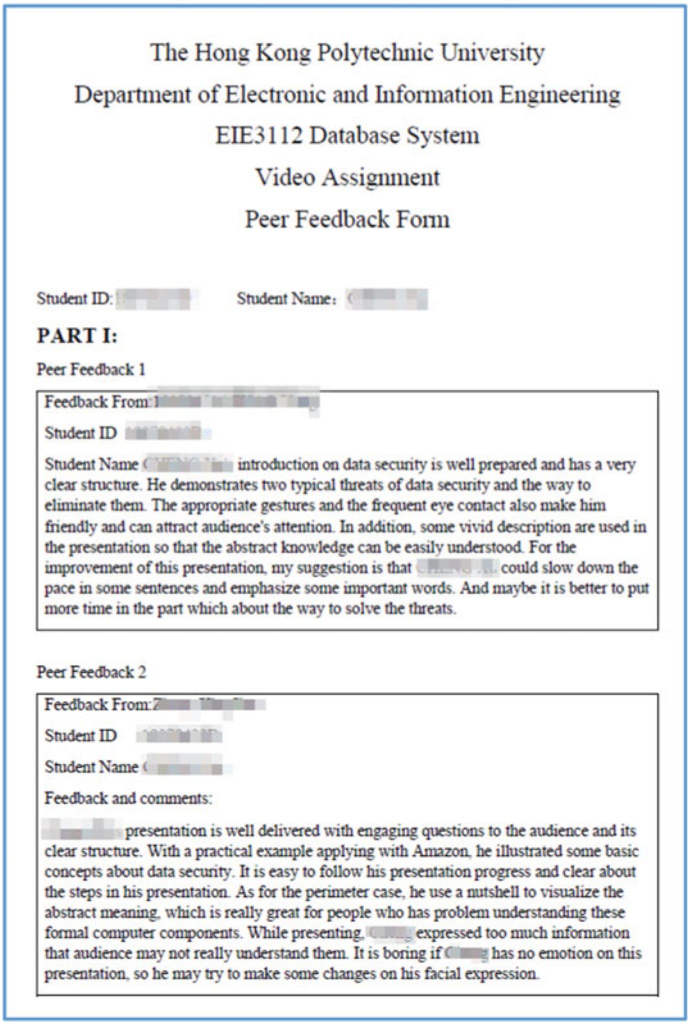
The second video assignment was due in early May 2020. Hence, students had eight weeks in between to give feedback to their groupmates and prepare for the second video based on the peer comments. The student concerned had to fill in Part II of the Peer Feedback Form (Fig. 22.6) with the changes made in the second assignment as a response to the peer feedback.

22.4.3.2 Assessment of Video Assignment as Part of Total Academic Score

The total score of the video assignment accounted for 5% of the total academic score. The first video constituted 30% of the video assignment score, while the second video accounted for 60% and the remainder 10% was the points rewarded for the submission of peer comments in Peer Feedback Forms. Therefore, if a student received 80 marks for the first attempt of the video assignment and 90 marks for the second attempt with the submission of the Peer Feedback Form (for both Part I and Part II), then he/she would receive a total score of 88 marks, as shown in Table 22.1.

22.5 Results and Analysis

We have received positive feedback from students with respect to the flipped classroom, video assignments, and SQL Challenge Game. The details of the surveys, observations, and relevant scores are as follows:



The Hong Kong Polytechnic University
Department of Electronic and Information Engineering
EIE3112 Database System
Video Assignment
Peer Feedback Form

Student ID: [illegible] Student Name: [illegible]

PART I:

Peer Feedback 1

Feedback From: [illegible]
Student ID [illegible]
Student Name [illegible] introduction on data security is well prepared and has a very clear structure. He demonstrates two typical threats of data security and the way to eliminate them. The appropriate gestures and the frequent eye contact also make him friendly and can attract audience's attention. In addition, some vivid description are used in the presentation so that the abstract knowledge can be easily understood. For the improvement of this presentation, my suggestion is that [illegible] could slow down the pace in some sentences and emphasize some important words. And maybe it is better to put more time in the part which about the way to solve the threats.

Peer Feedback 2

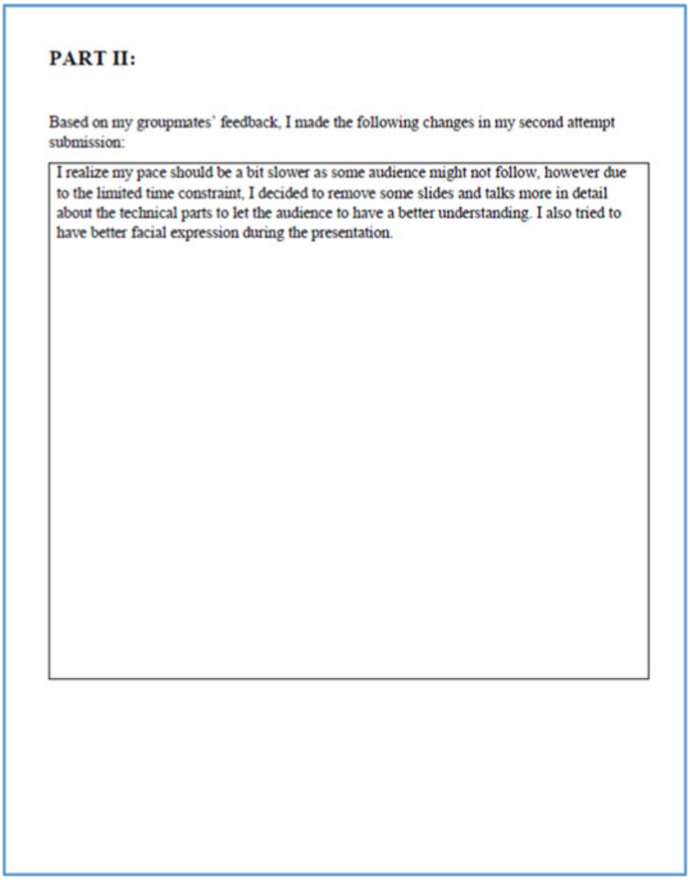
Feedback From: [illegible]
Student ID [illegible]
Student Name [illegible]
Feedback and comments:
[illegible] presentation is well delivered with engaging questions to the audience and its clear structure. With a practical example applying with Amazon, he illustrated some basic concepts about data security. It is easy to follow his presentation progress and clear about the steps in his presentation. As for the perimeter case, he use a nutshell to visualize the abstract meaning, which is really great for people who has problem understanding these formal computer components. While presenting, [illegible] expressed too much information that audience may not really understand them. It is boring if [illegible] has no emotion on this presentation, so he may try to make some changes on his facial expression.

Fig. 22.5 Part 1 of peer feedback form

22.5.1 *Flipped Classroom*

22.5.1.1 Students Lost Motivation to Study After Class

According to the entrance survey, over half of the respondents/students always or often lost their motivation to study a subject after leaving the classroom, as shown in Fig. 22.7.



PART II:

Based on my groupmates' feedback, I made the following changes in my second attempt submission:

I realize my pace should be a bit slower as some audience might not follow, however due to the limited time constraint, I decided to remove some slides and talks more in detail about the technical parts to let the audience to have a better understanding. I also tried to have better facial expression during the presentation.

Fig. 22.6 Part 2 of peer feedback form

Table 22.1 Calculation of marks for the video assignments

	Weighting (a) (%)	Marks given (b)	Marks counted (a) × (b) = (c)
Video presentation (1st attempt)	30	80	30% × 80 = 24
Video Presentation (2nd attempt)	60	90	60% × 90 = 54
Peer feedback form	10	Fully given with submission of peer comments	100% × 10 = 10
Total	100		88

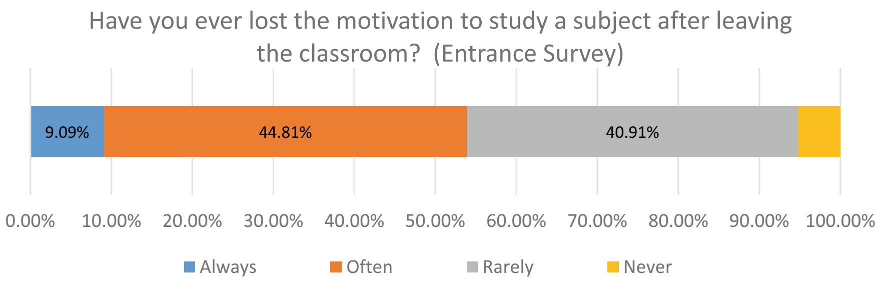


Fig. 22.7 Over half of the students lost motivation to study after leaving the classroom

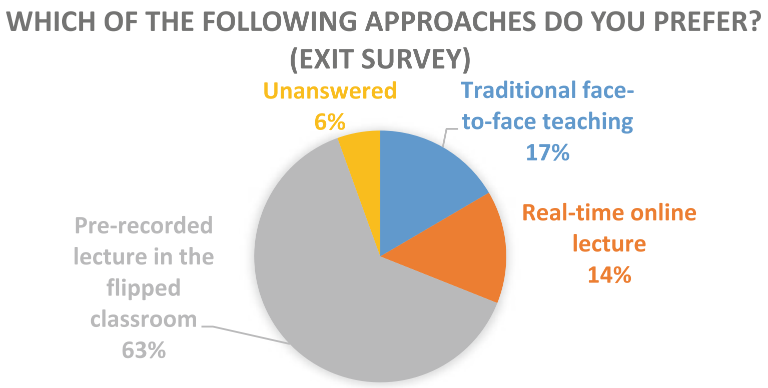


Fig. 22.8 Most students preferred pre-recorded lectures in the flipped classroom

22.5.1.2 Most Students Preferred Pre-Recorded Lectures in Flipped Classroom

Compared with the traditional face-to-face and real-time online lectures, most students opted for pre-recorded lectures in the flipped classroom (Fig. 22.8).

22.5.1.3 Overwhelming Support for Flipped Classroom as a Supplement to Traditional Face-To-Face or Real-Time Online Lectures

Though most of the students opted for the flipped classroom instead of the traditional face-to-face lectures and real-time online lectures, the flipped classroom itself was a supplement from the viewpoint of its duration and coverage. More than 80% of the students either strongly agreed or agreed that the flipped classroom as a supplement to traditional face-to-face or real-time online lectures was effective for learning (Fig. 22.9).

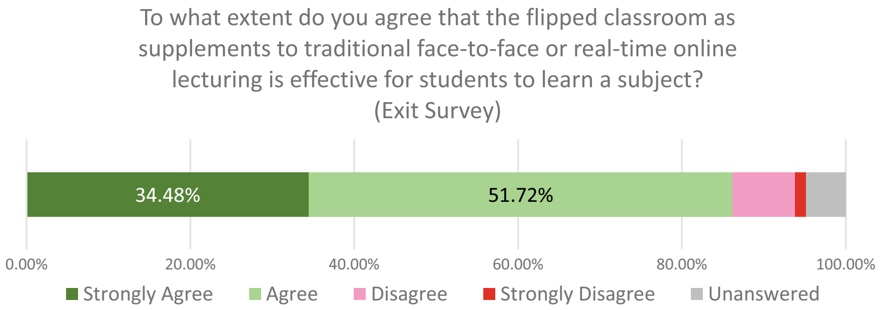


Fig. 22.9 Flipped Classroom as a supplement to the lecture is favoured by students

Table 22.2 Knowledge check quizzes have a mild to strong correlation with academic results

Quiz relevant to flipped classroom	Average marks rebased to 100	Pearson’s correlation ($n = 148$, $p < 0.05$)
Knowledge check quiz (SQL part 1)	80.42	0.3007
Knowledge check quiz (SQL part 2)	70.78	0.5217
Knowledge check quiz (data mining and machine learning)	81.89	0.3897
Knowledge check quiz (data warehousing)	78.04	0.6638
Knowledge check quiz (big data)	82.23	0.6752

22.5.1.4 Mild-to-Strong Correlation Between Certain Quizzes’ Scores and Overall Academic Performance

As mentioned earlier, quizzes relevant to the flipped classroom were arranged, and the scores from the quizzes were a yardstick to measure the effectiveness of learning. Five quizzes had been placed, and their scores had been rebased to a total score of 100 for analysis. As shown in Table 22.2, the quizzes’ scores had a mild to strong correlation with the overall academic performance. As the quizzes are related to the flipped classroom, the high correlation between the quizzes and overall academic result indicates that the flipped classroom has helped students with their study.

22.5.1.5 Flipped Classroom Increases Motivation to Study Outside the Classroom

More students agreed that Flipped Classroom (watching video lectures out of class) would increase their motivation to study outside the classroom (Fig. 22.10).

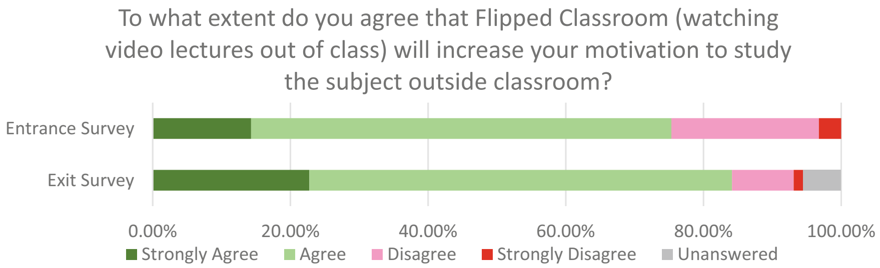


Fig. 22.10 Recognition for Flipped Classroom was reinforced at the end of the course

According to one student in an online interview, the flipped classroom, if online, would be even better in terms of efficiency than online classes. According to this student, the interaction in the flipped classroom and the online classes was similar as both types of classes were conducted online. The flipped classroom let students imbibe the knowledge piece by piece, while attending a 3-hour lecture might be pretty tiring despite the break in between. For the flipped classroom, one could adjust the pace of study. The flexibility for study might be why more students agreed that the flipped classroom increased their motivation to study outside the classroom in the exit survey.

22.5.2 Results of SQL Challenge Game

22.5.2.1 Playing Subject-Related Game Increases Motivation

In the entrance survey, more than 80% of the students strongly agreed/agreed that playing a subject-related game would increase the motivation to study the subject outside the classroom. This number slightly declined in the exit survey (Fig. 22.11).

22.5.2.2 High Level of Engagement

Amongst the 148 students, 141 students had played the Game, rendering 95.27% of the students participating in the SQL Challenge Game, as shown in Table 22.3. Out of the full game score of 500, the average game score was 399.6. As a result, the Game was well received.

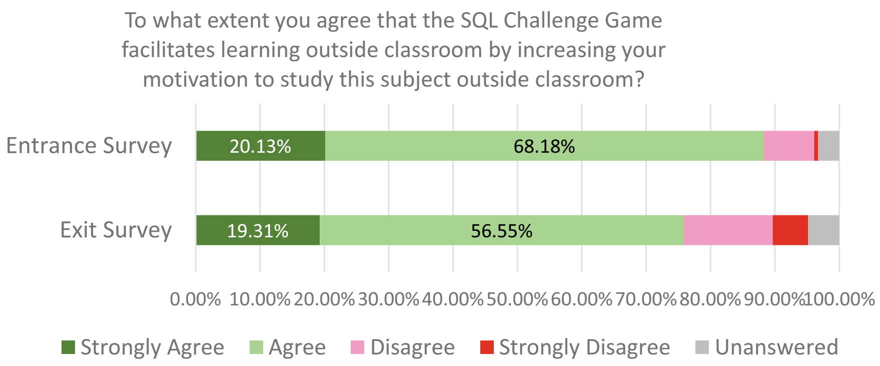


Fig. 22.11 Perception towards the motivation from the game declined but still strong

Table 22.3 High participation rate in the SQL game

	Percentage	Remarks
Participation rate	95.27	141 students participated (141/148)
Completion rate	54.73	81 students got a full game score of 500 (81/148)
Average game score	79.92	Out of the full game score of 500, the average game score was 399.6. (399.6/500)

22.5.2.3 A Decline in the Number of Students Intending to Play Challenge Mode Game

We asked the students their preference for the game modes in the entrance and the exit surveys. It turned out that the percentage of students in favour of competing with other classmates declined from 34.42 to 16.55%, as shown in Fig. 22.12. This could be attributed to the game setting in that students had to arrange by themselves for competition against each other, which took time. Some students just told us that they had waited for too long for a competitor, and they thus just kept playing the Solo Game.

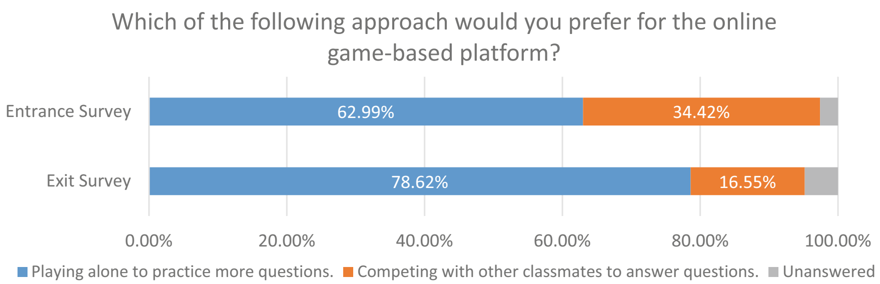


Fig. 22.12 In the end, more students prefer to play alone in the game

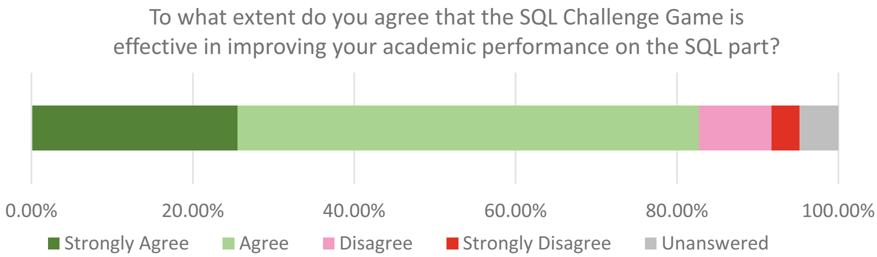


Fig. 22.13 Majority of the students agree that the game improved their academic performance

22.5.2.4 SQL Challenge Game Improved Academic Performance

A majority of the students agreed that the SQL Challenge Game effectively improved their academic performance on the SQL part, as shown in Fig. 22.13. The effectiveness was proven by the significant positive correlation, which stands at 0.6221 with a p-value less than 0.05, between the game score and the overall academic performance.

22.5.2.5 Slight Decline in Motivation Effect of SQL Challenge Game Performance

By comparing the exit survey against the entrance survey, we found a slight decline in the percentage of students favouring SQL Challenge Game as a platform to engage students in out-of-class activities, as shown in Fig. 22.14. Some students opined that the SQL Challenge Game is somewhat like a Q&A session because it is just writing up the syntax in response to the question with the ERD. They suggested that more game elements should be added. Meanwhile, the SQL Challenge Game did not provide a robot for students to play against in the Challenge Game, and some students told us that they could not find a partner to play with them in the Challenge Game. These might explain the slight decline in the motivation effect of the SQL Challenge

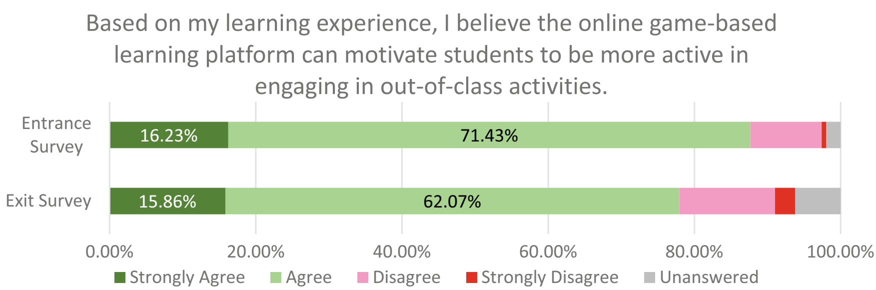


Fig. 22.14 Decline in perception towards the engagement effect of the game

Game. But still, there are nearly 80% of students agree that the game platform can motivate them to engage in out-of-class activities.

22.5.3 *Results of Video Assignments*

22.5.3.1 Video Assignments Were Well Received with Majority Improvement

The video assignments were well received by the students. On the whole, 140 students, i.e. 94.59% of the students, participated in the video assignments. Only eight students, i.e., 5.41% of the students, did not submit any videos at all, as shown in the grey area of Fig. 22.15. In all, 74.32% of the students improved their presentation in their second submission, while 10.14% experienced a setback in their presentation scores.

With the provision of peer comments, we noted a general improvement in the scores of the second submission of the video presentations. On average, amongst those who submitted both the first and the second videos, the video scores increased by 4.67% (Table 22.4). Meanwhile, 15 students experienced a setback in the presentation scores, while the video scores of 9 students remained unchanged.

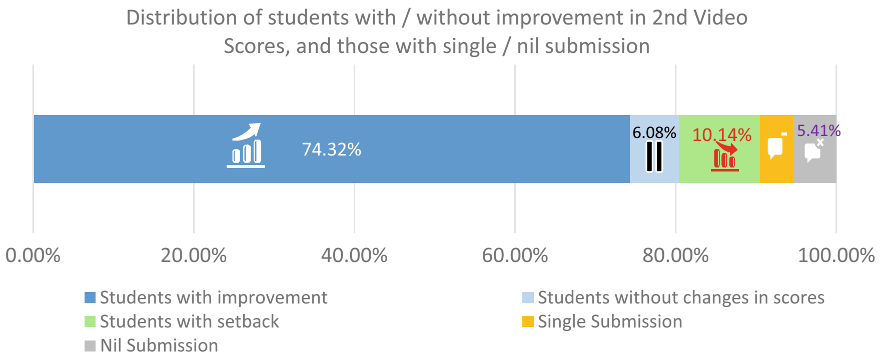


Fig. 22.15 Over 70% of the students had improvements in their 2nd video assignment

Table 22.4 Students, in general, made improvements in their 2nd video assignment

	First submission of presentation videos	Second submission of presentation videos	Increase in scores
Average scores	86.14925	90.17164	**4.67%**[a]

[a]These results were obtained from those students who had submitted both the first and the second videos, which accounted for 134 students out of the total of 148 students. By comparing the first and the second submission of the videos of these 134 students, we noted an increment in the video scores by 4.67%

Table 22.5 Categorisation of students into groups according to changes of video scores

	First video scores	Second video scores	Improvement (%)	Average academic scores	Number of students
Average scores of students **with improvement**	85.20	90.41	6.11	78.01	110
Average scores of students **with setback**	90.27	88.00	−2.51	83.21	15
Average scores of students **without changes**	90.89	90.89	0.00	85.07	9
Average scores of students **with single submission**	N/A	N/A	N/A	65.90	6
Average scores of students **without submission**	NIL	NIL	N/A	46.08	8

The improvement in the video scores was particularly significant amongst students with low scores at the beginning. As shown in Table 22.5, 110 students improved their video scores of the second submission with the lower average of the first video scores at 85.2. Meanwhile, for students with a setback or no change in scores, the initial scores were already high, with average scores above 90.

Meanwhile, six out of the 148 students had a single submission of video assignments. Their average academic scores were less than those of students with two submissions. Eight students did not submit any video assignment at all, and their average scores were even lower.

22.5.3.2 Improved Confidence and Communication Skills

Meanwhile, more than 70% of the students agreed/strongly agreed that their confidence had improved as a result of this course compared with the beginning. Also, more than 60% of the students agreed/strongly agreed that their communication skills had improved as a result of this course (Fig. 22.16).

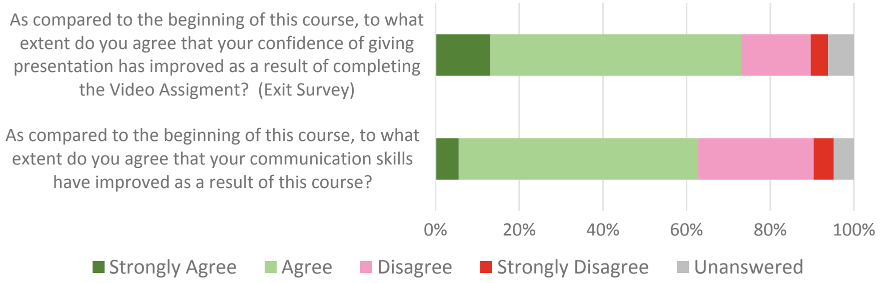


Fig. 22.16 Confidence in giving presentation and communication skills have improved in general

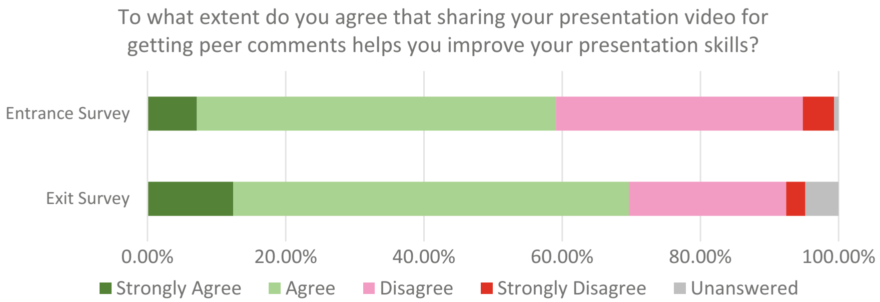


Fig. 22.17 Enhanced recognition of the positive effect of sharing presentations for getting peer comments

22.5.4 Sharing Presentation Comments Appreciated

A comparison of the exit survey with the entrance survey indicated enhanced recognition of the positive effect of sharing presentations amongst peers (Fig. 22.17). Close to 60% of the students in the entrance survey favoured sharing their presentation for peer comments. While in the exit survey, the figure in favour of sharing increased to nearly 70%, along with a reduction in students who disagreed.

22.5.5 Inspiration with Eye-Catching Topics

Although some students pointed that the video assignment might be similar to an English Language subject, many students had good ideas. For example, one interesting topic is data analytics applied to football with stories on how the football team could devise better tactics and training to beat the opponents by using data analytics, as shown in Fig. 22.18.

Fig. 22.18 Topics of interest were brought up to draw attention

22.6 Conclusion

22.6.1 Most Students Liked the Combination of SQL Challenge Game, Video Assignment, and Flipped Classroom

The combination of SQL Challenge Game, Video Assignment, and Flipped Classroom was well received, with 80% of the students expressing their preference for this, as shown in Fig. 22.19. As mentioned earlier, most students agreed that the SQL Challenge Game motivated them to study outside of the class. The video assignment encouraged the students to conduct research on their own while brainstorming with the peer commentaries. The flipped classroom facilitated the students' learning activities with flexibility.

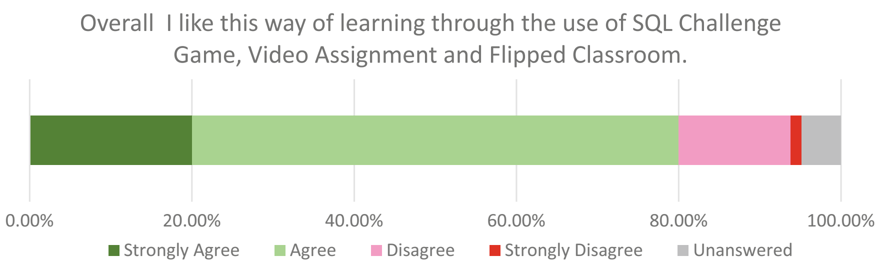


Fig. 22.19 In the end, 80% of the students favours this blend of learning approach

22.6.2 *Flipped Classroom Most Well Received*

We charted the results for the set of questions in the exit survey. As shown in Fig. 22.20, we observed that the flipped classroom was the best received, where students are most in favour of pre-recorded lectures and flipped classroom as a supplement to face-to-face/real-time online synchronous class.

Fig. 22.20 Opinions towards this subject in the Exit Survey are in favour

We conducted online interviews with ten students from the two classes to gain deeper insights into the various components of this Database Systems course.

One student in the interview told us that because of the pandemic, the flipped classroom looked different. This student found the flipped classroom to be excellent. As SQL is considerably new to the student, the code that he wrote had to be reviewed repeatedly, and from this aspect, the flipped classroom was amazing. Compared with online classes, there were times when the students might have missed something. The students focused on the points in online classes, but it took them time to understand them completely. The flipped classroom highlighted this problem and allowed one to review and learn at one's own pace.

According to another student in mainland China, the online classroom did not help him very much. On many occasions, the student encountered hiccups in signal transmission, and thus, his experience with the online classroom was not so satisfactory. Despite the playback function, considering that the length of the online class was three hours, it took him time to find the specific portions of the class that had been missed. Hence, he found the flipped classroom to be better. However, this student suggested that the flipped classroom be inserted with more exercises (questions) as he thought that the number of questions was small. In addition, he suggested that the review session of the flipped classroom should be inserted with more questions so that the students could better understand the contents of that particular lecture.

22.6.3 More Game Elements Should Be Added to Game Platform

Some students claimed that the game setting was similar to that of a Q&A session. Hence, more game elements should be added to make the students think strategically while making moves; this will increase the fun factor and make the Game more desirable. Further studies to determine different parameters such as game elements and the game devices are needed to help us design new courses to help students learn and improve.

Most of the comments were in favour of the SQL Challenge Game. Some students opined that they had been given the opportunity to practice writing the SQL syntax. Some students agreed that the Ranking Page motivated them to outperform the others such that the game attempts would not be left idle.

Nevertheless, there is room for improvement. Some SQL questions were repeated over time because of the problems associated with the gaming platform. Many students grumbled about the absence of model answers following the submission of wrong answers. We did not offer model answers on purpose over concerns about the leakage of the model answers. People were sceptical about the effectiveness of the challenge mode game in helping students learn because of the waiting time for opponents, and the challenge mode game might just be a scramble for answering questions in which one could not think deeply.

One student requested the availability of the display of the previous input so that the students could follow through and might be able to find out what was wrong. One student opined that an ERD should be applicable for more questions to save time from reading the ERD anew. The students' enthusiasm could also be observed by the suggestion of setting up a 'comments corner' on the Ranking Page.

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Chapter 23
Reflexivity on Delivering Experiential Learning Before and Since Coronavirus Pandemic

Shui Kau Chiu

Abstract To address challenges in an age of knowledge society and better prepare students for uncertainties, higher education has integrated experiential learning into curricula. One of the approaches is to expose students' learning to various physical contexts. Since coronavirus pandemic, such approach has become puzzling. With a view of balancing health consideration and learning needs, experiential learning has to be delivered with synchronous learning tools like Microsoft Teams. The delivery, under whenever circumstances, has posted various challenges to educationists including ethical, pedagogical and technical considerations. Based on author's experiences, therefore, this article aims at offering an autoethnographic and reflexive account on delivering experiential learning at higher education in Hong Kong before and since the pandemic. Through arguing that delivery of experiential learning has to be in line with social expectations and students' needs under new learning environment, this article will be an important reference for educationists and education policy makers.

Keywords Reflexivity · Autoethnography · Experiential learning · Knowledge society · Coronavirus pandemic · Hong Kong higher education

23.1 Introduction

Education has to be always beware of the changing needs of the society and respond timely. With an aim of better preparing knowledgeable and skilled talents, higher education has formulated many strategies to cope with the challenges. One of them is on highlighting an essential component of experience in learning. Because of that, especially for those applied degree programme, elements of experiential learning have thus been integrated into different curricula. Effectiveness of experiential learning, however, relies on various elements including the way of its delivery.

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Since educationists play a crucial role in pedagogy, their perceptions of how the experiential learning is delivered deserve a perusal. Strains from coronavirus pandemic further affirm the exploration and make it more relevant with future learning as education has to appropriately adapt with new teaching and learning environment. Therefore, a study of reflexivity on delivering experiential learning was summoned.

Organization of this article is as follows. Rationale of introducing experiential learning and its implementation at Hong Kong higher education will be briefly reviewed first followed by an inspection of linkage between experiential learning and reflexivity. Research objective, research questions, and methodology of this study will then be explained. After that, reflexivity of delivery experiential learning before and since coronavirus pandemic and the corresponding discussions will be examined. Before drawing a conclusion, implications and limitation of this study will be suggested.

23.2 Knowledge Society and Experiential Learning

Polanyi (1958) classifies knowledge into two main catalogues, namely tacit knowledge and explicit knowledge. Polanyi (1966) indicates tacit knowledge as something that "we can know more than we can tell" (p. 4). In other words, tacit knowledge is the knowledge that can hardly be expressed in verbal or non-verbal format. One of the channels to master tacit knowledge, such as riding a bicycle, is through experience and practice. On the contrary, explicit knowledge refers to the knowledge that can rather easily be transmitted via spoken or written manners. For instance, factual knowledge on historical events including date, time, and people involved can be easily recorded and understood.

Meanwhile, Drucker (1969) proposes a concept of "knowledge society" in the twentieth century. Basic understanding on knowledge society from United Nations Educational Scientific and Cultural Organization (2005) is that it is a society that where citizens can, under the protection of laws and orders and mutual respect, makes use of, and makes available of, the massive updated knowledge for the sake of economic and social development (pp. 17–20). The twenty-first century can be regarded as an age of knowledge society. Meanwhile, Drucker (1959) names those who make use of knowledge as their major asset for economical purpose as "knowledge workers". Davenport et al. (2002) and Yigitcanlar et al. (2007) point out that knowledge workers are vital for an economic development of knowledge society. Cooper (2006), Organization for Economic Co-operation and Development (2001), and Serrat (2010) advocate that knowledge workers are likely to be well educated, such as students from higher education.

One of the characteristics of knowledge society is that new knowledge is quickly generated, and it replaces outdated one at an unimaginable patch. While knowledge society acts as a symbol of advancement in human civilization, it also posts uncertainties to university graduates. As suggested by Lawler and Sillitoe (2013), Leon (2016) and Pavlin (2014), universities conventionally tend to transmit mainly explicit knowledge to students. On one hand, under the impact of knowledge society, a certain proportion of the knowledge may be outdated quickly and that students may have difficulties in encountering ever changing unpredictable challenges. Personal development of the graduates, and even prosperity of the whole society, may thus be eventually affected. On the other hand, Ambrosini and Bowman (2001), Jasimuddin et al. (2005), and Leonard and Insch (2005) argue that tacit knowledge is important and can be career-oriented. Students with unsophisticated tacit knowledge not only can hinder their capabilities in acquiring new skills and knowledge but also their creativities and immersions in the workplaces (Leon, 2016; Yang et al., 2020, p. 352;, p. 11). Therefore, instilling both explicit knowledge and tacit knowledge to students is important at higher education, especially for those applied degree programme (Blair, 2002; Hoskins & Fredriksson, 2008; Smith, 2001, p. 1025, p. 5; E. A., pp. 318–319).

23.3 Experiential Learning at Hong Kong Higher Education

One of the strategies to achieve the foregoing goal and to address uncertainties in an age of knowledge society is to enrich students' cognition through connecting learning with different sort of stimulations (Smith, 2013, p. 53). Experiential learning has thus been introduced and constituted as one of the core elements in some of the curricula at higher education, especially for the applied degree programme. Cheng et al. (2020) define experiential learning as "learning by doing, which emphasizes learning through participation in reflection and sharing in practice" (p. 3). Kolb (2000) proclaims that through experiential learning, students can immerse and reflect from different experiences that can hardly be expatiated, and then transform and internalize the whole learning journey into their own and become part of their knowledge.

It is impossible and unnecessary to review all previous literatures on experiential learning. However, some of the paradigmatic studies on Hong Kong higher education setting are as follows. Chui et al. (2015) interest in finding out whether a module on general education combining conventional lectures with extra-curriculum activities can promote students' leadership skills (pp. 151–152). After inspecting both qualitative and quantitative feedbacks from 38 participants, Chui et al. (2015) proclaim that the pedagogical approach is applicable to cultivate students' consciousness on leadership (pp. 152, 154, 157). Notwithstanding, feasibility in conducting the activities is one of the major considerations for future deliveries (Chui et al., 2015, p. 158).

To evaluate learning outcomes of a service learning programme on hospitality, Lin et al. (2017) arrange 17 students to work with a non-government organization in Cambodia for 14 days on different areas after having nine weeks of learning in Hong Kong (p. 74). By analyzing students' written reflections, Lin et al. (2017) discover that the programme enhances their performances in personal and professional development, leadership, communication, making analysis, and solving problem (pp. 75, 77–79). However, students with diversified backgrounds hinder the experiential learning and more proper assistances should be prepared (Lin et al., 2017, p. 80).

Snell et al. (2019) organize some internships programme to scrutinize its efficacy of instilling students with competency in leadership (p. 169). Through interviewing and studying students' assignments, the research reveals that the internships programme is effective in strengthening various characteristics of leadership among students (Snell et al., 2019, pp. 179, 182). Nonetheless, Snell et al. (2019) pinpoint that, during its implementation, perspicacity from various involved parties can further improve the whole experiential learning activity (pp. 191–192).

Meanwhile, in order to investigate an applicability of arousing students' attention on cyberbullying, Leung et al. (2018) ask students to discuss their understanding on cyberbullying after watching some videos on the same topic and reading certain messages posted in social media (p. 1041). While the finding pinpoints that the experiential learning is helpful to disconnect students from having a positive view on cyberbullying, the learning activity also suffer from several limitations such as its effectiveness and students' involvement (Leung et al., 2018, pp. 1048–1050).

With a view of consolidating students' conceptual knowledge and better preparing for their future teaching career, Ng et al. (2019) adopt experiential learning in a science module (p. 2911). Students are required to assume different roles to settle assigned issues and these learning activities are always supported by information technology (Ng et al., 2019, pp. 2918, 2921–2922). Even though the activities improve interpersonal relationship between lecturers and students, Ng et al. (2019) identify some barriers such as the way of ensuring fair assessment has to be better addressed when delivering the experiential learning (pp. 2924–2925).

Ting et al. (2019) look into difference of students' learning outcomes from attending lectures with solely lecturing and those supplement with technological-enhanced experiential learning (p. 6). Based on findings from 365 students, the study propound that students perceived understanding of the subject matter and their predicted academic performance are in line with their perceived amount of time that engaged in the experiential learning (Ting et al., 2019, pp. 10, 16). Nevertheless, Ting et al. (2019) also indicates that the learning activity can be further polished by offering an even more fair learning opportunity (p. 17).

The above compendious review exposes that, in general, experiential learning can be grouped into two forms, classroom housed and non-classroom housed (Sattler, 2018, pp. 53–54; Tomkins & Ulus, 2016, p. 159). The former signifies those learning activities are arranged inside classroom whilst the latter refers to the assigned activities that are located beyond classroom setting. What is more, the mentioned literatures also inform this study that delivery of experiential learning has to be constantly reviewed. No matter how educationists deliver experiential learning, they should equip themselves with necessary contemplations so as to reach a better pedagogical impact.

23.4 Experiential Learning and Reflexivity

Owing to innumerable considerations such as subject matters and learning needs, educationists have to use their professional judgement in tailoring and arranging the most appropriate experiential learning for their students. Nevertheless, the role of educationists in experiential learning requires further ruminations. As Brigstocke (2020), O'Brien et al. (2020), and Symonds (2021) proclaim, certain level of imbalance of power relationship between educationists and students exits in higher education. The relationship partially reflects at the design stage of experiential learning as students normally are not invited for consultation. While magnitude of students' involvement in planning experiential learning can be explained and even justified from pedagogical, managemental and even administrative perspectives, it also embodies a significant position of educationists in experiential learning. Learning outcomes of experiential learning can be comprised especially when educationists do not take students' interests into their paramount concern. For the sake of students' learning, it is vital for educationists to reflect from their positions since the way of how they perceive at their own identities and at the roles of students can shape attainments of experiential learning. Thus, educationists need to equip themselves with reflexivity when designing and delivering experiential learning.

No consensus has been reached on a definition of reflexivity (Corlett & Mavin, 2018, p. 378; Webster, 2008, p. 65). For instance, Enosh and Ben-Ari (2016) read reflexivity as "deliberate awareness involving both a contemplative stance (state of mind) and intentional activity aimed at recognizing differentness and generating knowledge" (p. 578). Archer (2009) interprets reflexivity as "self-referential characteristic of "bending-back" some thought upon the self" (p. 2). Elliott (2020) translates it as "a self-defining process that depends on monitoring of and reflection upon, psychological and social information about possible trajectories of life" (p. 43). Based on the aforesaid portrayals, this article conceives reflexivity as deconstructed interlocutions between introspections and retrospections within oneself under a particular setting.

As forecited, reflexivity is relevant with educationists. Studies like Brownlee et al. (2019), Dyer and Hurd (2016), and Edgington (2016) illustrate that educationists can deploy reflexivity to enhance their professional performances. Empowerment from reflexivity, competency of educationists in delivering experiential learning can be enriched. Nevertheless, reflexivity requires introspection, demands a critical and skeptical attitude challenging setting that taken for granted and genuine in-depth dialogues within oneself (Archer, 2007, p. 2; Burkitt, 2012, p. 462; Cassell et al., 2020, p. 751).

23.5 Research Objective, Research Questions, and Methodology

Revitalized from the previous discussions, research objective of this study is to enhance efficacy of future deliveries of experiential learning especially related to applied degree programme at higher education. The objective then leads to formulation of two research questions. First, can introspective reflexivity help to enhance efficacy of delivering experiential learning? Second, in what way does introspective reflexivity help to enhance efficacy of delivering experiential learning? The first research question informed this study with an initial understanding on applicability of employing reflexivity as a strategy to enrich usefulness of delivering experiential learning. When the answer of the first research question is positive, the second research question then informed this study on orientations of reflexivity in polishing fruitfulness of delivering experiential learning.

Key research approach of answering the two research questions is that it must enable researcher to probe into reflexivity. Since reflexivity is on interlocutions of oneself, autoethnography reinforces this study with a unique, vigorous and an inimitable propulsion. Autoethnography can be elucidated as using researcher's life journey to perceive and justify what he has experienced (Chang, 2016, p. 444). Autoethnography offers a better "understanding how the researcher is connected to a culture provides an opportunity to reflect on and explore the meaning of reciprocal interactions that shape a person's identity and everyday experiences from an insider's perspective" (Zubriski et al., 2020, p. 65).

Autoethnography works with reflexivity. Custer (2014) asserts that autoethnography "can radically alter an individual's perception of the past, inform their present, and reshape their future if they are aware and open to the transformative effects" (p. 2). In addition, autoethnography is relevant with educationists. Learmonth and Humphreys (2012) and Tienari (2019) annotate that autoethnography helps educationists to revisit and reposition their academic identity. Barr (2019) further propounds that pedagogical approach can be polished through autoethnography. By making use of this research approach, autoethnography offers a lens for educationists to retrospect and introspect various gamut in experiential learning (Fox, 2008, p. 38). In other words, autoethnography empowered capability of this study in exploring reflexivity. Other research approaches such as questionnaire and observation are inappropriate for this study since they can generate issues like ethical concerns and the Hawthorne Effect, informant's distorted natural behaviour after realizing of being the subject of a research (Haessler, 2014, p. 965). Researchers such as Howlett and Nguyen (2020), Martin (2011) and Mendonça et al. (2017) also adopted autoethnography in their studies related to experiential learning. Taking the above into account, therefore, this paper utilized autoethnography to offer introspective reflexivity on delivering classroom housed experiential learning before and since coronavirus pandemic at higher education in Hong Kong.

Data of this study was collected from two 3-h modules in general education that I taught, module A and module B, which were offered by one of the higher educations that provide applied degree programme in Hong Kong. Class sizes of module A and B were 29 and 23.7 (on average out of three classes) respectively. The two modules shared some common characteristics. First, medium of instruction was English and formative assessment methods like individual assignments and group projects were adopted. No test or examination was arranged. Second, all enrolled students were from other disciplinaries and only a very few of them were year one students. Third, majority of the enrollment were local students whose mother tongue was Cantonese. Fourth, students' attendances were recorded. Nevertheless, discrepancies existed between the two modules. First, module A was an elective course, but module B was a compulsory one. Second, mode of delivery was not the same. Module A was offered before coronavirus pandemic and students attended all the lessons on campus. Nonetheless, since module B was offered after the outbreak of the pandemic, ensuring public health by social distancing was a paramount concern. To balance with learning needs, over a period the lessons were delivered in dual modes, a combination of on campus and live broadcasting through synchronous learning tool named Microsoft Teams. Students could choose a mode to attend the lesson based on their considerations. Some of the lessons, however, were conducted solely online due to the state of the pandemic.

Concerning this study, I never use my role as the lecturer to exert any influences on my students in any directions. To avoid the Hawthorne Effect, students had no idea that a study was carrying out. Driven by the consideration, no interview was conducted, and no questionnaire was distributed. Neither audio nor visual recording was made for the purpose of this study as well. Data of this study was mainly from author's own research notes which were taken right after each lesson. The data was triangulated with other sources included daily interactions and communications with my students. This study needed not to seek ethical approval as it involved author's own reflexivity only.

After acquainting backdrops of this study from different angles, reflexive discussions on delivering experiential learning before and since coronavirus pandemic are as follows. As elements of classroom housed experiential learning were embedded into pedagogies of the two modules, they will be briefly mentioned as well. However, detailed descriptions will not be covered as they are beyond the scope of this paper.

23.6 Before Coronavirus Pandemic

One of the topics covered in module A was socialization. With a view of instilling relevant experiences and reflections to students, a classroom housed experiential learning activity was arranged in the lesson. The class was divided into four groups, and each group consisted of 7–8 students. The class was given a written and verbal instruction required them to imagine their various expectations on their futures. However, each group was assigned with different settings and these could be some indictors reflected the way of socialization in shaping their perceptions. Through participating in the activity, students could reinforce and reflect on different dimensions of socialization that could hardly be realized without hand-on experience. The class had around thirty to forty minutes for discussions and then each group had to present their ideas one by one. As the lecturer, I shared my views on their ideas and then debriefed the whole learning experience with the class afterward.

Students' engagement in the learning experience and associating the activity with the lecture were the major challenges to me. Failures in getting students' involvement and connecting with the lesson would distract students' attention and reduce their learning motivation. To ensure smooth delivery, I had to take advantage of floating tables and chairs in the classroom so as to facilitate students' participation into group discussion. Classroom without flexible setting can constitute an encumbrance of the activity. What is more, I had to make sure that all the groups my skill in utilizing information technology like projector and visualizer was also critical as they were the important pedagogical tools to simultaneously share students' ideas to classmates, draw their attention and connect them with my explanations. Thus, I had to be familiar with all the technical settings before delivering the activity. In addition, for fairness, I needed to make sure every student received an equal learning opportunity, and no one was neglected.

Deliveries of experiential learning needs to be flexible, and awareness of making corresponding adjustments has to be prepared to respond different learning challenges, for instance, posed by the pandemic.

23.7 Since Coronavirus Pandemic

During the time when module B was delivered in dual modes, at least two classroom housed experiential learnings were conducted at different schedules so that students engendered relevant experiences and reflections on the topics of laboratory produced food and blockchain. For the experiential learning on laboratory produced food, those students attended the lesson on campus were told to make use of the given materials to stimulate food production in laboratory. The class was divided into six groups, with around 4 students in each group. After explaining all the procedures, a set of material was distributed to each group. While performing the stimulation, each group had to write down their observations and complete a worksheet. The whole activity lasted for around 1.5–2 h. As those students who attended the lesson through Microsoft Teams could not perform the stimulation simultaneously, one of the supplementary measures was to ask them to watch a prescribed five-minute video on similar topic at YouTube and submit another worksheet. A conceptual plan was to arrange them to perform the same stimulation on campus when the condition of pandemic allowed.

On one hand, the whole design of this experiential learning activity can be perceived as a compromise between learning needs and the constraints under the pandemic. As some students chose to attend the lesson through Microsoft Teams out of health consideration, the alternative arrangement of asking them to watch a video and complete a worksheet seemed to be understood and reasonable. On the other hand, the experiential learning deserves reflexivity and reexamination from a perspective of educational equality. An interpretation of educational equality departs from educational access. Husen (1972) pioneered a belief that all students, regardless of their backgrounds, should be given an equal opportunity in receiving education. All unfavourable backgrounds, such as physical or regional limitations, gender and socio-economic status, should be wiped out. When adverse factors are removed, educational outcomes, like academic performances, should then be endured by students themselves (Tannock, 2018, p. 16). As Arat and Kerelian (2019), Chan et al. (2014), and Poon-McBrayer (2017) portray, issue of educational equality has recently been received a lot of attention in Hong Kong so as to reflect the social expectation on advocating an inclusive educational environment to safeguard fairness and minimize all forms of discrimination.

Nonetheless, students did not receive same learning opportunity in this experiential learning. Some of them had a hand-on experience of producing laboratory food for at least 1.5 h whilst some watched an online video for five minutes only. Despite a conceptual plan was formed to schedule a supplementary experience for some students at the time when possible, implementation of the plan was unpredictable and subjected to various constraints. Even if the students could perform the stimulation on campus at last, applicability and efficacy of the experiential learning on them would be subjected to further review as they received different learning itineraries when compared with their classmates. Especially for applied degree programme, exposure into different learning journeys can shape students' learning experiences and reflections into different directions. Although the arrangement of this pedagogical activity was affected by the pandemic, students' right to receive same learning opportunity should be upheld regardless the mode they chose to attend the lesson. Departing from educational equality, therefore, delivery of this experiential learning demands a refinement. When implementing an experiential learning in the future, feasibility of the delivery for all students should be taken into consideration. While Beard and Wilson (2018), Canhoto and Murphy (2016) and Hyams-Ssekasi and Caldwell (2018) depict the popularity of combination online elements with conventional pedagogy in future learning, design of experiential learning should receive a second thought when educational equality for all students cannot be ensured during the delivery. Particularly, educational equality should not be sacrificed at the expense of other factors like easy administration.

Concerning the experiential learning on blockchain, one of the assigned tasks for the students was to secure specimen of electronic health certificates from a hypothetical website which was designed and hosted by an external organization for our pedagogical purpose. The goal of the experiential learning was that, through participations, students could then have more experiences and reflections on the concept of blockchain. Regardless the mode that students chose to attend the lesson, they were notified in advance to prepare a digital device that could access to the Internet and a mobile phone that could receive SMS messages. As the lecturer, I explained all the instructions and led the class to complete various tasks step by step. The whole activity lasted for over 2 h. A debriefing was made after the learning activity.

Delivery of this experiential learning activity also deserves reflexivity from ethical perspective. In the activity, students needed to register an account on the website. While parts of students' information could be counterfeit, their own mobile number were required to complete the registration since they needed to receive SMS message from the system. Nonetheless, out of my expectation, on the first day of delivery, I discovered that students' mobile phone numbers were visible to all who already completed a registration. Though all students voluntarily followed the instructions without any objections, I felt uncomfortable to the setting. The society has raised her expectation over privacy protection. Since the pandemic, some students have chosen to attend the lessons through Microsoft Teams. Regardless the physical locations they are situating at, their backgrounds have been constituted as part of their privacies. Because of the consideration, for instance, I will not turn on students' camera function in Microsoft Teams unless they are willing to do so by themselves. In the same vein, even though we delivered a pedagogical activity, it did not mean we had the right to disclose students' privacy. After altering the situation, I expressed my concern and eventually the setting changed later as some digits were hidden. I also tried to ensure that the external organization would delete all the collected information after the activity. No data leakage was reported so far.

The above reminds educationists a significance of respecting everyone privacy, including those students, when designing and delivering experiential learning in future practice. In future learning, including for those applied degree programme, enriching students' learning experiences will require more input from external organization. In addition, pedagogical activities need to be embedded with more real-time and interactive elements. As Bradford (2019), Reid et al. (2018), and Wright et al. (2019) call forth, apart from focusing on students' learning experiences and their reflections, future deliveries of experiential learning should not neglect the expectation on protecting privacies of students, staff and all involved parties.

The delivery deserves technical consideration as well. As suggested, the website was hosted by an external organization. Despite of previous testing, on the first day of delivery of the experiential learning activity, the website was unexpectedly blocked by the firewall of the higher education probably out of security reason. I immediately used a laptop and pocket WiFi and managed to continue delivery of the experiential learning activity by instructing my students to connect with the Internet from non-institutional wireless network. The whole teaching plan, however, had to be adjusted due to the disruption. Nonetheless, due to the blockage, some of my colleagues teaching the same module at the similar timeslot failed to deliver the activity. After further understanding, the blockage was lifted afterwards, and the experiential learning activity could be delivered without facing the same technical difficulty.

The above reminds us to draw an attention on technical issue when delivering experiential learning in the future. Especially for applied degree programme, cooperation with external organization and utilization of online resources can hardly be avoided. On one hand, with a view of balancing cyber security and pedagogical needs, deliveries of experiential learning in future should therefore have much better understandings and communications with involved parties well in advance. On the other hand, as responsible educationists, we should prepare some contingent plans. After all, total reliance on anything is a risky decision.

23.8 Comparing Before and Since Coronavirus Pandemic

When compared with delivery of experiential learning before the pandemic, some remarks on pedagogical consideration should be made on its deliveries in the future. It should be noted that the above discussions, however, do not propose uniqueness of future pedagogical concern lays on its application of information technology. Researchers like Chiu (2019), Magnier-Watanabe et al. (2017), and Zhang and Choo (2019) illustrate information technology has been well utilized in experiential learning before the pandemic. Nevertheless, the pandemic does shape pedagogical consideration when delivering experiential learning in the future. Since the pandemic, maintaining a proper social distancing is an utmost concern. With a view of protecting public health, therefore, various measures have been introduced and many facilities were closed. Because of that, daily living of Hong Kong people has been greatly affected for around a year. On one hand, students have suffered from tremendous stress partially due to inadequate channeling of their loneliness and emotional needs under the pandemic. On the other hand, students have found themselves many difficulties in performing self-learning. For instance, because of social distancing, it is not easy for them to sit down and do revisions with their classmates in person. Besides, accessibility to learning materials is also restricted due to closure of both institutional and public libraries. Before the pandemic, on top of lecturing, students' learning could be easily supplemented with their own efforts almost without any constraints. Nevertheless, learning capability of students under the pandemic has been undermined (Azman et al., 2020, pp. 1058–1059; Basri et al., 2021, pp. 270–273; Mælan et al., 2021, pp. 15–17). With a view of helping the students to overcome the learning challenges from the pandemic, educationists have to assume a more active role. For instance, deliveries of experiential learning in future education should be accompanied with more online resources so that students can access to the learning materials without many difficulties. Educationists should also try to concern students' emotional needs and offer appropriate supports when necessary.

Another remark on delivering experiential learning is on consideration of students' mental needs. Utilization of information technology in delivery of experiential learning has become one of the pedagogical approaches. As Hargitai et al. (2021), Rizun and Strzelecki (2020), and Talib et al. (2021) delineate, with the challenges from the pandemic, application of information technology, including synchronous learning tools, has turned to be a common practice. Nonetheless, students' capability in drawing their attention in a physical classroom can be different from online lesson. Duration of the mentioned experiential learnings lasted from 1.5 h to over 2 h. Bailenson (2021) and Nadler (2020) propose that using synchronous learning tools for a long time can lead to tiredness whilst Fauville et al. (2021) proclaim female trends to suffer more exhaustion than male do. While discussion on the gender difference needs to be further validified, duration of engaging students in synchronous learning tools has to take their learning capability into consideration.

Integration with information technology also represents future deliveries of experiential learning have to be managed not only within classroom but also at online environment as well. Before the pandemic, educationists reviewed and made necessary adjustment to improve effectiveness of delivering experiential learning through practicing various techniques of classroom management. Attention of educationists could then be fully drawn on within classroom setting. The pandemic, however, has extended the management beyond conventional zone. In future deliveries of experiential learning, educationists have to live up to challenges of constantly and simultaneously engaging students from two different settings into relevant experiences and reflections, reviewing their processes and making appropriate adjustments.

23.9 Implications and Limitation

The aforementioned denotations verify the two research questions of this study. Through offering various challenges from at least ethical, pedagogical and technical perspectives, introspective reflexivity does help to enhance efficacy of delivering experiential learning. By having reflexivity at the delivery of experiential learning before and since the coronavirus pandemic, this study is an important implication to educationists and education policy makers. Brief accounts are as follows.

For educationists, in general, this study reminds them to use reflexivity as a strategy to keep their passions in education. Educationists surely have experienced huge stress and countless of discouragement and frustrations from different sources. Nonetheless, education is both a commitment and devotement to the students. Educationists should always keep vigilance and not to burnout. Especially for applied degree programme in future learning, reflexivity offers one of the effective approaches for educationists to realize the way of further polishing their pedagogies and to meet dynamics students' learning needs.

In particular, this study helps educationists to have a better awareness of offering educational equality and protecting privacy. Hong Kong higher education has advocated significances of offering fair and inclusive learning environment to students. Despite various achievements have been made, the pandemic reminds us to take an extra effort. Embedment of experiential learning with pedagogy is one of the key elements in curriculum design, especially for applied degree programme. When designing and implementing the integration, it demands a consideration of educational equality and privacy. Since the pandemic, expectation on information technology to facilitate teaching and learning activities has been stimulated and shared with educationists and students. The expectation is unlikely to fade out even after the pandemic. In the foreseeable futures, information technology is expected to assume an unparalleled role in experiential learning. While applications of information technology have helped to tackle a lot of pedagogical issues since the pandemic, however, it cannot address everything. By definition, information technology itself can safeguard neither educational equality nor privacy. Apart from considering and resolving all technical issues, it is educationists who are responsible to meet up with and not to overlook social expectations on equality, privacy and the likes when designing and delivering experiential learning in the futures. Failure to comply with the expectations can undermine efficacy of the learning experience and even can lead to undesirable consequences.

For education policy makers, this study can serve as one of the directions for policy evaluation of experiential learning in Hong Kong. Experiential learning was firstly introduced to Hong Kong in around 1970 as outdoor training programme (Cheung, 2013, p. 20). Experiential learning has been gradually integrated into secondary and higher education curricula since late 1990s and around 2000 respectively (Chan et al., 2019, p. 21; Cheung, 2013, p. 19). In the context of higher education, experiential learning is employed as a strategy to foster knowledge pursuit and whole-person development (Harfitt & Chow, 2020, p. 15). Nonetheless, as outlined above, effectiveness of experiential learning depends on qualities of its inputs. While reflexivity can help to shape quality of experiential learning, having reflexivity cannot be taken for granted. Apart from willingness, another critical element determining whether or not educationists can perform reflexivity over their pedagogies is availability. Especially when educationists have no other alternatives but have to engage into various administrative duties and prepare teaching materials for so many different modules due to limitation of resources in recruiting adequate manpower, expecting them to have genuine and in-depth reflexivity over their pedagogies can further overload their burdens. It is either infeasible or unsustainable. Regarding future learning, for the sake of educationists to keep their reflexivity on educational and pedagogical issues, education policy makers are advised to allocate more resources to higher education, especially for those applied degree programme as it highlights learning with experience and reflection.

This study, however, suffers from a limitation as it focused on classroom housed experiential learning. Delivery of non-classroom housed experiential learning can be different from those of classroom housed counterpart. Further similar studies on non-classroom housed experiential learning are recommended.

23.10 Conclusion

To sum up, higher education, especially those applied degree programme, has to cope with dynamics environment. The challenges from coronavirus pandemic have already illustrated that conventional pedagogical practices cannot remain unchanged. Even though the above discussions cannot be regarded as comprehensive, educationists can utilize reflexivity and take a prompt and powerful response. Reflexivity does offer a measure not only to polish educationists' professional identity and pedagogical approach but also to enhance students' learning experience. For the sake of students, future deliveries of experiential learning have to take social expectation and learning environment that students located at into consideration.

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Chapter 24
COVID-19 and Contactless Learning and Teaching: The Impact of Active Participation and User Acceptance

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Abstract Tertiary education in Hong Kong has dramatically changed after the outbreak of COVID-19. Teaching pedagogy and delivery method have been transformed into "Contactless Learning and Teaching" and online learning. However, the focus has been on online learning while seldom analyzing the effect of "Contactless Learning and Teaching" among previous research. This research addressed this gap by studying 156 university students in Hong Kong. ATLAS, a mobile app integrated with iBeacon technology was developed to deliver learning materials in "Contactless

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Learning and Teaching". The findings indicated that students who spent more time on "Contactless Learning and Teaching" have better academic performance. The active participation in "Contactless Learning and Teaching" and better academic results could also be explained by the Technology Acceptance Model in this study. The current study proves that iBeacon displays the potential of delivering learning and teaching materials amid the pandemic using the "Contactless Learning and Teaching" approach.

Keywords iBeacon/BLE technology · COVID-19 · Academic performance · Contactless learning and teaching · Technology acceptance model

24.1 Introduction

Since the sudden outbreak of COVID-19 in China around 2020 during the Spring Festival, it has spread rapidly worldwide (Huang et al., 2020). The disease spread relatively fast and affected the whole world (Singhal, 2020). After the pandemic outbreak, the Chinese government restricted all recreational activities, visits, and gatherings during the Spring Festival to prevent the spread of the virus (Tian et al., 2020). The COVID-19 now becomes a global issue (Sohrabi et al., 2020).

Several measures have been taken to prevent physical contact during the pandemic and contain the spread of COVID-19. The most stringent measure for epidemic prevention is lockdown (Lonergan & Chalmers, 2020), which aims to restrict the movement/mobility of people. Although the restriction measures are varied from country to country (Flaxman et al., 2020), the ultimate goal is to reduce economic activity and social interaction. For example, the French government implemented a strict nationwide blockade (Di Domenico et al., 2020); whereas, in some other countries, less strict measures of the lockdown are taken, such as discouraging social and physical distancing, prohibiting large-scale gatherings, and restricting the travel of residents (Born et al., 2021; Yamamoto et al., 2020). Psychological studies have found that the lockdown during the pandemic would influence individuals' well-being and psychosocial functioning, which would lead to a number of symptoms, such as depression, anxiety, sleep disturbances (Ernstsen & Havnen, 2021). Goolsbee and Syverson (2021) have also reported the economic collapse in 2020 caused by the pandemic of COVID-19. Thus, the revenues of the government have been reduced while they need to spend more to support those people in need (Bonaccorsi et al., 2020).

24.1.1 Influence of COVID-19 on Higher Education

COVID-19 has been spreading wantonly, exerting a great influence on people's life, work, and study. Like other social organizations, colleges and universities are also facing unprecedented challenges. The pandemic has forced the closure of schools, and more and more universities have to turn to online learning (Pokhrel & Chhetri, 2021). From the beginning of the outbreak to 3 April 2020, more than 90% of the students worldwide in more than 188 countries have been affected by COVID-19 (UNICEF, 2020). Online learning has been adopted as a learning method before the pandemic. Hrastinski (2008) argued that there are two types of online learning: asynchronous and synchronous types. Asynchronous learning is defined as allowing students to learn flexibly at their own pace, whereas synchronous learning is featured by using video-conferencing software to learn in real-time. Before the pandemic, most of the online learning methods were of the asynchronous type. Asynchronous learning is typical in MOOCs and it is similar to remote learning. Some of the components of asynchronous learning are integrated with the learning management system (LMS) in universities to enhance the learning experience of students as a supplementary means of face-to-face teaching. DeNeui and Dodge (2006) whether it would be beneficial to students to allow students to access the learning materials using LMS at any time. They found that the use of LMS is positively associated with students' academic performance. Thus, Daniel (2020) suggested that asynchronous learning is ideal as a learning method for universities and colleges under the pandemic since it is the simplest approach of remote teaching. Lowenthal et al. (2020) also examined asynchronous learning adopted in four universities in the U.S. They found that teachers will maintain their teaching quality under the pandemic even though they are not fully prepared or unprepared for remote teaching. However, asynchronous learning is not enough for students to achieve satisfying learning outcome under the pandemic if the interaction between teachers and students are needed as an essential condition for the discipline. For instance, the Harvard School of Dental Medicine was interviewed to collect feedback on remote teaching (Chen et al., 2020), and it is found that interactive elements are insufficient if asynchronous learning is adopted.

As a result, synchronous learning is preferred in some universities and colleges (Hrastinski, 2008). Students can discuss with their peers and ask teachers questions during the synchronous session. Technology has been developing rapidly and videoconferencing is frequently adopted and familiar to many people. Before the outbreak of COVID-19, scholars have already examined synchronous learning to satisfy the student's special needs. To name but a few, seven courses in Australian and New Zealand universities to implement synchronous learning for students who have to study remotely (Bower et al., 2015), and it is found that over 75% of students believe that they can gain same learning experience through synchronous learning as face-to-face learning. The results suggested that synchronous learning displays the potential of overcoming course delivery difficulties during the pandemic of COVID-19. For example, Guo (2020) also found that physics students have a better performance in basic calculus class as attending the synchronous online sessions than for those students absent in synchronous online sessions and only rely on asynchronous learning materials. For those students attending synchronous online sessions, more students believe that synchronous online sessions, which provide the opportunity for students to interact with the teacher, are the same as face-to-face teaching compared to their counterparts, implying that the engagement during lectures will be an important factor to facilitate students' study.

Despite the network support, great inconvenience is caused in delivering courses due to the pandemic of COVID-19; for this reason, it is necessary to carefully study the teaching quality and teaching pedagogy (Pokhrel & Chhetri, 2021). Moreover, such a serious epidemic has also caused a great psychological impact on students. College students are a vulnerable population, as they suffer more serious anxiety, depressive symptoms, and lack of self-esteem than the general public (Holm-Hadulla & Koutsoukou-Argyraki, 2015). What is more, a review by Aristovnik et al. (2020) indicates that negative emotions, including boredom, anxiety, and frustration are disturbing most teachers and students since they turned to another learning and teaching environment, and the students feel great burdens on students (Hernandez-Mella et al., 2019). Concerning the home quarantine during the epidemic, Aristovnik et al. (2020) also found that 42.6% of the students worried about their career future, and 40.2% about their study.

Besides, not every university or college, or every student in the world could benefit from synchronous online sessions. For example, most students from under-developed countries could not benefit from it due to technical issues (Coman et al., 2020), and there are not enough resources in some countries to implement synchronous teaching (Aboagye et al., 2021). Therefore, Suppan et al. (2021) re-designed asynchronous learning to include the element of engagement. They divided some medical students into groups with and without engagement modules in asynchronous teaching, and they found that students of asynchronous learning groups with engagement modules achieved better learning performance than their counterparts, implying that active participation during the class would be conducive to learning outcome, no matter it is synchronous or asynchronous teaching.

24.1.2 Contactless Learning and Teaching

To respond to the measures of the pandemic, the concept of "Contactless" is gradually become popular in many industries, such as healthcare service (Lee & Lee, 2021), sales and retails (Puriwat & Tripopsakul, 2021), hospitality (Kim et al., 2021), and human resources development (Yawson, 2020). Before the outbreak of COVID-19, the technology has been developing rapidly, so the contactless service could be provided in these industries, but there are few inventive provided to the practitioner to carry out the reform. The outbreak of COVID-19 became a trigger for an acceleration of the reform of contactless service (Makamure & Tsakeni, 2020). Hence, some scholars suggested that educators should develop contactless learning and teaching (Laplante, 2020). Online learning and teaching (including asynchronous and synchronous) are the formats in contactless learning and teaching. However, it is not enough for those disciplines requiring hands-on practice. In other words, the training of surgeons has been affected by the pandemic of COVID-19 since surgical trainees only had limited opportunities and clinical and surgical exposure to learning the operative and clinical skills (ElHawary et al., 2020), and it is necessary to urge the educators to provide a safe learning environment for those students. As a starting point, it is suggested that pencil-and-paper method should be replaced with advanced technology to monitor student attendance. For example, Ananta et al. (2020) used the smart card to monitor student's attendance records. In another example, Rajamanogaran et al. (2021) monitored student attendance in real-time using artificial intelligence. Teachers and students can be better prevented from the COVID-19 by using this contactless system. However, the above examples are given to discuss the logistic and administrative issues. It is also suggested that an innovative way should be adopted to implement the teaching for those disciplines that need hands-on experience.

One of the potential innovative ways that can be adopted for the teaching of those disciplines is self-learning location-based learning and teaching. Location-based learning and teaching have been applied to informal education settings for an extended period (Wang et al., 2017). For instance, Chen et al. (2017) developed a mobile app using iBeacon technology to facilitate students' self-learning in the science museum. They divided students into the self-learning and guidance group and found that the self-learning group would interact more with the exhibitions and gain a deeper understanding than their counterparts. Another example of informal education is a project led by Nosrati et al. (2018), who also adopted the iBeacon technology to disseminate Hamilton's cultural heritage and culture in Canada to the public. The results showed that the use of iBeacon app appreciation for culture and history had been boosted among Hamilton.

Other scholars had also used similar technology in formal education. For example, Schneider and Schaal (2017) developed a GPS-guided game (similar to Pokémon Go) for environmental education (EE) majors. Students are required to apply the knowledge of EE to address the location-specific issue in the real world. The results showed that with the use of GPS-guided game, the students' knowledge of EE and their awareness of environmental protection are greatly enhanced. Georgiou and Kyza (2018) also used a similar method for EE students, but they added the AR on top of the GPS-guided game. They identified a significant improvement in EE conceptual understanding, which is closely associated with the increased participation of students in the GPS-guided game. iBeacon technology has also been used in architectural design (Wu et al., 2016). The authors set up different Points of Interest (PoI) throughout the campus to drive students to learn smart green buildings. The results showed that it could help to improve the students' learning results regardless of their prior knowledge levels.

Other authors had also provided location-based services in the indoor environment. Atherton (2019) created several self-learning zones in different classrooms, so that students could learn simultaneously. They realized that students could learn collectively and independently, and the academic performance and motivation were improved among the independent learners. All the above studies have demonstrated that active participation in self-learning activities could help improve students' academic performance. Other studies have also shown that the teaching outcome of several disciplines benefits from it, such as language (Sun & Chang, 2014), cultural study (Hwang et al., 2017), history (Kyza & Georgiou, 2018), nutrition (Oppermann et al., 2018), and healthcare (Garrett et al., 2018). Therefore, the self-learning location-based learning and teaching found to positively influence the students' learning outcome of several disciplines since it provides the students with active learning opportunities. In contrast, it provides limited opportunity to the student in helping them achieve active learning outcomes by adopting synchronous or asynchronous teaching.

24.1.3 Factor to Influence the Implementation

The literature has shown a growing interest in using iBeacon or location-based technology in mobile to provide contactless learning and teaching (Ozdemir et al., 2018). However, only a few studies focus on how to encourage students to use the mobile app.

The application of location-based technology become famous in contactless learning and teaching recently. Many researches are trying to investigate its features that influence learners and educators' degree of acceptance among those technology (Al-Emran et al., 2018). Empirical evidence indicates that those technologies can provide support to the students in their learning activities of many disciplines, including education (Liu et al., 2010), business (Mac Callum & Jeffrey, 2013), and information technology (Hamidi & Chavoshi, 2018). With enhanced affordances of contactless learning and teaching system, there would be growing interest in the factors that affect its acceptance (Althunibat, 2015).

Davis (1989) suggested the Technology Acceptance Model (TAM) to examine the determinants of users' acceptance for using the technology. Originally, TAM postulates that *perceived usefulness* and *perceived ease of use* are two main factors associated with the user acceptance. Perceived usefulness is defined as the degree to which the user believes that it would enhance their performance by using a specific system. Perceived ease of use refers to the degree to which the user believes that it would cost less effort by using a specific system. TAM also posits that the actual use of a specific system is determined by *behavioral intention to use*, determined by both perceived usefulness and *attitude toward using technology*. Figure 24.1 shows the proposed initial model of TAM.

After the publication of Davis (1989), in several studies, it is argued that the attitude toward the use of technology would be removed to simplify the model without losing the explaining power (Davis et al., 1989; Szajna, 1996). Therefore, the extended model, TAM2 (Venkatesh & Davis, 2000), and another subsequent model, UTUAT (Venkatesh et al., 2003) had removed the attitude toward using technology.

Šumak et al. (2011) conducted a meta-analysis to summarize the TAM-related studies, and they found that the perceived usefulness and the perceived ease of use are two major factors that affect user's intention with using e-learning systems. For instance, Brunel University offered a series of online courses in LMS and examined the factors of increasing the use of the platform (Abu-Al-Aish & Love, 2013),

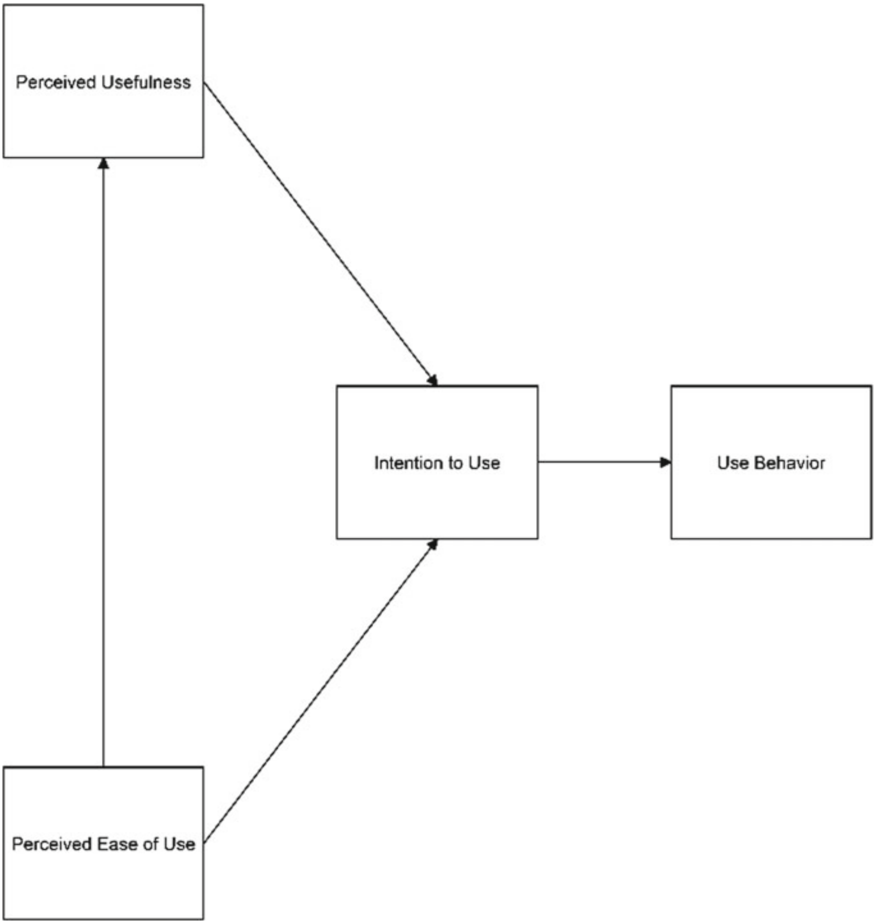

Fig. 24.1 Original technology acceptance model

finding that both the perceived ease of use and the perceived usefulness have been significantly and positively associated to use of the platform. Another example of this relationship can be found in Asia (Wang et al., 2009). Since the outbreak of COVID-19, there is a growing trend of examining the use of online and remote learning using TAM. For example, Siron et al. (2020) used TAM to evaluate the use of e-learning platforms. They found that both the perceived usefulness and the perceived ease of use are the major factors affecting students' intention to use e-learning at several state universities in Indonesia during the pandemic.

24.1.4 Gaps in the Literature and Present Study

The evidence suggests that active participation and great student engagement in self-learn location-based learning and teaching activity, are associated with better performance. Nevertheless, it is possible that some other factors such as user acceptance and academic discipline would affect the above relationship. There are some issues to notice due to the correlational nature of this study (Hung et al., 2017), as this study attempted to provide a better understanding of the influence of active participation based on user acceptance and academic discipline, which would provide insights into the issue and facilitate the educators to develop more effective teaching methods to help the students achieve better learning outcome during the pandemic (Devlin & Samarawickrema, 2010).

There are several gaps in the literature on the relationship between active participation and academic performance. First and foremost, the previous findings are concentrated on online and remote learning and teaching but paid less attention to the potential benefits of location-based learning and teaching. Focus is put on the TAM model instead of the relationship between TAM, academic discipline, and academic performance in most previous studies.

The present study tried to address these gaps by performing path analysis to include the TAM and academic discipline in our model (Sharma et al., 1981). In the present study, it hypothesizes that (1) perceived usefulness mediates the relationship between perceived ease of use and intention to use, (2) intention to use positively correlated with actual usage, (3) actual usage is positively correlated with academic performance, and (4) academic discipline does not moderate the relationship between actual usage and academic performance.

24.2 Method and Procedure

24.2.1 Participants

We recruited study participants from The Hong Kong Polytechnic University, The University of Hong Kong, The Chinese University of Hong Kong, and Hong Kong Baptist University between January 2019 and December 2019. A total of 156 students from 7 courses in 4 disciplines participated in this study.

24.2.2 Location-Based Service: Our Use of ATLAS Software and iBeacon Hardware

The project team developed a learning and teaching system named as "Augmented Teaching and Learning Advancement System" (ATLAS). The mobile app for ATLAS was developed to deliver self-learn learning and teaching activities by utilizing iBeacon-based technology and realizing "Contactless Learning and Teaching". For every activity, the teacher would set up several learning locations to deliver learning and teaching material. After the teacher set up the contactless learning and teaching activity in ATLAS, the mobile app would guide the students to different locations. It depends on the students whether to participate in the contactless activity, and it is a voluntary activity without affecting their final academic performance. In addition to the functions mentioned above, students also used the ATLAS app to take quizzes and tests. Students' mobiles install the app on their mobile phones and sign the written consent before participating in the study. More details are provided on the ATLAS website: https://www.atlas-learn.com/.

24.2.3 Measurement

24.2.3.1 Academic Performance

Academic performance was defined as students' in-class test scores in this study. Students were required to install the ATLAS app on their mobiles. All the tests were fact-based and designed based on multiple-choice questions. The quiz is organized via the ATLAS app and the participants' test scores are recorded in the form of a percentage.

24.2.3.2 Actual Usage

We used the time of participation in self-learn location-based learning and teaching activity is taken as the actual index of use in this study. The ATLAS app recorded their participation time in seconds automatically when they participated in the activity. Since the participation is voluntary as a supplementary means of the lecture giving, the actual use was also operationalized and defined as active participation.

24.2.3.3 Tam

The perceived usefulness, perceived ease of use, and intention to use were adopted by introducing the Technology Acceptance Model (TAM). Three constructs were modified to fit our system (ATLAS), which contained 9, 4, and 3 items respectively for perceived usefulness, perceived ease of use, and intention to use. The items were rated using a five-point Likert scale (1 = strongly disagree and 5 = strongly agree), where Cronbach's alphas were 0.97, 0.88, and 0.94 respectively for perceived usefulness, perceived ease of use, and intention to use.

24.2.3.4 Academic Discipline

We used Biglan (1973) classification is perform to divide the academic disciplines into soft (code = 1) or hard fields (code = 2). The disciplines are classified into soft (a low degree of consensus) and hard (a high degree of consensus) through the categorization.

24.2.4 Data Analysis

We performed a path analysis in R studio with the "lavaan" package, version 0.6–8 (Rosseel, 2012). Figure 24.2 displayed the hypothetical model being tested in the current study. We specified perceived usefulness as a mediator. The insignificant paths in the initial model will be removed, and then re-analyzed again until all the paths were significant. Maximum likelihood (ML) was used to estimate the parameter and the robust test statistic was reported. We specified 5000 bootstrap samples based on 95% confidence intervals (CIs). An indirect effect can be found when the 95% CIs do not include zero. Model fit would be indicated by a non-significant chi-square, Root Mean Square Error of Approximation (RMSEA) < 0.06, Standardized Root Mean Square Residual (SRMA) < 0.08 (Hu & Bentler, 1999). All alpha was set at 0.05, two-tailed.

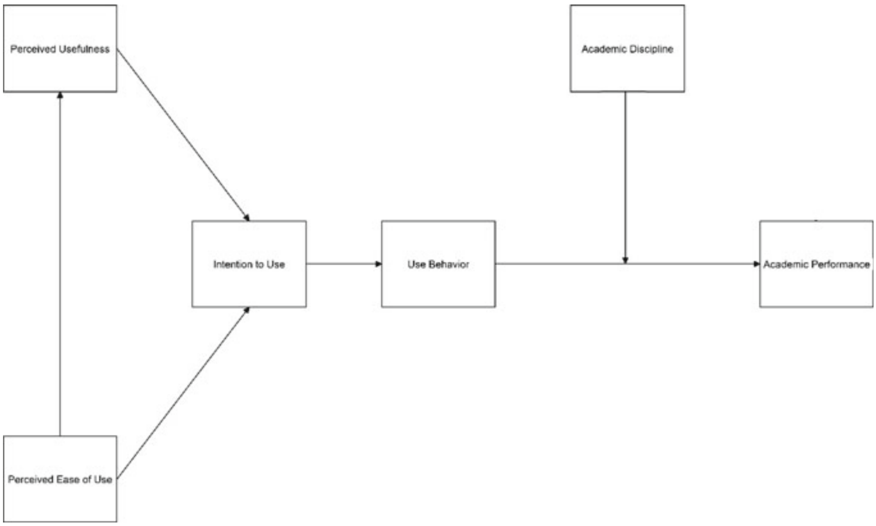

Fig. 24.2 Hypothetical model

24.3 Results

As shown in Table 24.1, participants' average test score was 58.5%, and 92.3% of them were hard field. Most of them came from the Hong Kong Polytechnic University. Students participated in the self-learn learning and teaching activity for an average of 45.78 s (SD = 145.18). The mean scores of the perceived usefulness, perceived ease of use, and intention to use were 3.00 ± 0.92, 3.34 ± 0.86, and 3.04 ± 1.00, respectively.

Table 24.2 showed the results of our path analysis. The model fit index suggests that the initial model does not yield a goodness of fit (X^2 (11) = 391.694, p = < 0.001, RMSEA = 0.471 (90% CI = 0.432 − 0.512, SRMR = 0.197)). We removed the

Table 24.1 Descriptive information

	Mean/N	SD/%
Test score (%)	58.48	36.29
TAM		
Perceived usefulness	3.00	0.92
Perceived ease of use	3.34	0.86
Intention to use	3.04	1.00
Use behavior (s)	45.78	145.18
Academic discipline		
Soft field	12	7.69%
Hard field	144	92.31%
University		
The Chinese University of Hong Kong	5	3.21%
Hong Kong Baptist University	7	4.49%
The Hong Kong Polytechnic University	129	82.69%
The University of Hong Kong	15	9.61%

Table 24.2 Initial model

Path			Standardized coefficient	*p*
Perceived ease of use	➔	Perceived usefulness	0.760	<0.001
Perceived ease of use	➔	Intention to use	0.127	0.029
Perceived usefulness	➔	Intention to use	0.806	<0.001
Intention to use	➔	Use behavior	0.161	0.042
Use behavior	➔	Academic performance	0.229	0.003
Academic discipline	➔	Academic performance	0.037	0.900
Use behavior X academic discipline	➔	Academic performance	0.000	0.998

X^2 (11) = 391.694, p = < 0.001, RMSEA = 0.471 (90% CI = 0.432 − 0.512, SRMR = 0.197)

Table 24.3 Indirect effect to intention to use

	Indirect effect via perceived usefulness	Total effect
Perceived ease of use	Standardized coefficient	Standardized coefficient
	0.525 [0.420, 0.626]	0.633 [0.511, 0.740]

Table 24.4 Final model

Path			Standardized coefficient	*p*
Perceived ease of use	➔	Perceived usefulness	0.650	<0.001
Perceived ease of use	➔	Intention to use	0.109	0.029
Perceived usefulness	➔	Intention to use	0.806	<0.001
Intention to use	➔	Use behavior	0.161	0.042
Use behavior	➔	Academic performance	0.226	0.004

X^2 (5) = 5.669, p = 0.340, RMSEA = 0.029 (90% CI = 0.000 − 0.118, SRMR = 0.038)

insignificant paths, which ranges from academic discipline to academic performance, and to interaction between use behavior and academic discipline, and re-analyzed the path analysis. The results showed that the final model yielded a goodness of fit (X^2 (5) = 5.669, p = 0.340, RMSEA = 0.029 (90% CI = 0.000 − 0.118, SRMR = 0.038)). Th bootstrap result showed that perceived usefulness is a mediator of perceived ease of use (ß = 0.525, 95% CI [0.420, 0.626]) (Table 24.3). Table 24.4 shows indirect effect and general effect of perceived ease of use. Regarding the relationship between intention to use and actual usage, a positive relationship was identified (ß = 0.161, p = 0.042). Actual usage was also positively associated with academic performance (ß = 0.226, p = 0.004) (Fig. 24.3).

24.4 Discussion

The findings suggested a significant relationship between college students' active participation and their academic performance. Moreover, this finding was consistent with the recent research (Carini et al., 2006; Kahu & Nelson, 2017). For instance, Carini et al. (2006) found that enhanced engagement of students is associated with improved learning outcomes. Their study also showed that students with lower learning ability could benefit more from improved engagement than their more capable counterparts. Another example of it is the research by Kahu and Nelson (2017), who assessed the emotional and cognitive engagement of students realized that students are emotionally engaged when they are interested in the teaching content and cognitively engaged when they believe in their ability to understand and complete a learning task. They argued that emotional and cognitive engagement could serve as

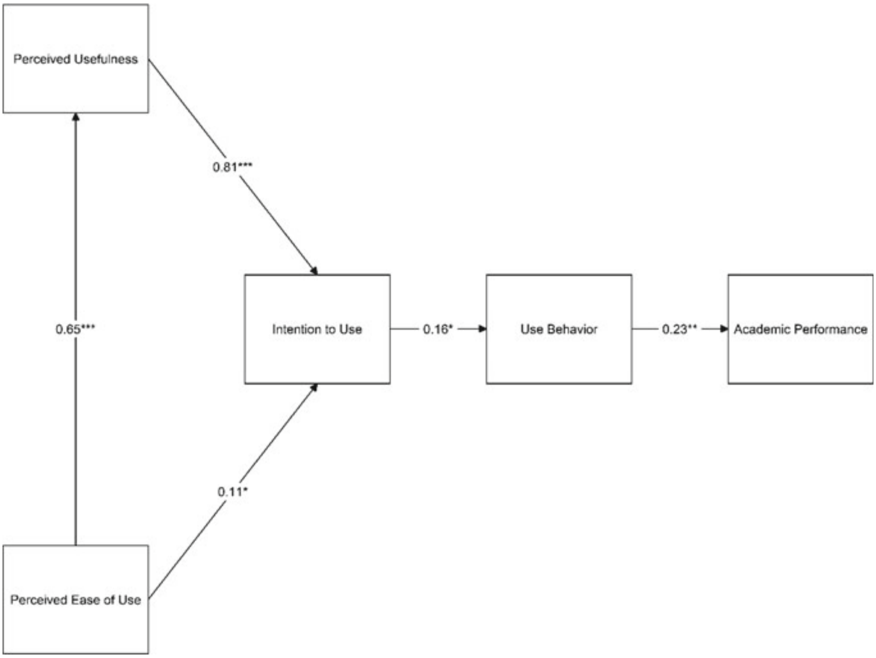

Fig. 24.3 Final model

important predictive factors of academic success. Therefore, we might explain this finding by arguing that students who actively participated in the activity might be more engaged than their counterparts (Montello, 1988) to improve their academic performance.

The moderation analysis also revealed that academic discipline does not moderate the relationship between college students' active participation and academic performance. This indicates that active participation is conducive to various disciplines in terms of academic performance. This finding is consistent with that of Ifinedo et al. (2018)'s. They conducted a cross-sectional survey to examine the use of Moodle and found that there was no significant interaction effect between academic discipline and use of Moodle in terms of academic performance.

Also, this study's findings suggested that the perceived usefulness of the mobile app did indeed mediate the relationship between perceived ease of use and intention to use. Furthermore, the findings showed that students who had the intention to use the mobile app would actively participate in the self-learning location-based learning and teaching activity. This finding was consistent with previous research (Dasgupta et al., 2002), which indicated that TAM would be useful in explaining the use of the e-learning system. The results also implied that perceived usefulness and perceived ease of use might affect academic performance ultimately, in the sense that technology acceptance, active learning, and appropriate learning technology might be more common in students with high expectations of the specific e-learning system. Previous studies had also supported that TAM is a predictive instrument for student's academic performance using different e-learning system, for example, Moodle (Ifinedo et al., 2018), Cloud Computing (Ali et al., 2018), UCOM (Tawafak et al., 2018), and Prometheus, which was developed by the George Washington University (Dasgupta et al., 2002). Hence, the current study differed from previous studies, in which using the e-learning system is compulsory. The use of ATLAS in the current study is voluntary. Our results had added to the literature that TAM would be explained active participation in a voluntary-based e-learning system.

Other studies have shown that active learning beyond the classroom could also potentially benefit academic performance. According to Rose et al. (2019), the final exam results are greatly improved if the student watches the supplementary learning video after class. Kudish et al. (2016) also argued that students who engage in the voluntary-based workshop improve academic performance as measured by GPA. The benefit of active learning beyond the classroom is also documented by Little (2015). They conducted a literature review on the flipped classroom, which used pre-recorded lecture videos to deliver learning and teaching materials outside the classroom, and found that student academic performance was improved when teachers implement the flipped classroom. To maximize the benefit flipped classroom, there was an educational reform to redesign the course curricula in different disciplines, for example, healthcare (McLaughlin et al., 2014), psychology (Borchardt & Bozer, 2017), and management (Albert & Beatty, 2014). In short, the previous studies indicated that active learning has an impact on students' academic performance.

The current finding would give university administrators and teachers important insights and recommendations to enhance the quality of learning and teaching during the COVID-19. First, given our finding of the relationship between student's academic performance and active participation, which is initiated by self-learning location-based learning and teaching activity, the thought, which face-to-face teaching will benefit the student most, should be abandoned. We suggested that this vicious cycle could be ended through teachers' continued education and professional development.

Second, educational reform should redesign the course curricula as a new normal learning and teaching practice. By redesigning all kinds of course curricula, we think that universities can maximize students' learning opportunities and outcomes, and more flexible learning and teaching delivery would be most beneficial to students, facilitating students to attend active learning and enhance their learning outcomes.

Various universities have increased the component to inspire students' active learning to apply these and similar findings to maximum effect. For example, 4 universities in the US used asynchronous videos to facilitate student's discussion beyond the class time (Lowenthal et al., 2020). These changes allowed students to interact more with teachers easily. Cardiff University also provided more discussion sessions for students to interact with teachers (Peimani & Kamalipour, 2021). The University of the West Indies designs several self-guided study materials composed of textbooks, digital electronic visual tutors, and asynchronous videos for Introduction to Digital Electronics (George, 2020). Even more, the Department of Sociology at a large northwest university in England (UK) implemented the lecture outside the classroom and facilitated students to make an observation based on the knowledge of sociology (Carlin, 2020).

Moreover, given our findings that students' academic performance was positively associated with the participation time in the self-learn location-based learning and teaching activity, teachers should adopt the innovative technology to carry out the location-based teaching activity to avoid close contacts pandemic. For example, iBeacon technology would be one of the promising innovative technology. Since iBeacon would be used to deliver information (including message, pre-recorded video, document, or even quiz and test) to mobile by the device's location automatically, the teacher can provide support to students to minimize their risk. For example, the University of Oklahoma had developed the NavApp, which utilized the iBeacon technology to help students navigate the university library (Hashish et al., 2017). Hence, implementation of iBeacon technology would be extended throughout the campus and provide learning opportunities to students with a minimum number of supporting staff and a tight budget. Another example is the case of ViRLUS (virtual reality learning ubiquitous space) (Konstantinidis, 2021). This system utilizes the Internet of Thing (IoT) and the concept of gamification to allow healthcare students to interact with virtual patients in a real environment. Therefore, it is believed that contactless learning and teaching would have the potential benefit for students (Georgiou & Kyza, 2018; Schneider & Schaal, 2017; Wu et al., 2016).

24.5 Conclusion and Further Direction

In the present study, it is highlighted that iBeacon can contribute to the research by validating previous findings; that is, students' active participation is associated with their academic performance. However, it has several limitations to overcome by future researchers.

First of all, since we employed the cross-sectional study design for current research, the result of the relationship between active participation, academic performance, and user acceptance may not be generalized (Sedgwick, 2014). Future researchers might use a longitudinal study design to understand better the underlying mechanisms driving our theoretical model.

Second, in the present study, the logistic issue arising from the implementation of contactless learning and teaching is not addressed, such as the number of students involved in an activity, the length, form, and content of each learning material. These recommendations may be important to educators and could be covered in future studies.

Third, this study adapted the iBeacon technology to provide self-learn location-based learning and teaching without integrating other innovative technology. The previous literature suggested that AR and VR would amplify the benefit of location-based learning and teaching. Further research might be conducted to compare the benefit of various methods in delivering materials among "Contactless Learning and Teaching".

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Part IV
Lifelong Learning, Partnering and the Future of Work

Chapter 25
Making Connections Between Work and Study—Maximising the Value of Degree Apprenticeships

Trudy Spencer, Sue Parr, and Robin Clark

Abstract Apprenticeships have been a part of education for centuries. The modern form of the apprenticeship, the degree apprenticeship, blends practical skills-based elements with a recognised course of academic study. The challenge for providers in integrating the work-based element of the learning with that delivered through the academic interactions are the focus of this chapter. The solution presented here is based on converting formal learning hours from the classroom to work-based opportunities where apprentices apply and practice activities in real world settings. The approach involves negotiating individual learning contracts, working in community of practice teams and providing multiple opportunities for students to fully reflect on their experiences at work. Assessment results have been encouraging and the experience has enhanced student confidence in relation to the work-based requirements of the apprenticeship. Reflections of this approach are positive, suggesting possible wider applicability to ensure that the value of the educational pathway is maximised.

Keywords Degree apprenticeships · Work-based learning · Negotiated learning · Mentoring

25.1 Introduction

The fast pace of change in the modern world is challenging education providers and professionals in many and different ways as they seek to provide meaningful educational experiences for learners. The need to keep learning relevant and authentic

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is a core element of many conversations in this space, especially where the educational award is intended to be a pathway into a career. Engineering, Technology and Management subjects are prime examples of where this is the case. Employers want to see the graduates they employ ‘ready for work’ and ‘able to have an impact’ at the earliest point possible. Professional bodies provide a framework to aid this transition, but there remains a gap as universities are catering to a wide range of possible job pathways that their graduates may embark on.

Degree Apprenticeships are a way for businesses to enable the development of their human resource in a way that ensures its compatibility with the strategic and operational aims of the company. The Degree Apprenticeship offers the opportunity for academic rigour alongside the practical relevance to both learner and company as the focus of the education is very much built around the idea that it should be applied and transferable into the learner’s work environment. Developed around agreed standards, the Degree Apprenticeships offer flexibility but also need a three-way commitment, from the learner, the provider and the company. This three-way partnership is the key to success and needs to be nurtured to work effectively.

The growth of Degree Apprenticeships in the UK Higher Education sector has seen a range of approaches being adopted, even when linked to the same disciplinary standard. This demonstrates the richness of this area and suggests that it has a major role to play in the development of the workforce of the future. As an academic department in a UK Russell Group University, WMG has developed considerable expertise over the last 5 years and has developed an approach that seeks to both challenge the learners and also meet the needs of the industry clients with which it works.

This chapter specifically focuses on one of the key work-based elements of the Degree Apprenticeship, namely the Negotiated Learning Module. This module guides learners towards the successful compilation of a portfolio of experiences they have gained in their work environment that demonstrate the achievement of the knowledge, skills and behaviours required by the standard. This can sometimes be a stretch for the learners, especially enabling them to see ‘past their day job’ to the wealth of contributions they make and also to where there may be gaps to fill.

25.2 The Context

WMG (formerly Warwick Manufacturing Group) is a unique University Department in that its focus is on ‘applied’ work, whether that be research, consultancy or education. Over 40 years it has become something of an exemplar in terms of the way in which it has developed effective academia/industry relationships that have resulted in relevant research programmes and a course portfolio designed to create the next generation of industry leaders. Today WMG specialises in three key areas—sustainability and the technologies and thinking to achieve net zero, the digital environment and the application to a range of industry requirements and workforce transformation through the provision of a flexible range of learning opportunities, both for award and non-award, that will meet the knowledge and skills needs of industry and wider society.

The focus is always on what will the added value be to industry/society of this piece of work/study. The landscape is complex, something that has consistently challenged the ways in which the department operates and how it interacts with prospective students, clients and funding bodies. In terms of education, the portfolio of courses is broad. From traditional 3 or 4 year undergraduate degrees and a comprehensive Masters provision, to short courses and bespoke provision including Degree Apprenticeships at different educational levels, the choice of courses is often linked to areas of research specialism within the Department. The increased options and desire for industry input to courses has made the space very dynamic and the diverse nature of the learners and their commitments has encouraged teachers to explore a wider variety of delivery models that better suit learner needs.

25.3 Degree Apprenticeships in UK Higher Education

Throughout their long history, apprenticeships have fallen in and out of favour for a variety of reasons. These reasons are very often to do with quality, cost, the political or employment environment and their perceived value or status. During the reign of Elizabeth 1st in the 16th Century, Parliamentary legislation made it illegal for anyone to "exercise any art, mystery or occupation now used or occupied within the realm of England and Wales except he shall have been brought up therein seven years at the least as an apprentice". In Britain, the more recent "high water mark for apprenticeships" was in the 1960's when roughly 35% of male school leavers aged 15–17 went on to do a trade apprenticeship. By 1990 the numbers had dropped to 53,000.

The nature of work has obviously changed fundamentally, as have the educational aspirations of young people, since the middle of last century and that change has continued even more rapidly in the first two decades of this century. The impact of Covid, the increased use of digital, the ability for more data to be collected (from machines as well as people) and the demands of Net Zero and other climate considerations will be shifting the nature of jobs further and faster than ever as we consider the future.

Apprenticeships were created with the intention of them being one response to the need for a better, more appropriately skilled workforce. Apprentices have knowledge and experiences that are developed not only as a result of what they learned in terms of content but also the environment in which they have been learning. The richness of that environment, whether working with experienced colleagues, working on real, critical projects within the culture of the employing organisation or when grappling with the challenges and opportunities that those experiences provide, has the potential to add immense additional value to the development of the apprentice.

Degree Apprenticeships were part of the new apprenticeship initiatives introduced in the UK in 2017. Previously apprentices had more usually been associated with the practical skills learning delivered at a pre-undergraduate level. In introducing undergraduate and postgraduate level apprenticeships there was a recognition from industry (who were driving this change) that they needed a workforce with higher level skills that would help them meet their current needs and would also develop the skills they would need to adapt to future challenges. Skills were needed, particularly in those areas experiencing shortages along with the reskilling of existing workforces to meet the challenges of changes in markets, regulations and/or technology. What businesses also needed was for apprentices to not only develop the necessary technical ability, but also, through the programmes, to become "self-managing practitioners and self- directed learners" (Lester & Costley, 2010). That way they would be able to be creative in identifying new solutions for their business and to develop the new learning or experiences they needed to support that growth.

At their best, Degree Apprenticeships integrate all of the elements to ensure the right knowledge is learned, the right application to real work-based problems are enabled and that the support for developing professional skills and behaviours is provided. This support encourages apprentices to be increasingly self-directed in identifying the learning and the work opportunities that will facilitate that learning as they progress through the programme.

Of course, much underpinning knowledge comes from the academic element of the programmes, but it is recognised that further knowledge and the real understanding of it comes from the workplace (Garnett, 2020) and the context that provides. All apprentices tend to work within project teams and have workplace mentors within the employing organisations which gives them a workplace community from which they also learn the skills they need and the professional behaviours that the organisations expect. In the twin academic and vocational environments (Siebert et al., 2009) and the opportunities that both provide for learning and peer support and challenge, the apprentices tend to develop very quickly the skills they need to progress in their careers. However, getting the balance of all of these elements right can be a challenge for education providers, providers who are more used to creating and defining their own curriculum in its entirety. For businesses too, ensuring apprentices have the time to reflect and to apply their learning, and the opportunities to experience and develop all of the skills that the apprenticeship standards expect, can be difficult when different business critical work may take precedence. One way to try and meet the various needs of everyone involved (the learners, employers and providers), whilst establishing a clear focus for learners, is through the use of Negotiated Learning (Laycock & Karpel, 2016). It is this area that forms the subject of this chapter.

Covid may be one very significant factor, but it is certainly not the only reason why so many industries today are changing or having to change quickly. By considering new business models, new technology, changes in regulations and differences in the way people want to live, businesses are having to look again at what they do and how they do it. Such changes and the need for speed in developing new competencies along with increased adaptability, emphasise the value of apprenticeships where individuals are able to develop in and with the business. It is the increased speed of these changes though that adds to the challenge for universities to have all of the current thinking within the curriculum. It is going to be increasingly common for conventional university curricula to lag behind, for example, the technology that apprentices are using day to day in their workplaces. Universities will need to become more confident about providing less of the curriculum themselves and recognising that learning within the workplace is equally academically valid as well as professionally vital. (Garnett, 2016). Flexibility and agility will be the crucial considerations of the future.

25.4 Literature Review

In exploring some of the underpinning literature, we will view it from three perspectives—those of policy, pedagogy and practicality. In doing this, the value of the ideas will be more transferable to other applied education contexts.

25.4.1 Policy

As stated earlier, the introduction of Degree Apprenticeships in the UK is a relatively recent step. In 2015 the UK Government published its vision for apprenticeships in 2020, particularly highlighting projected job openings in the millions and with a strong emphasis on the STEM and digital spaces (HM Government, 2015). This was reinforced in a Government Review in 2017 that stated that "*apprenticeships remain central to the Government's vision to improve skills, build sustainable growth and to enable individuals to succeed and progress in their careers*" (UK Department for Education, 2017).

These top level policy aspirations were all very encouraging, but the real efforts needed to take place in the fora that brought regulators, providers and industry clients together. This is the space where standards were identified, developed and approved. The Institute for Apprenticeships and Technical Education (IfATE) is the home for all of the standards and is instrumental in guiding the process (IfATE, 2021).

The journey forward has not always been easy as the question of appropriate funding and what providers can deliver within the funding constraints is still a topic of debate. This issue along with the associated areas of promotion, ease of engagement and the consideration of under-represented groups were explored in a Universities UK Report published in 2019 (UUK, 2019). Yet despite these challenges, the UK remains invested in the idea that degree apprenticeships have an important role to play in the future of higher education.

25.4.2 Pedagogy

When considering the pedagogy that is appropriate for an effective degree apprenticeship, several important elements need to be explored. Starting with a definition of work-based learning, it becomes clear that what we are considering is a meaningful integration of academic knowledge acquisition and professional skills development. The UK Quality Assurance Agency definition of work-based learning states, "*work-based learning opportunities enable students to apply and integrate areas of subject and professional knowledge, skills and behaviours to enable them to meet course learning outcomes*" (QAA, 2018).

If we then deconstruct this statement, we can start to explore the areas of pedagogy that are most important if we are to create valuable learning experiences for learners. Signature pedagogies, authenticity, learning together, student support and evaluation of learning are all identified as important areas for learning success. More fundamentally though, appropriate consideration of constructive alignment is also essential.

If we start with constructive alignment, Biggs seminal work is an important foundation for any course design (Biggs, 2003). The articulation of clear learning outcomes is supported by the appropriate standard, so provides a good starting point (Chan & Lee, 2019). The development of appropriate and engaging learning approaches that are appropriate for learners, that are varied and inclusive (Clark & Andrews, 2014) and that take account of the signature pedagogies for the subject being studied (Esterhazy et al., 2021; Shulman, 2005) are an important next step. This work then needs to be supported with appropriate assessment of learning and skills development that emphasises the dual objectives of work-based learning and degree apprenticeships more broadly (Lillis & Bravenboer, 2020).

Authenticity is an important feature of work-based education as the teacher seeks to provide a learning experience that is as closely aligned to the professional work environment as is possible. Much has been written on this topic across a range of disciplines, a valuable position as ideas about authenticity can be transferable between subjects or, if not transferable, can stimulate creative thinking that can lead to adaptation (see for example: Strobel et al., 2013; Bessa et al., 2018; Aadland & Aaboen, 2020).

Coupled with the goal of creating authentic learning are the remaining two elements identified above. Work is rarely a solitary experience, so the need to embrace group or team working is identified as an important feature of high quality work-based learning (Siebert et al., 2009). Work is often a very social environment so developing skills such as being able to listen, share and collaborate are essential to most businesses. The learners themselves are often a diverse group and will likely enter their learning with a range of previous educational experiences. When combined with the demands of the learning, their job and personal responsibilities, having an appropriate support network in place is important for success (Namjoshi, 2020). This last point will be developed in the next section.

25.4.3 Practicalities

From a practical perspective there are a few key themes in the literature regarding work-based learning. The first is around mentor support in the workplace. According to Rowe et al. (2017), high quality mentor support can have a significant impact on workplace learning, particularly in terms of identifying valuable opportunities and by providing guidance to learners. Minton and Lowe (2019) agree, suggesting that significant workplace learning can take place through the provision of formal employer support. Orland-Barak (2005) cited in Rowe et al. (2020) more specifically proposes that there is "*greater evidence of reflective thinking in participants who form close alliances with workplace mentors*".

Another theme is that regarding the academic staff required to deliver work-based learning. A number of authors recognise the specific skill set required by academics to oversee reflective practice and who themselves can challenge and innovate (Brockbank and McGill, 2007, cited in Rowe et al., 2020; Peach & Mansfield, 2018). There is a recognition of a shift in role from teacher to facilitator for this style of learning, with a blend of pedagogic and practical understanding required (Rowe et al., 2020). The literature recognises the value of this role to work-based learners. Regular contact through proactive touch points and the provision of bespoke guidance is of particular importance to these learners (Rowe et al., 2020).

Further to this, there is a recognition of the importance of the tripartite relationship between the apprentice, their employer and the provider to work collaboratively (Roberts et al., 2019). Minton and Lowe (2019) specifically highlight the importance of a close relationship between the employer and provider, which Peach and Mansfield (2018) note makes the tutor (provider) role particularly multifaceted and challenging. A slightly different perspective is put forward by Irons (2017) who, whilst agreeing with the value of a highly collaborative approach, identifies the intensity of the relationship, suggesting a significant amount of time and effort needs to be dedicated to this. He goes on to suggest that this has implications for the number of different employers one provider can work with in this highly collaborative manner.

A final practicality that the authors note from the literature is specific to degree apprenticeships and the need for these to be seen as fully integrated programmes drawing on work based pedagogical practice rather than separate "academic" and "on the job" learning streams (Minton & Lowe, 2019). They propose that to promote effective learning, programmes should be seamless and holistic based on sound work based learning design and facilitated by the strong relationships mentioned above. This can add to the challenge for traditional education institutions where not only the processes for approving new courses can be lengthy, but also it can be difficult to acknowledge the equal value of, potentially, more informal on the job learning. Allowing space in a conventional curriculum for individual apprentice defined learning that is appropriate to their immediate development needs and the requirements of the apprenticeship standard, but seems quite far removed from the elements of a traditionally defined curriculum can sometimes seem like a difficult step to take. Formal learning obviously tends to be very structured, informal learning is far less so—in order to combine the two some creative space or thread needs to be applied.

25.5 Senior Leader Degree Apprenticeship Case Study

This case study is based on WMG's experiences of delivering a Level 7 Masters Degree Apprenticeship Programme to part time learners; the Senior Leader Degree Apprenticeship, which accepted its first intake in September 2018. A three-year programme, delivering learning against a nationally approved Masters level apprenticeship standard, parts of which are assessed by an independent professional management body, presented WMG with some challenges in how to satisfy multiple stakeholders whilst providing a clear learning pathway for the students.

An additional consideration was how to fully integrate and recognise the value of the learning occurring in the workplace as a result of the programme. The nature of Degree Apprenticeships, with a strong focus on a learner's role at work, provide a unique opportunity for the taught programme to feed ideas and concepts to learners for them to reflect on in their specific work context. These ideas and concepts inform and influence the learner's approach in the workplace and can have a significant impact on their progression and that of the organisations they work for (Helyer et al., 2021). Some of this impact can be recorded in work-based assignments but these often capture just small, discrete aspects of the application of learning at work and do not fully reflect the complete learning journey made by a part time student.

Against this backdrop and in an attempt to address both of these dimensions, WMG decided to formally incorporate a proportion of the Apprenticeship portfolio requirement into the credit bearing Masters programme. This gave a focus for learners to record a more complete account of their learning journey with an emphasis on capturing learning in the workplace, which would then feed directly into the independent assessment at the end of the apprenticeship.

25.5.1 Negotiated Learning

The chosen approach took the form of a negotiated learning module. To acknowledge the individuality of our learners and the different levels of experience they bring to the course, the team decided to use Learning Contracts (sometimes referred to as Learning Agreements) as a mechanism to manage this diversity. Learning Contracts are agreements negotiated between students and educators defining individual learning goals, the methods by which they will be achieved and how they will be assessed (Stephenson & Laycock, 1993). In our context, the learners propose aspects of the Senior Leader Degree Apprenticeship standard that they have not yet gathered evidence of their competence in, to form the basis of their contracts. The starting point for this, as is often the case with work-based learning, is to undertake a self-assessment of progress and competence to date before looking forward to identify future objectives (Helyer et al., 2021). Learners are asked to target 100 hours of work-based activities or experiences to address their goals; which equates to two thirds of the dedicated learning hours for the module. This gives the learners a significant opportunity to create some purposeful learning experiences by which to address their goals and, in doing so, directly evidence the required aspects of their degree apprenticeship standard.

The learners submit a draft contract to start the negotiations, they receive formative written and verbal feedback where the module team suggest how the proposal might be enhanced. The learner then has some more time to reflect on and enhance their contract and make their formal submission. The marking of this submission forms the learning contract which the learner commits to achieving by the end of the module.

Another concept that was incorporated into the design of the module was the use of virtual Community of Practice teams. Small teams of learners are created and allocated a university facilitator to help guide their discussions. Virtual video conference seminars are scheduled for each team on a monthly basis where they meet to discuss progress against their contracts and their challenges to completion. The ethos of a community of practice is for the participants to support each other; once the team and process are established, they can become relatively self-regulating and the facilitator can take a lesser role in guiding them (Wenger, 2000). According to Siebert et al. (2009), such communities provide team members with the opportunity to verify their learning from work with other students from different contexts; this validation helps them progress, take new learning back to their workplaces and develop the ideas and motivation to tackle their outstanding goals. This process runs for up to a year, by the end of which the learners are expected to have achieved the goals in their contracts.

The module concludes with learners submitting Portfolio evidence sheets demonstrating the completion of their individual learning goals and embedded with business evidence to support the activities they have undertaken. These are assessed both in terms of their completeness in meeting the original goals but also with respect to their readiness for the independent apprenticeship assessment at the end of the programme. Learners are also asked to reflect on their work-based experiences as part of this module and can provide this in either a written or video log format. This option is provided to recognise the variety of learning preferences present in any group of work-based learners. Not all learners are confident in their writing ability but many are comfortable to communicate verbally as this is a predominant workplace skill. This gives them a fair opportunity to achieve well in this assessment without a reliance on their writing skills.

25.6 Lessons Learnt

From first experiences of delivering this module, the results have been very encouraging. The work-based activities the module has encouraged learners to undertake and therefore record in portfolio entries, have been substantial. Allocating learning hours to allow engagement in significant work-based activities has enhanced the quality of the portfolios being produced by learners and boosted their confidence in approaching the other components of the apprenticeship programme. This also translated into assessment outcomes for learners; thorough portfolio evidence has resulted in good overall module attainment.

The use of learning contracts was a good way to establish commitment to the module. Giving learners some control over their own module outcomes was well received and allowed them to influence the nature of the activities and experiences they undertook to enhance their exposure at work whilst gaining academic credits. Similarly, the community of practice delivery framework suited part time learners; the regularity of seminars maintained momentum and encouraged progress, and the self-supporting nature of the groups inspired creativity in the way that evidence was gathered against the apprenticeship standard. From a teaching perspective, the university facilitators reported a positive experience of attending the seminars as they were able to learn about the learner's organisations, current practices and challenges within the industry.

A contract re-negotiation process was managed on an ad-hoc basis during the module delivery. This was necessary in a small number of cases, where learners significantly changed their job roles and their access to work-based opportunities therefore also shifted. Laycock and Karpel (2016) acknowledge the requirement for this flexibility to address the real-life circumstances in which learners are working. This allowed all of the learners to achieve their contracts by the end of the module. The assessment approach also suited our learners. We received a variety of reflective accounts presented in a choice of formats. These different presentation options allowed learners to provide confident and individual reflections fully focussed on the value of their learning and to secure the module outcomes. As a final reflection, the marking for this module was very time consuming due to the individual nature of the activities undertaken and the need for assessors to review the relevant context and detailed evidence for each learner. This is something that will need to be explored further in the future.

The overriding conclusions from this experience are positive which has resulted in further groups of learners now progressing onto this module as part of their apprenticeship programmes at WMG. In reflecting on the experience thus far, the following advice can be offered when undertaking Negotiated Learning activities

- Use learning contracts to give learners a clear time target for which they can propose suitable activities
- Consider whether a re-negotiation process is required and define appropriate parameters to manage this
- Consider what interventions are required for individualised activities; not all supportive interactions need to be led by teaching staff
- Allocate adequate resources to provide individual learner support and to mark assessments.

25.7 Discussion

Drawing on the literature and our experiences of delivering work-based education, there are a number of areas for discussion.

Firstly, regarding the importance of the integrated nature of degree apprenticeship programmes. As some existing degree programmes may have been adapted to be delivered as apprenticeships by Higher Education Institutions (HEIs) rather than designed afresh, there is a danger that the apprenticeship is seen as a 'bolt on' to a pre-existing programme. This causes confusion in the learner population and a tendency to focus on the activities required for the degree programme rather than the apprenticeship. Our experiences, also supported in the literature by Minton and Lowe (2019), suggest that it is much better to deliver a fully integrated programme of study, combining the requirements of both qualifications; the degree and the apprenticeship. This helps learners understand the importance of applying their learning in the workplace, sets the scene for this work-focussed activity and ensures that all components required for successful programme completion are progressed. Incorporating negotiated learning into our apprenticeship programmes has been a positive way for us to better integrate our degree with the apprenticeship requirements, as learners undertaking this module are gaining credit towards their degree and at the same time preparing their portfolio for the apprenticeship end point assessment.

Another significant but challenging concept to accept is to recognise that not all learning needs to be directly provided by the HEI (Garnett, 2016). Traditionally HEIs have been responsible for directly developing and delivering taught curricula to learners and, whilst some do recognise the value of learning in the workplace, it is still challenging to accept that this is entirely equivalent to that which follows the more traditional model. Some HEIs, including Warwick, are developing work-based learning frameworks to provide a structure and options to support the inclusion of credit bearing work-focussed activities into programmes. This is a useful starting point to help pitch the level of proposed work-based modules and understand the nature of possible suitable learning outcomes. This approach also shifts the learner's perception of their education and development to appreciate connections into their role at work and the value of their challenges and achievements in this context.

Building on the emphasis placed on the tripartite relationship in the literature (Roberts et al., 2019), we have found that the programmes where we have the strongest relationships with our learners and their employers have been the most receptive to the introduction of work-based learning. These relationships have allowed us to propose and test the practicality and utility of work-based propositions and, with feedback, we have been able to adapt solutions to be most effective in the work environments in which our learners operate. We would recommend nurturing key employer relationships to facilitate these developmental activities and maximise their impact.

The coaching and mentoring provision for work-based learners is another key contributor to learner progress and their overall experience on programme. As learners are identifying individual targets and projects for work-based modules, they need the opportunity to discuss ideas and challenges to build plans and confidence in their approach. We have found that support from a university mentor can provide objective feedback and suggestions that often widen a learner's scope of thinking around activities and how learning might be achieved. The literature highlights the importance of the workplace support in these circumstances where experienced mentors can provide a business-specific context for learners, facilitate learning opportunities and make useful introductions (Rowe et al., 2017). A combination of both of these sources of support provides a sound basis for learners to engage in work-based learning.

This does however start to provide an indication of the intensity of resource need and the one to one support that this form of learning can require. The coaching nature of the facilitation required by work-based modules and the detail involved in understanding the context in which each learner works, requires more resource than traditional forms of teaching where groups of learners can be supported through activities together. We have also found this to be true of the marking of work-based assessments where context and detail is important to fully appreciate the learning achieved. Therefore, resource should be considered at the design and development phase of modules and the related assessments.

Our experiences would suggest that negotiated learning is a solid mechanism for allowing learners to apply their university learning to the workplace and identify additional opportunities offered by their work environment. Our case study provides some insight into how this might be achieved and issues that need to be resolved to facilitate this style of learning. WMG plan to embed this approach more fully into our future education provision to support the needs of industry and to enhance the learning experience we provide to our part time students. We see work-based learning as a crucial component of future educational solutions.

25.8 Conclusions

The Degree Apprenticeship space is evolving rapidly as the importance and value of work focused education increases. This chapter has highlighted experiences that will contribute to the understanding of what represents good practice and also where some of the biggest challenges reside.

As models and frameworks evolve, there is a clear need to ensure that work-based learning and applied education are viewed as a form of learning in their own right and thus receive appropriate consideration and development. They are complex spaces in which to operate, there is much to consider and that will not change as we move forward. Flexibility, agility and co-creation will be some of the features of the future as learners and companies demand more of providers. If institutions rise to the challenge, the benefits to all will be considerable as the workforce is transformed to meet the needs of the post Covid era.

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Chapter 26
Re-engineering the Food Industry: Where Do We Go from Here?

Daniel Ingo Hefft and Seamus Higgins

Abstract Food engineering as part of the global food system has a particular responsibility to society. Food matters for every single individual on this planet. It always has! The end of the twentieth century and the global realisation that nature's resources are finite introduced two new dimensions—other than growth and profitability—to the food industry, namely; environmental & sustainability concerns. As such, with future population and urbanisation growth, as well as greater societal costs, there is no doubt that our current food system needs re-engineering. A fundamental rethinking and radical redesign of the entire food chain, its practices and educational needs is required. This chapter highlights the importance of the discipline of food engineering as a change agent for the future of the universal food industry.

Keywords Food engineering · Food process engineering · Food engineering education · Agricultural engineering · FMCG · Food industry

26.1 Introduction

Food engineering as a technical multidisciplinary profession deals with the system and structures of food and production processes, as well as physical, chemical, and biological transformation processes. It is based on scientific laws and economical, ecological, and social norms.

It is an integral part of today's food industry which can best be defined as a complex network of global and diverse businesses that supply the large majority of the food consumed by the global population. The > £6 trillion industry represents 10% of global consumer spending and 40% of employment (Clapp & Scrinis, 2017).

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From a UK perspective alone, the food and beverage supply chain employs more than 4 million people, generates over £100 billion of value to the economy and is the largest manufacturing industry in the country outperforming both automotive and aerospace industries combined (Grant Thornton UK LLP, 2017).

Despite the fact that food and beverage is a basic need for every individual being, with the world population growing at approximately 83 million people per year (United Nations, 2017), the discipline of food process engineering is often undervalued and not represented in modern times.

Only a handful of countries offer independent food engineering departments in higher education, such as Turkey and Chile. For most countries, food engineering – if present – is a subset of agricultural or other engineering disciplines such as chemical and or mechanical engineering. Semi-independence can be found in some countries such as Germany or Poland, or developing countries such as India or China, where food engineering is often part of food technology degrees with additional engineering awards (similar to the former German *Diplom Ingenieur* title).

Food engineering is facing the same issues as many other engineering disciplines (Duderstadt, 2010; Febo & Day, 2017). On an international level, the work of Saguy et al. (2013) summarises the challenges food engineering is facing. While Niranjan (2016) identifies five "core themes" food engineering education should be based upon he also concludes that food engineering moved from a farm-facing focus towards a consumer-facing focus. This would also explain why a disconnection between the agricultural community and food process engineering has evolved in more recent times.

26.2 The Growth of Food Process Engineering and Mass Food Production

The roots of food process engineering, with one exception, goes back to the industrial revolution. That same exception, namely cereal milling and processing, to this day, still constitutes the most important global food source for human consumption.

The word cereal is named after the Roman god *Ceres*, the goddess of agriculture, grain crops and fertility the word also has a lexical meaning "to satiate, to feed". Today more than 60% of the world's food supply comes from cereal grains, with world cereal production standing at approximately 2.5 billion tons per annum (FAO, 2017).

"Milling" grain as a staple food has been with us since Neolithic times, when original millstones, a Quern stone or saddle and handstone, were used to crush early grains such as millet, emmer (a cereal grain closely resembling wheat) and einkorn. As further agrarian settlement evolved, larger horizontal millstones powered by hand or animals were used.

It was around 25 BC when *Vitruvius*, a Roman engineer/military architect, detailed the first undershot vertical water wheel to power a set of horizontal millstones by way of a 90-degree gear mechanism, for the milling of grain. It was the world's first industrial process, purposely designed to operate without being powered by man or working animals, and specifically designed for food production. When Leonardo Da Vinci immortalised *Vitruvius* in the fifteenth century, combining ideas about art and architecture, human anatomy and symmetry in one distinct and commanding image, entitled "Vitruvian Man", the same Vitruvius could also have been celebrated as the world's first food process engineer!

With the expansion of the Roman Empire to Europe and Britain, its milling technology followed. By the middle of the eleventh century, Britain's *Domesday Book* (1086) lists more than 5,000 engineered water mill sites in the UK. By the end of the thirteenth century, this number had more than doubled and by the sixteenth century, waterpower became the most important source of motive power in Britain and Europe.

The number of watermills in the UK probably peaked at more than 20,000 mills by the nineteenth century (Rangers, 2020).

In 1809 *Nicolas Appert*, a French chef, credited as being the father of food preservation, came up with the concept of preserving food by way of a heat process and hermetically sealing the preserved product in a glass jar. He may not have known the science behind the methodology he used, that would come 50 *years* later with *Louis Pasteur*, but he did win Napoleon's prize, "an army marches on its stomach" of 12,000 francs for inventing the process (Gould, 1997).

In 1813 *Bryan Donkin*, a Northumberland engineer, set up the world's first canning factory in the UK, having bought the patent from *Peter Durand* who registered the original patent in 1810 for the use of tin, as opposed to glass as originally used by *Appert*. The use of tin cans—albeit, without the lead seal solder, as was originally used to seal the tin's seam—and the steam retort system as used to cook the tin's contents under pressure, are still used to this day.

It was during the same period that many of the UK's iconic food companies and legacy brands developed, such as Sarson's malt vinegar (1794), Colman's Mustard (1814), Cadburys chocolate drinks (1824), Bird's Custard (1837), Rowntree's KitKat and Smarties (1882) and Bovril (1887). Although not food related at the time the "Lever" part of Unilever was started in 1890 with the launch of Sunlight Soap.

In 1887, a German engineer by the name of *Henry Simon* revolutionised Great Britain's flour milling industry by building the first "gradual reduction" flour/roller mill for the McDougall Brothers in Manchester.

The same trend followed internationally and in that same period, food and beverage company titans such as Nestlé (1866), Heinz (1869) Coca Cola (1886) and Kellogg's (1906) were born.

In 1924 Clarence Birdseye, an American inventor and entrepreneur, founded a company, *Birdseye Seafood, Inc.*, to market his new "flash frozen technology" foods such as fish, meat, and vegetables.

It was voted the most meaningful innovation in humanity's food history by the *Royal Society*, the UK's national academy of science, based on ranking according to four criteria: accessibility, productivity, aesthetics, and health.

The *Industrial Revolution* saw the rise of banks and industrial financiers, as well as factory systems evolving dependent on owners and workers. The *twentieth* century also saw the birth of "management" coming into being, to shape the world of work and industrial processing. "Such masters of the material universe, from *Frederick Winslow Taylor* to *Michael Porter, Tom Peters, and Michael Hammer*, would have a disproportionate effect on (business) management" (Kiechel, 2012); in general, including the food industry.

Twentieth century urbanisation, electricity, rail and road transport links, mass production, advertising, the growth of "big food" companies and supermarket distribution, all combined with lifestyle change, eating habits and mass-produced processed foods, to create the world's largest and most profitable manufacturing industry.

The *Industrial Revolution* not only changed the way food was manufactured but also a predominantly agrarian and rural population to a new industrialised and urban lifestyle.

The world's economic model, as proliferated for more than two centuries by way of the *Industrial Revolution,* came to end with the so-called *oil crisis* of the late seventies making it abundantly clear that the model was based on two false assumptions:

1. That there were limitless resources in nature.
2. And/or nature had an infinite capacity to absorb the world's waste.

While the entire world and industry is still grappling with the above realisations and consequences, there can be no doubt that this period of massive economic, social and Cultural Revolution was primarily driven by a combination of engineering innovation and technological change. Similarly, from a food manufacturing perspective, the same innovation and technological change gave birth to both mass food production and the global food companies we know today.

26.3 To what Degree has Food Process Engineering lost its Lustre in recent Times?

Despite food process engineering's auspicious start creating the means for food manufacturing, unlike other engineering disciplines, there is still no universally accepted definition of the term food process engineering in place (Kostaropoulos, 2012). Similarly, there is no specialised professional association solely dedicated to the interests of the discipline.

A recent article in the careers section of the Telegraph newspaper entitled "Engineering Jobs" details the engineering sector in the UK as "[…] vast and essential to the economic health of the nation. Engineers work in every major industry and are responsible for everything from streamlining manufacturing processes to designing cities to pioneering efficient new technologies" (The Telegraph, 2017). It then goes on to list a closer look at 20 of the "most common engineering positions in the UK".

Food process engineering is not listed, despite the fact that the food industry is the largest manufacturing industry in the UK!

Food (process) engineering, as a specialised engineering discipline and/or educational pathway, is no longer viewed as a worthwhile, prospective career choice. Perhaps, if one looks at how the food and beverage industry has (d)evolved in more recent times into a commodity-driven, brand valued, cost-driven profit model, one could also be forgiven for mistaking the role solely as a plant maintenance function or as part of a wider low-cost high-volume production driven operation.

The drive for cheaper production methods over the past 50 years has also driven other production cost-saving methodology such as Six Sigma (6σ), lean manufacturing, Kaizan, etc. Although powerful tools for increasing manufacturing efficiencies, they are primarily based on incremental improvement and do not embrace either the need for radical change and or the innovative skills set that a food process engineer considers as his/her prime role.

While most "big food" companies still retain research and development departments, their spend is the lowest across a survey of the 15 biggest manufacturing sectors—indeed food companies invest far below 5% of their profits back into research (Department for Business Innovation and Skills, 2010; ElAmin, 2008; Skillicorn, 2019; Statista, 2019). If one looks at research spending across a global list of the world's top one hundred companies one would have to go to position 77 to see the first food company listed, namely Nestlé with a research spend of just 2.35% (Skillicorn, 2019).

Food companies increasingly driven by quarterly profit reporting do not see engineering any more as being at the heart of their operation. Hence, companies now look to outsource (Ernst & Young Global Limited, 2013) or contract their operational advice and engineering requirements, particularly capital expenditure and future growth scenarios, to specialised business and financial consultants.

In 2011, the global consulting industry was valued at $205bn (£158bn). The market since then has grown with an average *Compound Annual Growth Rate* (CAGR) of 4.1% to a value of $251bn (£193.5bn) in 2016. The largest segment is *Operations Consulting* (around 30% market share), followed shortly by the *Financial Advisory* segment. (Consultancy.uk, 2017) No doubt, both of these segments view food process engineering solely as a 6–9% maintenance or operational expenditure (OPEX) cost.

It is perhaps ironic, that the birth of "the management century" and subsequent growth of the consultancy industry can be pinpointed, as per Walter Kiechel, to 1886 when one Henry R Towne, co-founder of the Yale lock company, delivered an address to the recently formed American Society of Mechanical Engineers titled "the Engineer as an Economist" (Kiechel, 2012). Towne (1986) argued that there were good engineers and good businessmen but seldom were they the same. He went on to assert that "the management of works" had become a matter of such great and far-reaching importance as to justify its classification as "one of the modern arts".

26.4 Food Manufacturing: 20th Century Growth, Profitability and "The Management Century"

Unlike other manufacturing industries that developed during the industrial revolution, the food industry, at its core, has always been about supplying a basic human need. As per *Maslow's* hierarchy of needs,, without biological and or physiological support, i.e. air, food, water, shelter etc., stating the obvious, a human being cannot survive (Maslow, 1943). Beyond sustenance, food also plays a central role in culture around the world; food is the centrepiece of tradition, celebration, and folkloric festivities.

Hence the conflict with business management theories, rooted in economics, which evolved during the last century. When *Taylor* published his *Principals of Scientific Management* in 1919 (Taylor, 1919), as *Oliver Stone Dene* summarised in 1923, he set off a century-long quest for the right balance between the "things of production" and the "humanity of production". Alternatively, as some would have it, between the "numbers people" and the "people people".

Similarly post WW2, the debate around company purpose and management's role; was it as per *Drucker*? "There is only one valid definition of business purpose; to create a customer" with a more inclusive view of "stakeholder capitalism", including stakeholders, employees, customers and the public at large—or was it more about creating wealth for shareholders by way of "shareholder capitalism" ? (Kiechel, 2012).

With the former broad-minded conception, steadily chipped away by partisans of the latter, a drive to profitably mass produce food was also spurred on by the rise of competitive retail market chains and a steadily growing urban consumer market creating a new market for readily prepared convenience foods.

All these factors contributed to creating the world's largest manufacturing industry by turnover and by profitably. If one looks at US stock market returns by economic sector (1963–2014), consumer staples with a 13.3% return has had the highest return of all economic sectors. A $1000 investment made in 1963 would now be worth $1 million plus.

The food industry's growth and drive for profitability also coincides with a dramatic shift in consumer eating habits, and the way the entire globe now eats and drinks has clashed with our biology to create major shifts in body composition. Obesity levels in the UK (Public Health England, 2017), and the US have more than trebled in the last 30 years and based on current estimates, more than half of the population could be obese by 2050.

The cause of the rapid rise in obesity, and subsequent rise in Type 2 diabetes and diet related illnesses, is complex and has been blamed on, amongst others, modern lifestyles; including human's reliance on transport, the invention of television, the usage of computers/ smart devices, and desk-bound jobs. Nevertheless, of course high-calorie, high energy-dense food and clever food marketing have also played a major role.

From a cost perspective, in the UK alone, obesity costs wider society £27 billion (Public Health England, 2017) and the present spend on treatment of obesity and diabetes is already greater than the cost of the UK's police, fire service and Judicial systems combined. Over the next eight years the US will spend $4.2 trillion, Germany $390 billion and Brazil $251 billion (Boseley, 2017).

The world's "big food" companies, over the same period, have also seen large growth with 41 of the top 50 (March 2019) food companies now professionally managed "by way of the modern art", MBA or financial/ economic specialists. Therefore, with the option to employ additional resources by way of a well-established management consultant industry, one would assume that these same companies would be best positioned to capitalise on the future population growth of the twenty-first century.

But this is not the case—the top 10 branded global food companies have lost an average 4% of their market share in the past five years, as one recent review puts it: "Large food manufacturers are losing the growth game" (Donnan et al., 2016). The top 25 food manufacturers had a compound annual growth rate of only 1.8%. Meanwhile, small and medium sized companies saw their sales grow with a compound annual growth rate of 11% to 15% (FDF, 2019). Clearly, the food manufacturing market landscape is undergoing massive shifts, and it appears that larger food manufacturing companies are struggling to keep up.

26.5 Food, Environment, Sustainability and Change

It was *Heraclitus*, an ancient Persian scholar (500 AD), who coined the words "The only constant is change". He viewed ever-present change as being a fundamental essence of the universe.

Perhaps what is not so apparent is how an increasing rate of change drives new development and growth, which in turn also accelerates existing processes from maturity to decline. The end of the twentieth century and the global realisation that nature's resources are finite introduced two new dimensions, other than profit, to the food industry, namely; environmental and sustainability issues.

A recent report from the *Ellen MacArthur Foundation* entitled *Cities and the Circular Economy for Food* presented at *The World Economic Forum* in January 2019 puts a number on it; for every $1 dollar spent on food, $2 dollars is incurred to produce it.

These figures include extracting finite resources such as phosphorus and potassium for fertilisers, fossil fuels used from tractors, to processing plants to road transport; for every calorie of food consumed in the US it takes 13 cal to produce it. The Agri Food sector is the world's second largest emitter of greenhouse gases, being responsible for nearly 25% of all human-caused emissions.

A third of all edible food produced goes uneaten despite the fact that 10% of the global community goes hungry (FAO, 2020) and the rise in over-nutrition is leading to obesity and other diet related chronic disease in many developing countries.

As confirmed by way of a falling market share confronting existing "big food" companies, we are beginning to see consumer led disruption assisted by digital technology, unprecedented processing power and unlimited access to knowledge, leading to a democratisation of information and an increasing distrust of the established food industry.

Where before key drivers for growth were led solely by taste, price and convenience, new emerging drivers include health and wellness, safety, social impact and experience, with transparency becoming an overarching driver on all counts (Ringquist et al., 2017).

We are also starting to see development and growth of several new niche food brands and smaller, more focused regional companies leveraging new technology, third party relationships and improved engagement to earn consumer trust.

These future change possibilities are being multiplied by new emerging technology breakthroughs in fields such as computing (AI, machine learning, quantum technology), autonomous machines and vehicles (robots, cars), the Internet of Things and Big Data coming with it, 3D printing, (bio)nanotechnology, material science, fuel cells and energy storage.

Response to change from the existing "big food" players has been mixed; on the one hand, there has been considerable talk and resetting of company objectives to include sustainability and environmental issues. The quoted report from the Ellen MacArthur foundation was part sponsored by two major players from the industry, namely, *Danone* and *Tetrapak*. On the other hand, larger food companies are establishing venture-capital funds to invest in start-ups. Nine of the ten "big food" stalwarts, such as Kellogg's, Campbell soups, Heinz, etc. have created new venture capital companies to "more fully participate" in growth opportunities.

A second irony from the management century; it was only in 1993 when Hammer and Champy (1993), Harvard, published a book entitled *Reengineering the Corporation: A Manifesto for Business Revolution.* They defined *Business Process Reengineering* as a fundamental rethinking and radical redesign of business processes to achieve dramatic improvement in critical contemporary measures of performance. Given the history of the food industry and the numerous contributions made by its engineers, over centuries, creating several radical redesigns and dramatic improvements, one would have thought that *Hammer* was simply stating the obvious!

From a business management philosophy clearly not, as he went onto expound:

> At the heart of reengineering is the notion of discontinuous thinking – of recognizing and breaking away from the outdated rules and fundamental assumptions that underlie operations. Unless we change these rules, we are merely rearranging the deck chairs on the Titanic.

Given societal costs and consequences as related to current food consumption, it should be obvious to all that unless we "re-engineer" the entire industry from farm to fork, then *Hammer's* adopted metaphor applies.

26.6 Re-engineering the Food System

Linking a very simple definition of engineering as being “to make things, or make things better” with the discipline of food (process) engineering perhaps the point has been lost by more recent numbers-orientated management that a food process engineer’s key role has always been, as proven over the past two millennia, to consistently re-engineer food systems to achieve beneficial change.

Similarly, with engineering educational institutions whether because of reduced research spend by way of “Big Food” companies, a greater demand for other process related engineering disciplines such as chemical, oil and gas and or perceived more popular food disciplines such as food science, food engineering as its own distinct discipline has not had the support required “to make things better”.

In the UK, there are more than 46 third-level institutions now offering over 88 courses by way of on-campus food science and related technology courses. There are just three universities offering food process engineering programmes.

In the U.S., MIT is the only top 5 university for engineering and technology to offer study opportunities in food engineering—albeit, as a subset of chemical engineering. The Georgia Institute of Technology supports the spirit of bringing food engineering back to its biosystems/ agricultural engineering home with its Food Processing Technology Division. However, the key focus of this division is from farm to silo and barely considers the factory stage. (Georgia Institute of Technology, 2021; MIT Department of Chemical Engineering, 2021; QS Quacquarelli Symonds Limited, 2020). Similarly, a number of various US Land-grant universities train food engineers as a part of academic programs in Food Agricultural and Biological Engineering as well as Food Science and Technology disciplines.

A global web survey of the food engineering profession conducted in 2016 by Saguy et al. (2013) addressing forthcoming challenges in the food sector, ranked the following key areas in terms of priority;

1. “More innovative profession offering better entrepreneurship and broader activities.
2. Broader/better applied education that could be utilised in food/other fields.
3. More professional opportunities to serve humanity”.

> As “the Fourth Industrial Revolution” starts to build on the so-called third digital revolution, characterised by a fusion of technologies that is already blurring the lines between the physical, digital, and biological spheres, the pace of change is evolving at an exponential, rather than a linear, rate. (Schwab, 2017).

Combining this statement with global population growth and the fact that 80% of all food production will be consumed in cities by 2050 means “*the breadth and depth of these changes will herald the transformation of entire systems of production, management, and governance*” (Schwab, 2017).

26.6.1 *How can this rapid Pace of Change be achieved in the Food Industry without dedicated Food Engineering Skills and/or the Educational Resource needed to provide the same?*

Traditionally the food industry looked to source graduate engineering talent from schools of electrical and mechanical engineering and created an industry apprenticeship for the same engineer to adjust to learning all things food, including existing food process systems. Does the industry have either the time to follow this traditional recruitment route and/or the need to replicate existing processes, given the prerequisite that the same industry needs to radically transform itself?

Perhaps a major contributing factor to the dearth of food engineers by profession, the lack of academic support or career recognition—or both—as already highlighted, has been the fact that over centuries, food engineering has never been fully recognised as its own distinct discipline. E.g., *Vitruvius* recognised for his architectural prowess as distinct to his contribution to cereal/food processing. Perhaps, by the inherent technical nature of food process engineers, public relations has never been viewed as required additional flair!

Despite the growth of several professional engineering bodies since the *Industrial Revolution*, not to mention the growth of professional business management and consultancy, the food engineering profession has allowed itself, to be viewed primarily in a production maintenance role as opposed to the change agent required to provide the means for sustainable, safe and nutritious food production. Likewise, from a professional engineering status, somehow the discipline has allowed itself to be part swallowed as a subset of chemical engineering and or other disciplines.

26.7 Defining Food Process Engineering

The need for the food industry to re-engineer itself, as per the preceding section, also warrants a complete rethink of how we define food engineering relative to the same food system. The design and operation of safe and cost-effective food process lines requires a completely new multidisciplinary and educational approach.

As mentioned previously there is no generally accepted definition of what a food engineer actually does. In 2019, one of the co-authors of this chapter (Hefft) detailed what could be considered as a food engineering definition and what that same definition entails.

> Food Engineering is a technical multidisciplinary profession that deals with the system and structures of food, production processes as well as physical, (bio)chemical and biological transformation processes. It is based on scientific laws, economic, ecological, social, cultural and religious norms. (Hefft, 2019).

This definition clearly links food engineering, stating the obvious, to its primary source and produce (food). It also links the same definition, as it once was, to its native (and historic) home namely land based food produce.

Unlike chemical engineering and or other process engineering disciplines Food engineering needs to embrace the entire food chain from farm to fork while also looking at the physics and biology of processing the same foods.

While similar to other engineering disciplines, food engineering also entails the application of scientific laws and observations in order to develop technical solutions considering economic, safety environmental and sustainability concerns. However, the additional points of social, cultural, and religious norms also differentiate it from other engineering disciplines in the sense that the food we produce and eat is also dictated by local heritage, our upbringing and beliefs.

If one accepts this proposed definition, it could also form the basis to scope future educational curricula for food engineering programmes.

While various disciplines have been involved with food from the mid-nineteenth century onwards, it was only in the 1960s that food science and technology became a subject in its own right. This new group of professionals stopped identifying themselves as chemists, physicists, microbiologists, chemical engineers, etc. working in food, but adopted the terminology of food scientists or food technologists (Institute of Food Science & Technology, 2020).

From a food engineering perspective, apart from taking a leaf from their PR book!, when it comes to re-engineering the existing food system, thanks to food science research we know some of the “why” and the “what” that is required. The obvious challenge will be developing the methodology, or the “how”, that can achieve this beneficial change on a volume basis, likewise, educating and training the “who” best qualified to implement the process changes required.

26.8 Educating a new Breed of Food Engineering Professionals

Educational frameworks for modern food process engineering programmes are scarce. Perhaps a good starting point would be as has been proposed by Niranjan (2016) in his comprehensive paper titled *A possible reconceptualization of food engineering discipline*. Other solutions towards creating better frameworks might include liaison with food educational institutions in countries such as Argentina, Chile, Germany and Turkey, where taught food engineering programmes are successfully established. The same fact also highlighting a need for forming transnational collaborations and alliances for the development of a global food engineering educational approach.

The creation of new degrees and or technical programmes also requires suitable accreditation to give graduates reassurance that their qualification in food engineering is valued, professionally recognised and governed by a body that can support them throughout their professional career.

Such Professional bodies, ideally, with land-based affiliation and recognition by national Engineering Councils, must embrace food engineering as its own unique discipline. The same organisations could also assist higher education with advice on the design of optimal curricula to meet changing industry standards and requirements.

Like most true engineering disciplines, colleges and polytechnics are also suitable hosts to cater for this need, giving students the opportunity to get practical hands-on experience of various process systems and their application. Obviously, this will require a clear shift in public perception and or professional body recognition that a university degree is to be valued over a college or polytechnic degree!

However, universities remain of importance being more focussed towards text-book knowledge and research aiming to give students a solid understanding of the theories driving food systems.

Ideally, if one could create a balanced ratio of new graduates from both channels to fill the industry's needs for process change and future food engineering positions.

A new breed of food engineers will need recognised global qualifications based on a collaborative effort from industry, education providers and professional bodies. Likewise, food engineers of tomorrow must have a diverse background, reflecting the discipline's need for both practical and theoretical skills.

26.9 The Urgency of Demand

Last year's UK inflation rate was 2.48%. Year-on-year average salary increases for food engineers rose at 3.68% or more than 50% above average inflation rate. Experienced food process engineers working in project contract roles have seen daily rates increase between 15 and 25% over the past two years as demand for skilled food engineering professionals' increases and other industries, such as the burgeoning pharmaceutical industry, compete for the same skills set.

A 2017 Grant Thornton survey conducted on behalf of the Food and Drinks Federation in the UK states those companies of all sizes in the sector struggle to recruit engineers. Fifty percent of food companies in the fastest growth sector, with turnovers of £250-500 M, find it "very difficult to fill" these roles while the other 50% describe it as "difficult" (Grant Thornton UK LLP, 2017).

The same picture is painted internationally, according to US based Food Engineering readers. Almost two-thirds of respondents to their annual State of Food Manufacturing Survey expect that the throughput at their plants is to grow this year (versus the previous year) and more than half of respondents expect it to increase by more than 10%.

Given existing demand for the limited number of food process engineering professionals available now, how will a global food system manage future growth while still developing "Future Food" and the required process changes involved? While this chapter outlines a longer-term scenario for future food engineers one also needs to consider interim demands.

26.10 University of Nottingham: A Case Study

Modern food and beverage manufacturing processes are highly sophisticated, involving all unit operations, mass and transport phenomena across all types of materials. The same could be said of chemical process engineering and hence the growing affinity with the food industry—a notion well supported by the *IChemE* Special Interest Group for Food.

The *School of Chemical and Environmental Engineering* at the *University of Nottingham*, ranked number 2 in the UK, pioneered their 4-year *MEng* degree programme in chemical engineering in 1961 followed by their *MEng* degree in environmental engineering the late 1980's. With both their one year in industry work programme and graduate placements they have seen major interest from both large and midsize food companies in recruiting the same students.

Responding to industry demand, The University has now introduced a new postgraduate taught programme in Food Process Engineering and expanded their current MEng degree programme to include optional food processing modules. They have also been able to combine a food specialisation with their existing expertise in chemical process engineering subjects, such as heat transfer and plant process design. Likewise, their expertise with environmental aspects such as water and waste. Having this holistic approach in food process engineering courses helps to create an engineer with the skillset not just to execute engineering tasks well, but also creating an engineer who considers the environmental and societal impact of their work.

The department also sees its mission to provide the academic formation of a *chartered engineer* (CEng) and to produce *Master Food Process Engineering* graduates who are technically competent, industrially aware and good communicators, with the project management skills to take on leadership roles in a change environment.

The advantages of the above model are numerous;

- It draws on an existing pool of already qualified graduate engineers be they electrical, mechanical, chemical, or as is more common in Europe and developing countries, undergraduate degrees in both Food Science and Engineering.
- It can create a new breed of food process engineering professionals, ready for industry, within an 18–24-month timeframe.
- Particular aspects or modules of the programme can be re-packaged for block release programme enabling existing food or other engineers to upskill to a Food Process Engineering master's level while still employed in industry.
- It can also become a new pipeline for *PhD*, *EngD* and research students to pursue new methods of food process engineering.

The food industry and the food engineering profession needs to support and develop more initiatives of this nature.

From a chemical engineering perspective, *IChemE* has another 29 accredited universities in the UK with several others listed globally whereby a similar model could be easily replicated. Likewise, *IMechE* UK has over 30 universities accredited for advanced manufacturing programmes that once again could be enhanced to support food process engineering.

26.11 National Food Security; Defining a New Generation of Food Engineers

A 2019 report from the UK's Food & Drink Federation entitled a recipe for Growth, Prosperity and Sustainability, "A Plan for Success" has an opening paragraph that states food is a matter of national security and is part of the UK's Critical National Infrastructure. It goes on to state that a government's first duty is to feed the country or as summarised by Jay Rayner: *"If you can't feed a country you don't have a country"* (Rayner, 2017). The recent EU/Brexit debate and the current Covid outbreak has also polarised discussion around food imports and supply chain vulnerabilities. If one applies the same critical food infrastructure debate on a global basis - given the macro forces at play, such as, global population growth, the shift from rural to urban life and food production's vulnerability to future climate change the same national security aspects applies to all countries.

The current food model allows 30% of global food production to go to waste (around 16% in developed countries and up to 50% in developing countries) is no longer sustainable while wealth inequality continues to widen creating disparities in access to healthy and nutritious food amongst poor socioeconomic and income groups (Accenture Strategy, 2017; FAO, 2019).

All of these concerns come back to the simple fact that, whether viewed from an economic, social or political perspective, food availability and the production of same has always been about supplying a basic human need as opposed to simply generating a higher return for shareholders.

Governments also need to take due cognisance of the above facts and recognise the need to create a more sustainable and environmentally friendly food chain for their constituents. It cannot be achieved without the correct skills set. In the more recent past, many Governments have played a proactive role in encouraging new developments, research and training needs to build both their Aeronautical & automotive sectors. In the UK GDP from food manufacturing is greater than both of these industries combined.

If as above the same food industry is now considered a matter of national security and or the need to re-engineer the current model is fully recognised then state funding should be made available to finance the setup of these degrees and to support research and the educational needs to fast rack the same.

As Accenture highlights in their recent report "The future of food; new realities for the industry", the food industry will soon look nothing like its former self, and we will see more change over the next ten years than we have seen in in the last 50.

Digital manufacturing platforms, urban and domestic agriculture, food as a service, vertical farming, DNA based diets, alternative protein sources, lab-grown meat, non-heat food preservation techniques such as HPP or Plasma arc are all new technology and smarter manufacturing methodology that needs to be applied on a volume basis.

AI bots that work together sharing vast quantities of data optimising block chain ingredient traceability, inventory and production methods, delivery and customer interactions, need to interact with custom designed manufacturing techniques.

A new generation of food engineers needs to be educated with practical challenges as to how one can apply change management and project development techniques in a rapidly changing technological environment.

A new generation of food process engineers must also have a better understanding of farming and the land-based food sector as both communities are dependent on each other and used to be one.

As technology moves on it has never been easier to share ideas and data between associated professional and educational institutions. An integrated approach of both land-based agricultural and food-engineering disciplines, along with colleagues in food science may ultimately lead to a more integrated and sustainable food supply chain.

As said at the outset of this chapter, food engineering is a technical multidisciplinary profession that deals with the system and structures of food, production processes as well as physical, chemical and biological transformation processes. It is based on scientific laws and technical, economical, ecological and social norms.

Given the rapid advances in technology, process and quality control automation, packaging, food hygiene, additives and allergens all become critical control elements of food process design.

Global, standards can only be improved with a new generation of qualified food engineers, new food research and an educational system that can support the same.

26.12 Conclusion

The food industry and food process engineering—Quo Vadis?

Although the industry has had many successes over the past 50 years in terms of scalability and offering abundance in food supply to many parts of the world, as per concerns outlined in this document, the industry is still in need of future change.

Whether these concerns are viewed from an economic, social political or educational perspective, it is clear that the present model needs to change direction.

New emerging drivers such as health consciousness and wellness, social impact, and sustainability issues coupled with a new required transparency, are already affecting and changing the future direction of "big food" companies. Given the current drive for cost-savings, as opposed to innovation over the past 50 years, how can the existing industry make that change to a diet-driven, health-valued, knowledge-based food system putting the consumer into the centre of its activities without the correct skills set to enable the same?

When it comes to re-engineering food systems, as per core competencies, food (process) engineering professionals have driven beneficial change in the food industry for more than two millennia. They are best placed to lead and develop both the innovation and new production processes that will be required.

The obvious challenge for the food industry and its engineers will be developing the methodology, or the "how", that can achieve this beneficial change on a volume basis, likewise, recruiting, educating, and training the "who" best qualified to implement the process changes required.

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Chapter 27
The Relevance of Applied Education to Urban Sustainability: A Case Study of a Degree Programme in Horticulture, Arboriculture and Landscape Management in Hong Kong

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Abstract Applied degree programme is an innovative form of vocational education and training. The aim of this chapter is to examine the challenges and opportunities of the implementation of an existing vocational degree programme and its transformation into an applied degree. Bachelor of Science in Horticulture, Arboriculture and Landscape Management, BSc(HALM), which is a degree programme in Technological and Higher Education Institute of Hong Kong is used throughout as a case study. The purposes of BSc(HALM), and the methods to achieve them would be examined. Knowledge classification, workplace training and cultivation of transferable skills would be explored. The process of incorporating the positive impacts of COVID-19 would be elaborated to evince the revolution of applied degree programmes. The challenges and potential solutions, at individual, programme, industry and social levels, would be identified and discussed. Teaching and learning experiences would serve as evidence to support the arguments in this chapter.

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27.1 Introduction

Vocational education and training (VET) prepares learners to work in a specific industry. An applied degree programme features some characteristics of VET such as the provision of vocational experiences, an orientation toward career development, and diminished theory-laden academic studies. This book chapter is based on a prospective applied degree programme in Hong Kong. In late 2020, the Education Bureau of Hong Kong announced the Pilot Project on the Development of Applied Degree Programmes. The Bachelor of Science in Horticulture, Arboriculture and Landscape Management, which would be referred to as BSc(HALM) thereafter, in Technological and Higher Education Institute of Hong Kong (THEi) is preparing to be a pioneer in the conversion into an applied degree. THEi belongs to Vocational Training Council, which is the largest VET organisation in Hong Kong. Meanwhile, Hong Kong was hit hard by COVID-19. Despite lingering panics, the tertiary education sector must respond to various challenges.

Hongkongers are used to enjoying the benefits brought by urban vegetation. An organic and biophilic landscape filled with large trees would be favoured by citizens (Lo & Jim, 2012). Other intangible ecosystem services of urban green space invariably benefit the city, such as temperature regulation (Lee & Jim, 2019), air pollution abatement (Jim & Chen, 2008), thermal comfort improvement (Cheung & Jim, 2018; Fung & Jim, 2020) and many more. Horticultural and arboricultural techniques could contribute to sustainable and attractive landscape designs in which vegetation serves as an integral element.

According to the Development Bureau of the Hong Kong Special Administrative Region (2018), in the last decade, approximately 71,903,900 plants have been planted in Hong Kong. Among them, shrub was the most popular lifeform, while trees and herbaceous plants had comparable contributions. Focusing on trees, the sum of trees planted in urban areas was approximately a tenth of that in rural areas. Paradoxically, in spite of the enormous number of plants planted, the local green space supply could be as low as 2.84 m^2/person (Jim & Chan, 2016) and unevenly distributed (Lee et al., 2019). Further improvements have yet to be put into effect.

In response to the growing demand for high-quality urban greening, BSc(HALM), which is a four-year baccalaureate degree, has been established 2015. In 2020, the re-entitlement from Bachelor of Arts to Science better suits the nature of the programme. In four years, undergraduates have to attain credit points by studying programme core and programme elective courses, general education courses, and fulfilling the internship hour requirements. Graduates enjoy diverse employment opportunities from private and public sectors.

The objective of this chapter is to examine the challenges and opportunities of the implementation of an existing vocational degree programme and its transformation into an applied degree. This chapter consists of four parts. First, changes to the traditional paradigm of education are summarised in order to structure a framework for creating an applied degree. Then, crises and challenges brought by COVID-19 are enumerated while the corresponding response mechanisms are identified. After that, relevant themes in applied education are expounded to promote the exchange of experiences in designing an applied degree. Finally, the outlook of applied education is illustrated in the context of Hong Kong.

Defining applied education is difficult because of the astonishing diversity in the interpretations by the different possible disciplines of studies. However, in an earlier study, applied education was defined by its nature of curriculum, relationship with career planning, and outcomes for learners. In short, applied education provides an alternative to conventional curricula for students who aim at building competencies for specialised career and obtaining recognition after the completion of study.

27.2 Changes in the Traditional Paradigm

27.2.1 Experiential Learning for Tackling Loosely Classified Knowledge

Applied degree programmes are characterised by their multi-disciplinary nature. Classification is the structure of a body of knowledge and boundaries demarcating it from the knowledge of other academic disciplines (Bernstein, 2000). For instance, a biology student may have limited exposure to the knowledge acquired by a geography student, vice versa, in the case of traditional degree programmes. Yet, applied degree programmes often dwell on loosely classified knowledge and fragmented professions (Chapman & Kirby, 2008; Wheelahan, 2019). The relatively weak sense of classification implies that students are invariably challenged by the fuzzy boundaries of different bodies of knowledge. Unlike long-established disciplines, the systematic selection of the applicable and practicable elements from traditional disciplines is a common and inevitable practice for applied degree programmes. For example, in *Plant Taxonomy*, a core course of BSc(HALM), students master the skills of plant identification as field biologists do. Nevertheless, analysing the spatial distribution of certain plant taxa requires practical skills borrowed from geography.

Applied degree shifts from drilling deep into theoretical knowledge of a specific discipline to a broad coverage of various fields of practice from multiple disciplines. In many workplace activities, co-operations with colleagues from diverse academic background are frequently expected. Learners in applied degree are trained to utilise multi-disciplinary thinking. Workers with applied degrees may be more adaptive in the cooperation and bargaining with specialists from divergent backgrounds.

In order to effectively deliver the loosely classified knowledge, experiential learning has occupied a considerable proportion of planned learning hours of BSc(HALM) students. In traditional academic programmes, field trip is used as a supplementary learning activity. However, in BSc(HALM), field trip is a routinised activity. Not only can students visit exclusive locations, but also listen to live interpretation by professional practitioners. For example, in a core course *Plant Propagation*, students can visit several local plant nurseries, both public and private. For BSc(HALM), the importance of field trips is raised, functioning as check points in the learning progress of students. Assessments are designed around the contents of field trips, consolidating the intended learning outcomes.

For applied degree programmes, field trips should serve a purpose which is more meaningful than merely going to the places already depicted on textbook. Engaging and interactive learning activities are expected in field trips. For example, in courses such as *Plant Entomology* and *Plant Physiology*, students collect insects and vegetation respectively, and make their own specimens. Characteristics of the specimens are examined so that students can apply knowledge of species identification. Moreover, professional regulations such as collection ethics can be taught in tandem with academic knowledge. As a results, applied degree programmes can transform field trip into a multi-purpose learning experiences for passing on professional knowledge and attitude.

Being a BSc programme, laboratory sessions are mandatory in many BSc(HALM) courses. Throughout the four-year study, students are expected to progress from basic to advanced laboratory techniques. For instance, in the first year, an introductory course called *Environmental Chemistry* familiarises the students with fundamental practical procedural knowledge in a laboratory setting. As a sophomore picks up more conceptual knowledge, the level of specialisation is increased. For example, in a course called *Soil and Environment*, various soil analyses are performed. Repeated demonstrations by teachers and imitations by students ensure a consistent application of knowledge. When working on final year research project, the students could use the underpinning knowledge to obtain experimental results on their own. The continuous, iterative learning process taking place in the laboratories is indeed a scaffolding strategy packaged in a experiential mode of knowledge acquisition. For BSc(HALM) students, spending more time in the laboratory than in the library is commonplace.

Field trips and laboratory sessions enable out-of-classroom learning. Still, context-specific knowledge is hammered into the brain of students through teacher-directed learning. Applied degree must equip students with problem-identifying and problem-solving skills that are necessary for career development. Problem-based learning is thus utilised to nurture such skills by solving complex problems in a real-world setting (Jabarullah & Hussain, 2019). For example, in a module called *Tree Safety Inspection and Climbing*, students have to collect and analyse field data of critical tree dimensions in order to generate guidelines for preventing pavement damage by tree roots. Only scanty information is available for reference. However, with sufficient guidance, students exercise creativity and initiate autonomous learning. During the project, students rack their brains to devise efficient field measurements methods and formulate practical solution to the stated problem. Students are also required to evince their proposed solutions with results of data analysis. Similar learning activities sharply contrast the conventional examination-based education. Adaptive and innovative capacities supersede that of rote memorisation. In the age of digitalisation, obtaining information has become next to effortless. Yet, the functional ability to bring creation and innovation to heel is a critical labour market currency. On this aspect, problem-based learning is an invaluable tool to revolutionise teaching and learning in applied degree programmes.

Upon completing practical trainings, students can envisage expanded career possibilities. In several courses of BSc(HALM), practical training is the main mode of learning. For example, in *Tree Climbing and Aerial Rescue* as well as *Chainsaw Operation*, approximately 70% of learning hours are spent through outdoor practical training. Students must learn the occupation-based expertise and fulfill task-based assessment. Such arrangement certainly aids expertise deployment in future. But if nothing other than industrial skills are taught in an education programme, the maximum career attainment of students is very likely to be capped at sub-management level. An applied degree programme should open up vocational possibilities beyond craft apprenticeship. In practical training, students will acquire not just occupation techniques, but domain-specific communication skills.

It is clear that intellectual knowledge about management models alone may not be conducive to workplace communication. BSc(HALM) adopts a two-pronged approaches. On one hand, management and administration practices are taught. On the other hand, practical training helps fine-tune their individual expectation on work partners in the future. Students understand how their expertise is recognised and valued (Guile & Unwin, 2020). For instance, the physically exhausting field learning experience puts students in the shoe of frontline staff. Later, when graduates rise to managerial positions, reasonable demands can be placed on subordinates who will in turn pay respect to their supervisors.

27.2.2 Training Provision in Work-Integrated Learning

More commonly known as internship, work-integrated learning (WIL) is a distinct education experience which emphasises practical application of knowledge in workplace. WIL is useful for extending the education-to-work transition and improving the performance of VET students (Deutscher & Winther, 2018). Unlike countries such as Germany and Switzerland, educational tracking in Hong Kong is normally initiated when a student is about to reach adulthood. Thus, an occupational identity must be constructed hastily within the two- to four-year period of at postsecondary education. A great deal of traditional degree programmes places intellectual training on top of workplace experience. But the reverse is true for applied degree programmes which by default focuses on the vocational development of students.

Through WIL, students can transform their acquired knowledge from theoretical symbols to deployed expertise in workplace training. Learning via trial-and-error can be enacted in the specific societal and institutional configurations of different WIL companies and organisations. With industrial involvement, specialist knowledge and generic problem-solving skills can be reinforced and enriched alongside the accumulation of field experience (Nyanjom et al., 2020). As mentioned above, students can widen their horizons and determine a certain specialty to master in near future. These processes accelerate the process of maturation of students, and enhance the performance at their future workplace.

WIL is a graduation requirement in BSc(HALM). Normally, students need to attend at least one full-time work-based training in one of the three summer semester breaks. In order to obtain a holistic competence portfolio and expand their professional network, students often exceed the minimum WIL requirement. Some students even participate in WIL after the completion of the final semester and before embarking on their vocational route. The popularity of WIL implies a close relationship with the industry and an ample provision WIL places. An applied degree programme needs to periodically review its relationship with the industry and offer workplace training. A formal feedback mechanism between BSc(HALM) and WIL partners enables retrospective reflections to deepen the cooperation in future.

Numerous industrial partners welcomes students of BSc(HALM), providing diverse WIL opportunities in disciplines such as horticultural operations, arboricultural practice, landscape design, sports field maintenance, greening in construction, and many more. However, some BSc(HALM) students face difficulties in completing WIL due to engagement in full-time occupation which already provides occupational participation. In extraordinary cases, the student is an entrepreneur with business aspirations in the horticulture and arboriculture sector. Thus, exemption from WIL is possible upon the agreement by an academic supervisor. While an applied degree should maximise the diversity of WIL places, a certain degree of flexibility must be maintained to optimise the occupational progression of individual students.

A WIL example is selected to demonstrate the difference in internship provision between traditional and applied degree programmes. As the first example, Fung Yuen Butterfly Reserve, which is Site of Special Scientific Interest in Hong Kong, provides internship for BSc(HALM) every year. Interns assist staff to achieve conservation goals for rare butterfly species. Meanwhile, through learning by doing, context-specific knowledge such as conducting ecological surveys can be acquired. Contrary to students from conventional disciplines, such as environmental management, biology and ecology, BSc(HALM) students possessed more practical skills. For instance, horticultural skills are useful for propagating host vegetation for attracting butterflies. From the perspective of an employer, such skills are synonymous to labour market currency. In simple terms, fewer trainings are needed to assimilate applied degree graduates in the workplace. In addition, joining multiple WIL implies that the experience from previous internship can be carried on, generating synergy and activating deeper learning. In this sense, applied degree programmes generate more work-ready graduates.

The belief that students from applied degree programmes are intellectually malnourished may be refuted by WIL experiences. It is true that applied degree graduates obtain vocational training at the cost of intellectual exercises and academic discourse. Meanwhile, research found that the advantages of vocational education at the onset of employment would disappear later (Forster & Bol, 2018). Nevertheless, vocational training can be regarded as an alternative format of intellectual training. The utilisation of and reflections upon occupational skills will ultimately lead to conceptual ideas about workplace improvements and innovations. By the same token, the objective of conventional academic training is to achieve innovation via other pathways such as deliberation and debates. For example, using the previous example, BSc(HALM) interns can systematically compare and contrast the effectiveness of different vegetation species in attracting butterflies. Therefore, when evaluating the intellectuality of applied degree programmes, tailor-made assessment criteria should be used.

27.3 Transferrable Skills

Applied degrees can equip students with essential transferable skills in the name of general education (GE). In conventional degree programmes, students are required to take courses offered outside home faculties. The knowledge-based definition of GE may overlook the possibility of injecting elements of transferable skills in such highly suitable setting. In fact, BSc(HALM) students are required to take GE courses such as *Critical Thinking and Innovation* and *Entrepreneurship Mindset* since the first year of study. The early onset of formal training of transferable skills also aids the acquisition of professional skills. Take analytical reasoning and logical thinking as an example. No matter in study or work, these two transferable skills are highly pertinent. During the study of BSc(HALM), in the course *Tree Risk Assessment*, the main causes responsible for tree failure have to be identified from a myriad of environmental factors. In future, as the students become arborists, such skills will be exercised. GE is a perfect opportunity to trigger the conscious learning and application of a wide spectrum of transferable skills, transforming students into all-round workers.

Following an interesting yet philosophical question, 'how transferable are transferable skills?', researchers found out that the development of transferable skills are restricted (Nägele & Stalder, 2017). Many of the transferable skills cannot be taught through verbal instructions, but actual experience. But applied degree programmes are viable platforms for nurturing transferable skills. As elaborated above, experiential learning activities are widely adopted by BSc(HALM). For example, in a course called *Landscape Contract Management*, students work in small groups to compile a contract for a landscape design project. Task-based transferable skills such as attention to detail and project management are engaged. Also, team work and communication are called into play. These transferable skills are picked up most efficiently by autonomous learners in a cooperative group setting (Canelas et al., 2017). More transferable skills are exploited in the activities of other courses. Experiential learning gains unprecedented attention in applied degree programme than in the traditional ones. It is high time that applied degree programmes make full use of experiential learning to cultivate transferable skills.

One may wonder how transferable skills can widen the potential range of employment of applied degree graduates. At individual level, the possession of transferable skills is positively associated with employability (Clarke, 2008). Internalising the experiential learning experiences, applied degree graduates may have a more proficient expression of transferable skills. In job interview, workplace scenarios may be constructed to test one's abilities to tackle complex problems. For example, BSc(HALM) graduates may be asked how to establish a turf under weather constraints within a tight time limit. Transferable skills such as adaptability and problem-solving abilities are needed to overcome the challenge. Based on the rich and diverse learning experiences in applied degree education, the interviewee can give a presentable answer. More than that, more transferable skills will be needed as graduates start their career. Therefore, transferable skills play an important role in the recruitment and selection process, as well as during the entry into workplace.

27.4 COVID-19

27.4.1 Challenges and Opportunities

COVID-19 brought both crises and hopes for applied degree programmes. In Hong Kong, the first positive case of COVID-19 was recorded on 23rd January, 2020. Since then, there have been 11,838 confirmed or suspected cases while only 210 deaths were resulted at the point of writing. The tertiary education section has suffered from huge impacts. Globally, there is a consensus that COVID-19 distorted the learning trajectories of students (Daniel, 2020). In Hong Kong, classes have been suspended intermittently at different scales. Work-at-home arrangements affected the co-ordination of teaching activities among the lecturers. For BSc(HALM), extra class suspension episodes occurred as members of the programme were close contacts of confirmed cases. Both students and teachers had to adapt to the new normal under the pandemic. However, COVID-19 is a precious opportunity for the society to reflect on the value of applied degree (Avis et al., 2021). Being benefitted from vocational training in specific domain, applied degree graduates possess specialised skills which help secure employment even under economic slowdown. For instance, urban green infrastructures must be properly maintained and operated. Therefore, COVID-19 presented an opportunity to promote the value of applied degree education.

From an optimistic standpoint, BSc(HALM) may reap benefits from COVID-19. The concomitant economic downturn has highlighted the importance of a guaranteed income. From the perspective of BSc(HALM), no matter how many cases are confirmed, urban vegetation has to be taken care of. Horticultural and arboricultural skill sets are essential to urban planning and management in whatever stages of the economic cycle. Due to depressed air travel, the recreational function of local urban green space is magnified during the pandemic, thus requiring more intensive maintenance to endure elevated utilisation. The mediating effects of urban vegetation on the spread COVID-19 also highlighted the contribution of urban green space to the resilience against public health crisis (You & Pan, 2020). Thus, an increase in the demand for professional workers in the industries related to urban greening can be anticipated in the post-pandemic world. Figuratively speaking, applied degree programmes such as BSc(HALM) are an anchor in the storm and a sail in the wind, providing the upcoming generations with security in crisis and direction in future.

27.4.2 Intended, Enacted and Experienced Curricula

The normal conduction of any school curricula is seriously challenged by COVID-19. Additional challenges surrounded applied degrees, especially for field-based programmes such as BSc(HALM). The impacts can be related to the concepts of intended, enacted and experienced curricula (Hume & Coll, 2010; Zhang & Hu, 2010). The definitions are provided before the discussion. Intended curriculum focuses on the formal aims and contents of an education programme which are regulated by legal means such as academic accreditation. Enacted curriculum refers to the actual learning activities offered to students which are influenced by local and socio-political context. Experienced curriculum is defined as the learning process experienced by learners. Divergence among the three curricula can be expected in normal times, but magnified under the pandemic.

Comparable to the situation in ordinary degree programmes, quick changes in the formal arrangements and the overall syllabus structure are next to impossible for applied degree programmes. Worse still, field learning and practical trainings are hindered by legally binding social distancing measures. Teaching plans cannot be implemented in the intended format. The situation of BSc(HALM) is typical for applied degree programmes. For example, a course called *Turfgrass Management* originally featured visits to sports ground to field demonstration of mowing, fertilisation and other operations. Despite being postponed, field trips are an integral component of the course in the intended curriculum. As the same happened to other courses, postponed and aggregated study load was resulted in the upcoming semester. It is suggested that, during programme accreditation, alternatives or back-up arrangements can be used for benchmarking the intended curriculum. Being a source of uncertainty, the pandemic exposed the inherent inflexibilities of the intended curriculum of applied degree programmes.

The enacted curriculum orbited around COVID-19. During the pandemic, face-to-face teaching was suspended for most of the time, and was replaced by online teaching. The education sector, globally, has run into the same situation (Kansal et al., 2021). Only when a low number of confirmed infection cases was recorded, a hybrid mode was adopted, enabling simultaneous physical and online teaching. The frequent, unexpected changes to teaching arrangements implied exponential increase in the duties and pressure not only for students, but also teachers. Altered teaching plans and trial-and-error cycles generated extra deviation of the enacted curriculum from the intended one. When face-to-face teaching was impossible, certain teaching strategies gave way to those with lower effectiveness. Take the course *Turfgrass Management* as an example again, the activity of circulating various grass specimens in the lecture hall had to be replaced by just displaying pictures on the screen of online class. The teaching staff of applied degree programmes directly controls the quality of the enacted curriculum during the pandemic. On the other side of the table, the response of students to the pandemic-induced pedagogical adaptations certainly influences how the teachers further modify the teaching strategies. For BSc(HALM), some industrials practitioners are hired on a part-time basis as lecturers, who may be less pedagogically responsive to the pandemic. Based on the difficulties encountered by students in online learning, instructions can be given to the lecturers to modify their teaching plans. Applied degree programmes, especially those featuring a substantial portion of field-based learning, should assist teachers, both full-time and part-time, to safeguard the quality of enacted curriculum not just in the pandemic, but any possible crises.

The quality of the experienced curriculum is a function of the subjective evaluation by students. The learner plays an important role in the formulation of the experienced curriculum, in contrast to the teaching and preparations by the teachers. Due to the considerable amount of field-based learning, more pedagogical modifications may be required in applied degree programmes than traditional ones. Continuing with the previous example, as turf maintenance actions follow a particular schedule, students may be disappointed at the changes in the contents of the make-up field trips. Meanwhile, differences in the level of cyber literacy forced some students to spend time familiarising with new online learning tools rather than absorbing professional knowledge, aggravating the pre-existing differential pace of learning. Other factors, including unstable internet access, restricted class interactions and efforts of adapting to alternative learning modes, may modulate the experienced curriculum. Unfortunately, it may take longer time for some students to develop the compassion for teachers who also share similar difficulties. Increased frustrations and decreased learning motivation thus cause the contraction of the experienced curriculum. Teachers of BSc(HALM) enhanced the experienced curriculum through formal and informal channels. Emails about course arrangements and learning resources have been sent much more frequently than the pre-pandemic times, reminding students of the connection between the teachers and the other students. Additional technical instructions and support were made available so that the attention to the class would not be disrupted by less important technical matters. Harmonious student–teacher relationship improves the experienced curriculum (Fix et al., 2019). Thus, apart from the official channels, year tutors, via messaging apps, often chat with the students. Most often the topics of conversation are simply daily matters. Nonetheless, as companions, the teachers can make use of mini-dialogues to boost students' motivation and cultivate a proactive learning attitude. It is believed that support for these strategies can be canvassed to embellish the experienced curriculum of the applied degree programmes in the post-pandemic eras.

27.4.3 Unexpected Discoveries

An intensive mode of learning may be preferred during pandemic to the traditional once-a-week mode. Before the pandemic, each course would take up a three-hour session per week. Take the course *Environmental Chemistry* as an example, the theoretical knowledge would be taught in a lecture, which would be followed by the laboratory demonstrations the week after. However, during the pandemic, whenever face-to-face teaching was resumed, teachers tended to squeeze lecture and the corresponding practical session on the same day, with the former in the morning and the latter the afternoon. Such full-day rundown has been welcomed by students. The quick succession between the theoretical discourse and practical application is reported to help crystalise thematic knowledge acquired not long ago. More critical and meaningful questions can be raised when the memory is still fresh. Another advantage of intensive learning for students is a greater degree of flexibility in time management. Many BSc(HALM) students work part-time in the horticulture and arboriculture sector. The accumulation of relevant work experiences is in line with the purpose of applied degree programmes. In this aspect, intensive learning is beneficial for the students.

Nevertheless, intensive learning may be unwelcome when conducted online. The exchange of feedback between remotely connected teachers and students is hindered. Students progress at different rates despite being exposed to similar contents, whereas teachers are less able to cater individual students. For BSc(HALM), in order to bridge the achievement gaps, teachers often deliver real-time, online lectures and make screen recordings simultaneously. Extra opportunities to learn can be created using the videos. Apart from audio-visual aids, other learning materials such as textbooks and articles should be made easily accessible for students. Given adequate support, efficient knowledge acquisition can be permitted by intensive learning.

Asynchronous learning has gained popularity among applied degree students during the pandemic. Taking up asynchronous learning, which is an alternative to synchronous learning, students can break away from a rigid timetable and a fixed learning setting where all students meet at the same place and in real time. Independent learning or self-initiated group learning can be promoted (Garrison, 2003; Hiltz & Goldman, 2004; Daniel et al., 2021). In spite of COVID-19, BSc(HALM) teachers enriched the learning experiences. Field trips could not be held due to social distancing measures. In the course *Landscape Materials, Structures and Technology*, virtual, self-administered field trips were recorded. Students reflected that voice-over in the video could be heard much more clearly than in-situ interpretation. When laboratory sessions could not be arranged in the course *Soil and Environment*, they were recorded and published online. Students can play the videos in loops even when taking public transport, aligning themselves to the overall pace of learning of the whole class in their own fashion. For students taking the course *Tree Safety Inspection and Climbing*, the assignment briefs and the accompanying video instructions were uploaded. Self-guided completion of the assignments tested the abilities of students to work independently. Applied degree programmes can be hugely benefitted from the experiences of intentionally or unintentionally implementing asynchronous learning.

However, asynchronous learning may introduce fluctuations in learning curves of students, especially those with low learning motivation. In the context of Hong Kong, it is less likely for high achievers in the secondary school to pursue an applied degree. BSc(HALM) is somehow influenced by this culture. Passive learners may be pampered by asynchronous learning. Self-guided learning may become an excuse for skipping lectures. Open-book examinations may be abused. To reverse the trend, supervision is necessary. For instance, in the course *Research Proposal*, consultation sessions are held continually so that students can report the writing progress of their proposal. Also, the teacher can adjust the teaching contents in response to the actual situation. When the difficulties are resolved, the aforementioned strategies can be used as a means to maintain the quality of applied degree programmes.

27.5 Local and Global Themes

Vocationalism in education has gained widespread attention. When the challenges of COVID-19 fade away in the future, a number of concerns has to be addressed with reference to the local context. BSc(HALM) is used as a case study to illustrate the challenges and possible solutions.

27.5.1 Pacing and Sequencing of Knowledge

As discussed above, the loosely classified knowledge which is learnt by BSc(HALM) involves multi-disciplinary specialist knowledge. When multiple fields of knowledge are presented, students may come across difficulties in finding a starting point and following a smooth learning curve. For example, year one students need to take seemingly related but sharply different courses such as *Biodiversity* and *Aboricultural Practice.* In Hong Kong, students are often described as introvert. Being shy and reserved, the students may be anxious about expressing their disorientations, especially the first-year ones. Applied degree operators must recognise and sufficiently tackle the divergence of knowledge.

BSc(HALM) runs regular programme reviews, and maintains adequate communication with the students. At the end of each semester, the academic staff of BSc(HALM) holds a programme meeting to exchange the experiences in the delivery of teaching activities. Recommendations can be generated before deciding on the teaching arrangements in the upcoming semester. Also, as a mechanism to collect feedback, a student-staff forum is held for each year after the assessment period of each semester. Students can directly reflect their difficulties in learning. The pacing of the teaching and learning can be adjusted based on the feedbacks received. By appropriate sequencing of knowledge, applied degree programmes can help shed light on the journey of knowledge acquisition of students.

27.5.2 Composition of Students

Applied degree programme needs to appraise the existing knowledge of intakes and provide educational support. In Hong Kong, after finishing secondary schools, most of the students choose university degree programmes. VET has been stigmatised as being inferior to university degrees. In fact, students who are admitted in VET programmes attained lower points in public examination on average. Such educational tracking system may erode the self-esteem of students, adversely affecting their learning attitude. Applied degree programmes have to tailor-made their curriculum by taking into consideration the composition of the students.

To enhance the learning experience and reinvigorate the learning attitude, BSc(HALM) provides remedial classes and workshops. Physics, biology and chemistry make-up classes are held annually to establish the prior grounding for students who did not study science-related subjects in secondary schools. Metaphorically speaking, a chain is as strong as its weakest link. The effectiveness of obtaining multi-disciplinary knowledge can be boosted by the strengthening the fundamental knowledge of least understood discipline. The make-up classes partly compensate the weak sense of knowledge demarcation and the fragmented and atomised learning experience. The provision of fundamental knowledge via additional instructional time and tutoring is an important step for educational scaffolding. To wrap up, it is vital for applied degree programmes to equip students with basic knowledge before proceeding to advanced knowledge.

27.5.3 Expectation Management

Expectation management is a critical component in applied degree programmes. As stated repeatedly, VET is characterised by being a multi-disciplinary nexus of knowledge. In the workplace culture of Hong Kong, the more skills a worker can perform, the more labour market currency he or she possesses. But for applied degree learners, specialising in a few skills should be preferred. Some students may be deterred by the frustrations of attempting to excel in every discipline related to their major. At another extreme, certain students may achieve good grades and express interests in whatever domains of knowledge in the study. Nonetheless, when the high achievers pursue a deeper understanding of a wide spectrum of disciplines, they may still be upset. To sustain positive motivation of learning, the discussed irrational belief must be extinguished.

Instead of being a jack of all trades, a student of applied degree programmes should be a master of a well-defined set of specialist skills. In BSc(HALM), such message is instilled both overtly and covertly. For each course, the intended learning outcomes explicitly state the highly specific field of knowledge to be covered. As the course goes on, the intended purposes of each assignment is targeted at a specific area of knowledge. On the covert side, when students make choice, such as the final year project topic and the WIL partner, they face the implicit constraint of being able to focus on a particular realm of knowledge. As rational beings, students tend to make decisions whose consequences converge to a specific knowledge domain of interest to them. Therefore, applied degree can, on one hand, emphasise the impossibility to master all disciplines which are covered in the curriculum, and, on the other, direct students to thrive in a particular area of knowledge.

27.5.4 Care and Support

Involution, which is a term describing the processes arresting the progression of an aging society, has recently caught the attention of the education practitioners. In order to avoid the fierce competition of climbing up the congested social ladder, many teenagers opt for sub-degree programmes or even drop out from VET programmes. Is there anything that applied degree programmes can do about this difficult situation? Nothing. Such a structural problem lies beyond the reach of any individual programmes. BSc(HALM) suffers as well. Some students expressed that they could not find a purpose and satisfaction in their study. Other related societal factors aggravate the harsh reality. Plunging birth rates have taken a heavy toll on the number of new intakes of BSc(HALM). If pressing issue of involution is ignored, in tandem with other social dynamics, the operation of applied degree programmes will be negatively affected.

Applied degree programes can respond to the social context with a multi-pronged approach. Before the admission of new intakes, the body message of any promotion campaigns of applied degree programmes should emphasise personal aspirations and self-realisation in addition to career prospects. More care and support can be provided. Students need to be constantly reminded that the grueling journey will ultimately lead to the attainment of professional qualifications which can be recognised globally. At the same time, students must understand their career prospect will be affected by changes in the labour market of the industry (Wheelahan & Moodie, 2017). In BSc(HALM), gatherings and extracurricular activities are often held to enable mutual support between teachers and students in casual settings. By incorporating the social and personal dimensions, applied degree programmes can become more empowering in terms of education and social development.

27.5.5 Response to Social and Global Dynamics

Applied degree programmes should offer advice on career and employment based on the social contexts. In the latter of 2019, the anti-extradition bill movement in Hong Kong has created to a new wave of emigration. Youngsters have been welcomed by many countries. The United Kingdom has opened a new immigration route for British National (Overseas) Visa holders in Hong Kong (Government of the United Kingdom, 2021). Canada has launched Hong Kong Pathway which attract fresh graduates and skilled Workers with faster permanent residency (Government of Canada, 2020). The affordable tuition fee and bright career prospect render local VET programmes in Hong Kong a less competitive option. BSc(HALM) takes direct impacts from these developments. A considerable proportion of BSc(HALM) intakes consists of sub-degree VET graduates. However, with so many emigration options, the attractiveness of local applied degrees will be downgraded. If the existing mode of operation continues, many local applied degrees will be phased out.

Two approaches are suggested for applied degree programmes to maintain their competitiveness, namely up-to-date and down-to-earth. More resources and training opportunities must be secured by following the latest policies in the industry. For instance, BSc(HALM) has been registered as the only degree-level scholarship programme under the newly established Urban Forestry Support Fund under the Development Bureau of the Hong Kong Special Administrative Region (2020). Slashing the tuition fee, the scholarship has attracted new intakes. On the other hand, practical advice must be provided to students facing struggles with their study. Each year, BSc(HALM) students express the desire to continue their studies overseas. In most cases, under the guidance and sharing of teachers, the students manage to complete their baccalaureate degree and set off for postgraduate studies overseas. This also indicates a possibility that an applied degree programme can function as a stepping stone for developing careers overseas. Therefore, not only should applied degree programmes adjust to local changed, but also the global trends.

27.6 Gearing up for the Future

27.6.1 Connecting the Field and the Classroom with Technology

Applied degree must be sensitive to the latest development in the industry, especially technological advances. From environmental engineering to landscape surveying, BSc(HALM) is tied to a wide range of environmental technologies. For example, Internet of Things can be implemented in fertilisation and irrigation systems. Tree risk assessment, if assisted by remote sensing, can be conducted much more efficiently. In fact, many sensing and artificial intelligence technologies are to be suited for use in urban greening. VET institutions co-evolve with emerging industrial technologies (Lund & Karlsen, 2020). Applied degree teachers should get in touch with the latest technological developments. An excellent method is to conduct research projects in which students can be involved in the use of sophistocated equipment and technologies.

It is wondered whether teachers of applied degree programmes have to be able to operate the technologies. Undeniably, students can be greatly benefitted from tech savvy. BSc(HALM) embraces such principle. For instance, the lecturer of the course Geographical Information System earnt a PhD degree in the same field. It is true that demonstrating industrial technologies can enhance interactive and intuitive learning (Lepellere et al., 2019). Nevertheless, applied degree programmes should assign some weights to intellectual trainings on top of technical exercises. For instance, knowledge related to making professional judgements is relevant when the students become managers in the future. Nevertheless, experience in handling the technologies is favourable to effective management. In short, applied degree programmes need to spend time, but not too much, on field technology.

Technologies can function as a link between applied degree programmes and the corresponding industries. In BSc(HALM), simple techniques can be demonstrated in laboratory sessions or field visits. Nonetheless, a technology-enhanced learning environment can help students familiarise with field practices (Davies, 2011; Mårtensson, 2020). An increasingly popular tool is augmented reality (AR). Research has shown that AR can raise the motivation of VET learners (Acosta et al., 2019). BSc(HALM) has purchased a chainsaw AR system, which can simulate the powering of a chainsaw and the subsequent pruning motion. More interestingly, horrible graphics will appear if a wrong use of chainsaw is detected. Some students may be deterred by the difficulties in using new technologies. But, the extensive use of technologies in practical and pedagogical settings help dissolve technophobia and cultivate an open mind towards new technologies. With an enhanced technology literacy, the competitiveness of applied degree graduates can be elevated.

27.6.2 Crossing the Boundary

As mentioned above, it is common for VET graduates to pursue overseas studies or employment. The international transferability of VET, including applied degree programmes of course, is thus important (Li & Pilz, 2021). Several strategies can raise global exposure. First of all, international events can attract scholars, practitioners and students around the globe. BSc(HALM) co-organised the International Urban Forestry Conference in January 2020. The students attended panel discussion and presented their final year research projects. Other applied degree programmes can hold similar events to gain international popularity. Second, an applied degree programme must ensure its comparability to equivalent level programme(s) in foreign educational systems. In Hong Kong's context, BSc(HALM) awards bachelor's degree just as universities do. But in other countries, for example, Germany, BSc(HALM) may be regarded as a programme of University of Applied Sciences (Hochschule), in contrast to university (Universität). Third, applied degree programmes should assist graduates in obtaining professional recognition. BSc(HALM) fulfils the educational requirement for obtaining the credential of certified arborist from International Society of Arboriculture, which is an international professional body. With these measures, an applied degree programme can bridge itself with international education and professional systems in order to promote the career prospects of students.

The provision of international learning activities can sharpen the competitive edge the applied degree programmes, as well as their students. Thorough overseas exchange tours and apprenticeship schemes, reciprocal relationships among applied degree programmes can be promoted internationally. In BSc(HALM), students can applied for Reaching Out Award, which acts as a subsidy for overseas learning experience. Apart from professional skill development, students can be exposed to cultural shocks and distinctive shop floor culture with respect to various countries. Under the influences of globalisation, international learning experience is an asset for applied degree graduates.

A major barrier of internationally transferable labour market currency of applied degree graduates may be their limited language proficiency. If graduates are to pursue developments overseas, being able to understand the roles and purposes of job tasks in a foreign language is vital. VET equips students with both technical terms and colloquialism in a specific industry in a local context (Searle, 2020). But the competency vanishes quickly once the graduate is placed in a foreign context. In BSc(HALM), providing two mandatory English courses in the curriculum can merely improve students' English proficiency. Further challenges are expected when graduates attempt to work in non-English-speaking regions. Applied degree students can improve foreign language proficiency insofar as that they can manage the existing study load. More trainings may be needed in this aspect to boost the international competitiveness of applied degree graduates.

27.6.3 Teachers Can Do and Teach

Teachers in applied degree programmes possess a unique multi-role identity which differentiates them from those in conventional degree programmes. Applied degree teachers are the mediator between the industries and the academic programme. To foster an intimate relationship between an applied degree programme and the industry, teachers need to catch up with the latest trends and development (Dymock & Tyler, 2018; Schmidt, 2019). The more up-to-date information the programme possess, the more competitive graduates it can produce. For example, academic staff of BSc(HALM) are supported by Discipline Initiated Development Programme to take part in events and examination held by the International Society of Arboriculture. In professional development, the emergence of interpersonal networks can help attract industrial practitioners to become (1) part-time teachers in practical subjects, (2) internship partners, (3) keynote speakers in career talks and (4) potential employers of graduates. The successful inauguration and continuation of mutually beneficial cooperations with the related industries can benefit any applied degree programmes.

Academic staff should also be the pathfinders to discover new knowledge through research and lead the upcoming generations in doing so. The deliverables of research projects can be shared among practitioners and contribute to the industry. More than a dozen of research grants are open for application by academic staff of BSc(HALM) every year. Applied degree programmes are expected to provide academic trainings for its degree-level qualifications. By taking up research projects, teachers can sharpen their competitive edge in creating knowledge. Performing the role as research practitioners, teachers can inspire students with a disposition to pursue an academic career. In fact, students from BSc(HALM) are often recruited as research helpers. The relevant experience equips them with practical skills and help secure a place in research postgraduate programmes. Therefore, what teachers in applied degree programmes should offer lies beyond pure vocational training.

No matter how much industrial and academic prowess a teacher team possesses, effective pedagogical approaches governs the educational outputs of an applied degree programme. BSc(HALM) teachers are eligible for Continuing Professional Development activities. From designing syllabus to classroom management skills, a wide range of workshops help spark the teacher-student dynamics for an enhanced learning experience. Research has shown the usefulness of such contextualised trainings in implementing transformative learning (Andersson & Köpsén, 2019; Bound, 2011; Tyler & Dymock, 2019). Moreover, thematic trainings are provided to disseminate the principles and actions for handling students with special educational needs. In short, the more effective the teaching practices are, the greater the knowledge dissemination function of applied degree programmes.

27.7 Conclusion

Traditional degree programmes have long been criticised for having boundaries of the specific academic discipline. Many practical implications have been derived from the experiences of BSc(HALM). With an aim of equipping students with vocational development and involving multi-disciplinary specialist knowledge, the renovation of tertiary education now runs to the applied one. BSc(HALM) is one of the pathfinders of the applied degree in Hong Kong, providing students with a balanced amount of theoretical knowledge and systemically multi-purpose learning activities, covering but not limited to the laboratory sessions, technology-enhanced learning, and WIL. The situation-based curriculum constructs the transferable skills of students.

These years, mankind is hard suffering from the COVID-19. However, it is also a juncture for reflecting the barriers of traditional education. This enforced BSc(HALM) to gain experience on asynchronous teach-and-learn. During the pandemic, a challenging hybrid mode, audio-visual experience, and voice-over online lectures were adopted. Surprisingly, most of the feedback from students is positive, the harmonious student–teacher relationship BSc(HALM) insists on, encourages the quality of online learning. Innovative assessment has shifted the learning outcomes from rote learning to concept checking and situations-based problem-solving. These discoveries and experiences help revise and rationalise the teaching for the operation of applied degree programmes.

With the inspirations from the pandemic, learning and working are no longer limited regionally. Applied degree programmes should be ambitious to maintain their competitiveness by filling with up-to-date and down-to-earth learning outcomes. Developments of graduates would not curb the local markets but seek the global ones. BSc(HALM) targets to ensure its comparability to equivalent level in foreign educational systems. Awards, overseas exchange tours, and apprenticeship schemes would be strategies for promoting internationally. Actions must be taken to strengthen applied degree programmes. All stakeholders, including students, teachers and practitioners, must be alerted about the latest development in the related industries. Adequate support to teachers has to be provided.

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Chapter 28
From Deindustrialization to Reindustrialization: A Repositioning of Vocational Education and Training for Improving Synergy and Connection Within the Social Structure in Hong Kong

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Abstract Vocational Education and Training (VET) is usually understood to nurture talents in industrial development, but it seems different in the Hong Kong context. In view of the deindustrialization in the 1990s, VET had been no longer on the vital education agenda for long, until an initiative of rebranding to Vocational and Professional Education and Training (VPET) was carried out in 2015. However, it is noted that the VPET initiative is not called for facilitating reindustrialization (also known as Industry 4.0) in Hong Kong. The remained disconnection to industrial development results in problematic and questionable positioning of VPET within the social structure in the local context. Hence, this paper concludes that the repositioning of VPET in social structure is needed in response to the alignment of reindustrialization for global VET development. VPET initiative should become a new paradigm for incorporating the strategic planning of STEM with digitalization and craftsmanship fostering as an innovative feature to promote VPET in Hong Kong better.

Keywords Vocational and Professional Education and Training (VPET) · Hong Kong · Reindustrialization · Industry 4.0 · Repositioning

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28.1 Introduction

Industry Revolution 4.0 (Industry 4.0) has been changing the global landscape of different industries on a larger scale. Although some countries might be in relatively slow progress on the industrial revolution, usually due to the lack of financial investment and governments' determination with policy supports, most countries and their industries may continue to embrace industry 4.0 head-on. In this perspective, digital technology carries on advancing at a rapidly changing pace, when industry 4.0 is regarded as a paradigm shift in manufacturing technology (Valdez et al., 2015). Basically, 'Industry 4.0' refers to the growing rate of advanced technologies in the workplace, such as automation, and the digital disruption occurring to the economy resulting from them. Digital skills not only refer to specific technical or expert skills, such as those typically required for software development or complex coding, but also to those required to use digital technologies effectively to communicate and acquire information and operate within a digital-based workplace (Wibrow et al., 2020). Because of its close connection to industry, Vocational Education and Training (VET) performed a prominent role in ensuring the workforce is properly skilled for Industry 4.0 era.

Throughout the 1980s, a lot of industrial activities were shifted to mainland China, resulting in Hong Kong's role as a transshipment centre for goods made in China being reemphasized. This deindustrialization trend was further solidified after the handover in 1997 to China. In this connection, reindustrialization has been identified as a potential new area of economic growth with the supports of a new economic policy initiative in 2016 by the Hong Kong government to recapture Hong Kong's glory days of one of "Four Asian Tigers (Dragons). "The high-end manufacturing nature of reindustrialization will generate research and development needs to be conducive to investment growth by the industries and provide quality jobs for local I&T talents and the young generation (Research Office, Legislative Council Secretariat, 2020).

VET systems usually aim to deliver post-school, technical-vocational track education to ensure the quality of the vocational workforce, including skilled production workers, professionals, and technicians. It focuses on meeting the specified needs of the regional industries and local students and builds up a direct linkage with local industries through training their workforces. Therefore, VET should be more tightly tailored to the labour market and serve more explicit economic development roles (Busemeyer & Trampusch, 2012). In the industry 4.0 era, the role of VET is imperative in terms of preparing students and existing workers to get ready for a highly digitalized workplace, carrying out technology diffusion to enhance productivity, quality, and innovation (Toner, 2010). In Hong Kong, VET was rebranded as Vocational and Professional Education and Training (VPET) in 2014 and sparked more government attention by establishing two government task forces for following up VPET development and direction holistically. However, VPET remained its questionable positioning in social structure and unclear policy linkages and alignments with other policies in Hong Kong (Yau and Chun, 2020). In this respect, this paper aims to investigate the current positioning of VPET and its alignment with reindustrialization initiatives and conclude whether VPET development is meeting with the global trend with the development of industry 4.0.

28.2 First Stage: Undermining Status of VET Due to Deindustrialization Since the 1990s

28.2.1 The Decline of Prevocational and Technical Schools in Hong Kong

In the 1990s, Vocational education in Hong Kong had undergone significant changes. Manufacturing industries had relocated to mainland China due to the structural economic changes and development towards service-based activities in Hong Kong. Vocational Training Council (VTC) shifted its training focus from manufacturing to service sectors. Technical and craftmanship education was no longer significant and attractive to students. In view of upgrading employees' skills and responding to economic transformation, the Employees Retraining Ordinance was adopted by the Legislative Council, and the Employees Retraining Board was established. Regarding secondary education, there were adequate places in traditional grammar schools. Most Parents did not prefer technical secondary and prevocational schools due to the social norm. They believed that students in these schools were generally inferior to those studying academically and conducted in grammar schools. These schools were usually labelled as low banding schools.

With the falling students' enrollments, prevocational schools and technical secondary schools tried recruiting secondary six students who will attend the Hong Kong Advanced Level Examination, the distinction between the vocational-technical schools and the traditional grammar schools were blurred. In 1996, the "art, practical and craft and technology subjects" accounted for approximately 25–30% of technical secondary schools' curriculum, which was very close to that (15–20%) of traditional grammar schools (Research Office, Legislative Council Secretariat, 2015). The Government then reassessed the functional roles of the vocational schools. Under the above contextual backdrop, secondary vocational education and training had undergone a reform because of the structural change in the manufacturing industry and changing community needs. The "Review of Prevocational and Secondary Technical Education" was presented by the Hong Kong Education Department (1997), stating that the curriculum adopted by technical schools and traditional grammar schools in Hong Kong were very similar. Some technical schools would like to change their schools' names. The review suggested that these technical secondary schools could change their registration names and did not require to state explicitly the wordings of "technical secondary school." Hence, the wordings like "prevocational" or "technical" that appeared in the school names were eventually deleted, and the negative labelling effect was resolved. However, a few schools kept using their "technical" school name, such as "Kowloon Technical School" and "Aberdeen Technical School," the Education Bureau facilitated the integration of technical training and practical schools into the realm of mainstream secondary schools (Leung & Tse, 2018).

28.2.2 VTC as a Stepping Stone of Modern VET Development in Hong Kong

In local VET history, VTC, which was established in 1982 in accordance with the Vocational Training Ordinance, performed a prominent role in Hong Kong VET development (Legislative Council, 1982). It is a permanent and statutory body vested with administrative powers and financial support from the Government, specializing in handling and coordinating industrial training affairs. In 1984, the first development centre, the Management Development Centre of Hong Kong (MDCHK), was first set up. Various centres for different professions and industries, such as textile, soldering, and electrical engineering, were established in the subsequent years (Vocational Training Council, 2007). In addition, more technical institutes and two technical colleges were set up to take over the Higher Diploma and Higher Certificates courses previously offered by the Hong Kong and City Polytechnics in the 1980s and 1990s. With the launching of the integration policy by the VTC in 1999, all Technical Institutes (TIs) and Institutes of Technology were merged into the Hong Kong Institutes of Vocational Education (IVE), vocational education thus offered by VTC was extended to the post-secondary level. The IVE became a stepping stone to offer a wide range of professional-related programmes, such as business, engineering, hospitality, and information technology. Nevertheless, the positioning of VTC in light of the economic transformation has not been thoroughly investigated, causing the status quo of VTC to continue for some time.

28.3 Second Stage: Shifting Status of VET Under Education Reform and Ongoing Renewal of the School Curriculum Since the 2000s

28.3.1 Secondary Education Level Development of Vocational Education

At the education reform, vocational education is partly embedded in the new senior secondary education implemented in 2009. Senior secondary students (Secondary 5 and 6 students) can select one or two "Applied Learning" courses as their elective subjects for the Hong Kong Diploma of Secondary Education (HKDSE), which puts equal emphasis on practice and theory linked to broad professional and vocational fields. Applied Learning (ApL) aims to enable students to understand fundamental theories and concepts, develop their beginners' skill set, career-related competencies, and generic skills. It also enables students to explore their career aspirations and orientation for lifelong learning (Education Bureau, 2021). There were 36 Applied Learning subjects in six different areas, namely: (1) Creative Studies; (2) Media and Communication; (3) Business, Management and Law; (4) Services; (5) Applied Science, and (6) Engineering and Production. According to Education Bureau (2021), more than 10,000 students in 320 schools have studied ApL in the past decades. However, the enrollment of Applied Learning subjects in recent years only accounts for approximately 6% of the total students in HKDSE, indicating its sustainably low recognition in students' points of view (Wong, 2021). Even students studying Applied learning subjects were able to obtain recognition of the Qualification Framework, it remained as inferior choices, compared to other elective subjects (Research Office, Legislative Council Secretariat, 2015).

28.3.2 Post-Secondary Education Level Development of Vocational Education

The transition of Hong Kong from a manufacturing-based economy to a knowledge-based economy posed a significant impact on the VPET providers. The Government promulgated policies, such as developing university education and offering professional diploma and sub-degree courses, to develop higher education, targeting 60% of upper secondary school graduates receiving tertiary education in 2000 (HKSAR Government, 2000). The Self-financing degrees, including VPET programmes, have increased since then. Many publicly funded universities began to offer self-financing programmes at sub-degree and degree levels with various vocational focuses. The Department of Extra-Mural Studies, HKU, as the earliest self-financing university extension, was established in 1957 and then renamed in 1992 as the School of Professional and Continuing Education (also known as HKU SPACE). In 2001, Hong Kong Community College (HKCC) and the School of Professional Education and Executive Development (SPEED) under the College of Professional and Continuing Education (CPCE) were established by PolyU to meet the needs of secondary school leavers for higher education. For the continuing education for working adults, the School for Higher and Professional Education (SHAPE) was set up to provide top-up degree programmes for Higher Diploma graduates in 2003.

Moreover, four management, financial, information technology, and other professional training centers were merged to establish the Institute of Professional Education And Knowledge (PEAK) (PricewaterhouseCoopers Advisory Services Limited, 2021). Further to these VET developments, with the inputs of industries, the Technological and Higher Education Institute of Hong Kong (THEi) was established in 2012 to target providing vocationally and professionally oriented bachelor's degree programmes. THEi's programmes provide students with real working experience and help them attain professional recognition (PricewaterhouseCoopers Advisory Services Limited, 2021).

28.4 Third Stage: A Milestone from VET to VPET Initiative Since 2014

28.4.1 The VPET Initiative and Ongoing Follow-Ups

The Task Force on Promotion of Vocational Education (the 2014 Taskforce) was formed in 2014 to conduct studies and advise the Secretary for Education on strategies and long-term blueprints to raise the awareness and recognition of vocational education in Hong Kong. After gathering different stakeholders' opinions and making reference to other regions' experiences, it is recommended to rebrand VET to VPET, covering programmes up to degree level with a high percentage of curriculum consisting of specialized contents in vocational skills or professional knowledge" (Education Bureau, 2015, p. 86–87). Another recommendation is encouraging the Government to promote and support VPET on different occasions and recognition of VPET as an integral part of the community (Education Bureau, 2015, p. 102) and seek the major chambers of commerce's support to enhance the status and career progress of VPET.

A few years later, a Task Force on the Promotion of VPET ("the 2018 Task Force") was established to review and consider enhancements to the promotion of VPET in Hong Kong as a follow-up action. A more comprehensive consultation review was conducted with key stakeholders such as VPET institutions, secondary schools, industry organizations, employers, think tanks, and youth organizations. In sum, the review report reiterates that VPET's integral role mainly is to equip students with work skills for the future in Hong Kong's education system. The 2018 Task Force urges the Government to deepen and strengthen collaboration with industries to provide more diversified and quality VPET programmes for the youth generation and provide an orientated parallel development of academic education pathways and the VPET pathways. Recommendations were not only made to promote VPET but call for a higher privileged role of VPET within the Hong Kong entire education system, including stepping up promotion of VPET in secondary education through existing platforms (such as Applied Learning and the Life Planning Education), reaffirming the importance value and functioning of VPET in higher education (including the proposed applied degree and Higher Diploma), creating flexible vocational progression pathways for in-service practitioners under the Hong Kong Qualifications Framework (HKQF) and intensifying the future promotion of VPET with a coordinated and innovative approach (Education Bureau, 2020). A series with the theme of "2020 Hong Kong Skills Year" was also initiated to raise public awareness of VPET.

The Steering Committee on Promotion of VPET and Qualifications Framework was established in September 2020 to strengthen the coordination on overall strategy in promoting VPET and fostering closer industry partnership to generate synergy, as well as to take over the functions of the Steering Committee on the Qualifications Framework Fund (HKSAR Government, 2020a). The Steering Committee took up the advisory role to promote the VPET in Hong Kong.

28.4.2 The Launch of a Pilot Project on Applied Degree Programmes

The Pilot project of the development of Applied Degree Programmes was launched to pursue a recommendation made by the 2018 task force (Education Bureau, 2020). According to the report, the applied degrees should be distinct from other degree programmes, including:

(a) the qualifications should be equivalent to those of conventional academic degrees (i.e. to be pitched at Qualifications Framework Level 5);
(b) a more flexible admission requirement should be adopted. Apart from academic results, other relevant factors (e.g., achievements in Applied Learning subjects, skills-based competence, and achievements, working experience, etc.) should also be considered;
(c) applied degree programmes should have an applied focus blending theory and practice, provide substantial internships and work-based learning experience, and prepare graduates for a specific trade/industry, though they can also support articulation to other qualifications; and
(d) there must be strong industry involvement in the development of applied degrees with trade recognition (HKSAR Government, 19).

The Pilot project was launched to gain experience in the practical issues involved in developing applied degree programmes and assess the implications for the higher education system. Under the project, institutions with at least three years of experience in offering self-financing degree programmes under the Study Subsidy Scheme for Designated Professions/Sectors (SSSDP) are invited to express interest and submit proposals for taking part in the pilot project. Finally, four degree programmes are selected for the pilot project, namely:

(a) Bachelor of Nursing (Honours) programme by Caritas Institute of Higher Education;
(b) Bachelor of Engineering with Honours in Testing and Certification programme by The Open University of Hong Kong;
(c) Bachelor of Science (Honours) in Horticulture, Arboriculture and Landscape Management programme by the Technological and Higher Education Institute of Hong Kong of the Vocational Training Council; and

(d) Bachelor of Science (Honours) in Applied Gerontology programme by Tung Wah College.

These institutes have advantages in industry-specified elements with keen human resources demand concerning the coverage of the SSSDP so that they will take the lead on the implementation of this pilot project. Subject to the satisfactory completion of relevant accreditation, the applied programmes will be launched in 2022/23 academic year earliest (HKSAR Government, 2021). After narrating the modern historical development of VPET, the following sections will further investigate the existing positioning of VPET in the Hong Kong social system.

28.5 Findings

Presently, VPET is newly positioned to cover the new addition of programmes up to the degree level providing a wide variety of specialized vocational skills as well as professional knowledge. However, to what extent VPET initiative is supported by a well-aligned policy planning for its sustainable development? Is the VPET initiative in response to the international trend of industry 4.0? The current positioning of VPET and its alignment with the whole social system will be further examined.

28.5.1 Vague and Narrowed Positioning of VPET: For Multiple Pathways of Students or Situating Economic Needs?

Hong Kong's highly competitive education system guarantees an ample supply of talent for the workforce, but it also screens out many fewer achieving ones, who can still become invaluable assets to the economy once the proper training can be provided. Unfortunately, entrenched mindsets and social stigmas on vocational education are still perceived by many as inferior to academic qualifications. These owe much to the long-held perception that vocational training is tantamount to dirty hands, a poor working environment, and meager wages. While it is still the case for certain industries, innovation and technology have also opened new horizons and opportunities for transformation to the VPET pathway. However, many school leavers in Hong Kong continue to shy away from the vocational track for two key reasons. First, there is a stigma of "academic failures" attached to VET. Owing to cultural and historical reasons, people in Hong Kong prefer traditional academic disciplines, seeing VET as a second-tier choice that does not enjoy a more privileged status. In addition, there is a perception that VET graduates may earn less than university graduates, even though acknowledging the practicality of vocational education (Keh & Tang, 2020b). Against this conventional backdrop, VET was suggested to be rebranded as VPET in 2015; those graduates can articulate to bachelor's degree programmes or top-up degree programmes offered by local or overseas universities. Even so, a survey conducted in 2017 stating around 70% of students and parents continued their poor understanding of VPET, indicating the lack of recognition for (VET Bauhinia Foundation Research Centre & The Education University of Hong Kong, 2017). When the public's general perception of VPET seemed gradually improving, a sizeable proportion of respondents still did not have sufficient knowledge of the articulation opportunities available through VPET, according to Government tracking surveys in the last few years. Students' motivation and interest in pursuing VPET remains lower compared to academic pathways, and the challenges come across when the public fails to appreciate the diverse career opportunities available through VPET, as well as the mainstream views did often associate VPET with relatively lower qualifications (mainly at the sub-degree level or below) only (Education Bureau, 2020). In light of this context, the Government aims to level up VPET status by boosting more bachelor degrees, yet it did not direct the economic development effectively and strategically. In particular, VPET cannot position well on helping individual industries nurture suitable and sufficient talents to meet the needs of human resources supply.

Existing VPET positioning is also restricted by the myth of professionals' aspiration from the traditional social norms. The general social and parental expectations keep presetting obtaining a bachelor's degree was the most desirable study decision, enabling their children to pursue a more prosperous career upon graduation easily, and academic qualifications commonly predetermined career prospects. This social and parental expectation thus had exerted additional pressure on students to pursue professional jobs, such as engineers, accountants, doctors or lawyers, etc. The monotonous economic structure where workforce and policy focus was tilted towards a few traditional pillar industries such as financial services, professional services, trading, and property development, barring young people from pursuing education or careers in these areas even if they fit their interests (Benson, 2016). For example, emerging industries such as e-sports or gaming are more favourable for a particular group of young people, which is believed to align with the Government's policy in encouraging innovation and technology development, but these careers were still commonly seen as frivolous and "lower-tier" (Commission on Youth, 2018, p. 38). The traditional norm labelling gaming job is for "losers" to pursue, the VPET development about emerging industries still cannot help benefit of diversifying the Hong Kong economic base and providing more career options for young people with various academic qualifications and skillsets to let the provision of VPET have closer alignment on situating those industry workforce needs. Finally, parents' predetermined mindset of what constitutes a "good job" may directly conflict with young people's interests and ambitions. This traditional mentality that only academic track could easily pursuit a promise for a reputable and successful career pathway for young people is changing slowly, causing the unconducive conditions for VPET repositioning.

Two task force reports can imply further arguments. In the 2014 task force, the rationale of the rebranding of VPET is said to identify a long-term vision to change the entrenched perception of VET being a second choice (Education Bureau, 2015).

While VPET is covering programmes up to degree level with a high percentage of curriculum consisting of specialized content in vocational skills or professional knowledge, it will be no longer confined to the education and training provided in mainly VTC, the second-tier post-secondary choice. VPET will be expected to equip learners with the necessary practical skills, attitude, and knowledge for their effective performance in the relevant professions/industries, so VPET-related industries are also wide-ranging. With this context, professionalizing VET is regarded as the most properly feasible way for the Government to overcome the positioning problem of VET in social structure. The initiative objective is to nurture our youth aspiring more "professional" jobs, which means blue-collar jobs linked with VET might be faded out. In the 2018 task force, the recommendations stated that the society has to reiterate the value and positioning of VPET in higher education, in respect of the VPET pathway from the academic route while upholding their parity in terms of both quality and recognition is clearly defined and differentiated (Education Bureau, 2020). Even the task force attempted to address little linkage with the international trend of "industry 4.0", highlighting the function of VPET should be enriched to emphasize its association with work skills for the future because the requirement and format of jobs are being constantly transformed to varying degrees in the digital age, and prepare students and practitioners for the evolving workplace (Spöttl & Windelband, 2021). Frustratedly, it is apparent that the Government keeps their original mindset that VPET is mainly aimed for study articulation for our youth as a diversified pathway choice, but inadequate evidence showing that the repositioning of VPET within the social structure is determined, impacting the ineffective synergic development of VPET remains unchanged.

28.5.2 Fragmented and Misaligned Policy Planning Between VPET Initiative and Reindustrialization Policy

The Government tends to "emphasize innovation and technology rather than manufacturing in the current industrial policy-making process." A holistic industrial policy is basically empty and subordinated by the policy initiative of innovation and technology, which results in a devitalization of traditional industries. On the other hand, the status quo of traditional industries not being taken seriously by society has not been changed for a long time, and it might underestimate the potential that traditional industries can contribute to reindustrialization. According to the "Report on Manpower Projection to 2027", it is estimated that the local labour force will decline by an average of 0.2% per year between 2017 and 2027 due to the aging population and low fertility rate, while the demand for workforce will grow by 0.3% per year during the same period, bringing about an overall labour shortage of 169,700 by 2027 (Labour & Welfare Bureau, 2019). In terms of knowledge and skills matching, the report showed that employers consider 36% of the employed population (about 1.02 million people) to require training, and the discovery echoes with IMD's Global

Competitiveness Report 2019, demonstrating Hong Kong's ranking in both education and training is less than ideal (Schwab, 2019). In recent years, it has been common for various countries to take the lead in formulating industrial development strategies and policy frameworks, which has led to a new wave of innovation in industrial policies and industrial organization and management systems. For example, Singapore has created an Industry Transformation Map for 23 selected manufacturing and service industries and has broken away from the categorization of secondary and tertiary industries to form six closely related industry clusters (Singapore Minister of Finance, 2021). At the same time, a dedicated agency, the Future Economy Council was established to coordinate and implement the projects by studying the industry landscape, future trends, and needs for formulating targeted measures to systematically enhance productivity, develop skills, promote innovation and internationalization. South Korea is another example of how the government initiative can effectively revitalize industrial development. In 2019, the South Korean Government announced the Manufacturing Renaissance Vision, proposed to build an intelligent, eco-friendly, and innovative industrial structure by using a convergence approach, establish a fund to help traditional companies improve their competitiveness through restructuring and innovation, and restructure the entire ecosystem for industrial development (Shin, 2019). Even in Europe, the United States, and the other regions, manufacturing accounts for a considerable proportion of GDP. Sadly, this is a far cry from the target of "doubling the ratio of local Research and Development (R&D) expenditure to GDP from the current 0.73–1.5% within five years since 2017 (Chan, 2021). Hong Kong's R&D activities depend more on government investment in terms of funding sources.

In the 1960s and 1970s, the manufacturing industry was the main driving force of Hong Kong's economy, with electronic technology ranking first in Asia and Japan coming in second. However, on the one hand, with the reform and opening up, the profit-driven production factors in the Mainland have been optimized, and enterprises have moved their manufacturing plants northward in search of more excellent development prospects and lower production costs. On the other hand, Hong Kong's excessive pursuit of the third sector as the engine of economic development has attracted a large amount of monetary capital from the real economy to the virtual economy, which has seriously weakened the development of the manufacturing industry. The decline of the manufacturing industry has led to obvious drawbacks such as the imbalance of the industrial structure and the hidden losses, including the lack and loss of labor quality, traditional experience, technology, production experts and supporting enterprises' industrial-academic cooperation. Compared with the world's manufacturing industry, there are still some obvious shortcomings, mainly including the cultivation of various enterprises, the layout of critical nodes of the industrial chain and the supply of core technologies.

On the contrary, many provinces in Mainland China attach great importance to start-ups and give them much support, while Hong Kong is already lagging. The most crucial thing is the imbalance of human resources supply. Hong Kong does not lack scientists and business leaders, but there is a significant shortage of vocational professionals needed for reindustrialization, and the inverted triangle of human resources ladder structure has seriously hindered the innovation and development of Industry 4.0. The inverted triangle of the human resources ladder structure has seriously hindered the innovation and development of Industry 4.0. Whether we can cultivate enough vocational professionals and revive the blue-collar class in Hong Kong will directly affect the success or failure of Industry 4.0 in Hong Kong.

Although Hong Kong policymakers have been developing a strategy to reduce the city's overdependence on the services sector and cultivate high-end industrial production, popularising the term reindustrialization still occurs the problem of bias of the whole economic structure. Li et al. (2020) mentioned there were approximately 92,000 employees in the manufacturing industry as of 2017, accounting for 2% of the workforce; the share of Hong Kong's GDP has dropped from about 20% since the 1980s to about 1% at present. Generally, the Government's measures to support innovation and technology, and reindustrialization are mainly divided into three categories: one is directly funded by the Government (and its designated institutions); the other is the Hong Kong Science and Technology Parks Corporation (HKSTP), taking the critical initiative in providing enterprises with cheaper industrial land than the market with its support services; the last one is supporting grants to public institutions such as the Hong Kong Applied Science and Technology Research Institute to encourage enterprises for investing research and development capacity to improve efficiency (Li et al., 2020). Summing up, it can be seen that the Government's reindustrialization policy objective is focusing on nurturing high-end manufacturing. In light of the land shortage and the high cost of human resources in Hong Kong, the policy intention to revitalize existing mainstream manufacturing industries is not keen. The existing unclear and misled positioning of reindustrialization fails to transform our traditional industry and provide synergy from different stakeholders and sectors to revitalize our (re)industrialization policy initiative.

28.5.3 Disarticulation Between International Industry 4.0 Trend and Traditional Industries' Needs

Industry 4.0 refers to the 4th Industrial Revolution, which is given to the current trend in robotics, data exchange, and automation. It is a concept coined by German economist Klaus Schwab in 2015, defining it as the emergence of the digital economy and the use of automation and data exchange in industrial technologies, which contains the artificial intelligence for computerized technical processes, a synergy between networked machines, Internet of Things as well as human beings in decision-making. It will be characterized by atechnological revolution to enhance the automation of manufacturing processes introducing customized and flexible mass production technologies where machines operate independently or cooperate with humans while the machine constantly maintains itself. According to Wang et al. (2016), industry 4.0 is the proliferation of cyber-physical systems that introduces the fourth stage of industrialization, and the identified main features contain “Interoperability, Virtualisation, Decentralisation, Real-Time Capability, Service orientation, and Modularity” (Shafiq et al., 2016).

Rüßmann et al. (2016) described nine technologies that enhance production by integrating and automating isolated production processes or machines to optimize production flow, leading to greater efficiencies and changing traditional production relationships among suppliers, producers, and customers as the bridge between human and machine. It is emphasized that not all technologies are necessary to be required for implementing an establishment of an Industry 4.0 working environment, a combination of a few of the technologies which tailoring to each industry needs should be prior considered. The main goal is that the technologies used from the above can be regarded as the key enablers, meeting the Industry 4.0 design principles for companies to help create an Industry 4.0 working environment. In this sense, the enablers of Industry 4.0 may seem daunting and uncommon in some industries because they symbolize highly advanced technology, which may likely become a problem about the training of workers in certain industries that are unfamiliar with these technologies. No matter who the employers and employees are, they need to comprehend the trend towards enhanced automation. Other Industry 4.0 technologies will keep emerging, resulting in workers with higher-level cognitive skills such as decision-making skills and analytical capabilities will be more in demand in the long run. The technologies signify that the role of VET is imperative in improving the teaching practices and assessment applied by appropriate and capable trainers for a better training outcome.

Provided that the importance of using new or advanced technologies in the workplace is growing, such technologies contribute to the digital disruption currently occurring in Industry 4.0. Thus, it is crucial to note that digital skills are not only referring to the more expert or technical skills, such as those typically required for complex coding as well as software development, but also those required to use digital technologies and acquire information for effective communication to operate within a digital work environment. Productivity Commission (2016, p. 82) states that ‘all workers need the skills to interact with digital technology, whether it is maintaining records in caring professions, taking orders in retail, or operating equipment in the processing plant,’ because industry 4.0 workplace required every skill tied with technology closely (Reeson et al., 2016). Mentlík and Helísek (2018) mentioned that industry 4.0 is a process of digitization of products, services, equipments and applications of exponential technologies. It requires more interaction through interconnectedness and communication of people, devices, and machines to fully utilize all previously untapped information. This connection increases the efficiency of machines and equipment, reduces costs, and saves resources. By digitizing, the companies can gain intelligent tracking and constant overview thanks to transparent processes that will enable them to react quickly and flexibly to possible changes in markets.

Since 2016, HKSAR Government has supported thousands of reindustrialization projects through the Innovation and Technology Bureau (ITB), Hong Kong Productivity Council, Cyberport, HKSTP, etc., by directly subsidizing and supporting preferential rent. However, there is room for improvement between the Government’s policy goals for reindustrialization and the practical baseline situation of the industry, highlighting that the development of traditional industries has been neglected in the new policy initiative. Historically, Hong Kong was once famous for its industrial sector, with the manufacturing industry being the main driving force of its economy in the 1960s and 70 s, but the emergence of the knowledge-based economy model in the late 1980s shifted Hong Kong to have an overreliance on the tertiary industry as an engine of economic growth. It inevitably will severely weaken the local manufacturing industry, which continues to shrink at this point, accounting for only 2.5 percent of the total employment in Hong Kong. Hence, it is understood that reindustrialization has provided a "false hope" for stakeholders of traditional industries that expect the Government to adopt a number of policies to shed light on these popular Hong Kong traditional industries again (Hillebrecht, 2019). However, the Government is not enthusiastic to accommodate labour-intensive or land-intensive manufacturing industries due to land and labor resources limitations.

On the contrary, the Government aims to attract high-end manufacturing industries to prevent spending too much land and labour resources to facilitate the diversified development of the local economy, shift the over-reliance on the service industry, and foster more high-quality talents for innovation and technology. In particular, it tries to provide a brighter career prospect for Hong Kong young people (Lam & Ng, 2020). The negative supports on facilitating the transformation of traditional industries to advanced manufacturing industries not only turned all traditional industries' stakeholders' disappointment, but brought about an evident imbalance in industrial structure and concealed damages, such as the loss or degradation of labor quality, traditional workmanship, craftsmanship, production expertise, supporting industries, and cooperative opportunities between academia and industrial sector. Indeed, the Hong Kong government has planted the seed to reindustrialize Hong Kong via focusing on certain high value-added, less land-intensive manufacturing sectors and nurturing them with a coordinated plan by lining up partnerships with companies and universities to achieve a more integrated knowledge transfer strategy. Nevertheless, this would be unlikely for a universally beneficial Industry 4.0 plan to be achieved, nor the interest of young professionals be protected in Hong Kong.

28.6 Discussion and Recommendation

Given the above discoveries, the positioning of VPET is a bit delinked with the economic development needs. To better shift the current situation, repositioning of VPET in social structure will be examined, and incorporating strategic planning of STEM development with digitalization and craftsmanship will be further discussed below.

28.6.1 Repositioning of VPET in Social Structure to Better Achieve Reindustrialization

While reindustrialization commonly is conceptualized as using high-end technology to upgrade industries, the understanding of industry should be broadened. From this point of view, the industry should not be confined to manufacturing, and it should mean all the processes involved, including purchasing, research, design, manufacturing, engineering, branding, and marketing. In other words, reindustrialization should be meant innovating all the processes involved in the industries. In a webinar discussion held in the Hong Kong Polytechnic University (2020), Dr. Daniel Yip, Chairman of the Federation of Hong Kong Industries pointed out that Hong Kong industry has to move ahead from a four-pronged approach as “the next normal of Hong Kong industry”:

1. Relocating factories: Enterprises can choose to locate the different processes of business: purchasing, manufacturing, engineering, legal, finance, and other professional services in different countries and regions, according to their comparative advantages.
2. Exploring new markets: The consumption power of many other countries and regions should not be neglected, apart from China market.
3. Developing High-tech products: The focus should be on talent development, product design, manufacturing, and intellectual property. Exporting technology and high-end skills should also be considered.
4. Enhancing local production: Several local industries, including jewellery, food, green technology, printing, and smart manufacturing, still enjoy many competitive edges. With the enhancement in technology, they have good potential for further development.

Given that the Government intends to adopt reindustrialization as a new economic engine for Hong Kong, developing semi-automated or fully-automated industries and emphasizing sectors is essential. It can support our sustainable development and high value-added manufacturing. However, it is found that not all industries can apply automated and smart production; the concept and literal meaning of reindustrialization conflicted with the overall policy planning. Even the policy focus of reindustrialization is high-end industries, but the traditional industries are worth further attention for revitalization, so the industrial policy can be more operational and manageable to meet different sectoral and industry stakeholders’ expectations.

Industry 4.0 is a cornerstone to the leap of super-big changes in working and operation systems in the marketing, manufacturing, extraction, distribution, assembly, and service industries (Avis, 2018). Industrial automation that recognizes artificial intelligence enables the service provision and production systems to be more humanistic and intelligent. An advanced system should detect anyone in a location, greet everybody anytime, give directions, and provide multiple machine-based needs services automatically through various media, such as loudspeakers and mobile phones. This revolutionary change certainly changes the need for competency and work skills drastically. The vocational education curriculum with linear monodisciplinary is not up-to-date. Instead, various skills are needed for a multidisciplinary, interdisciplinarity, and transdisciplinary curriculum (Amiron et al., 2019; OECD, 2021). Moreover, the Cyber-Physical Production System (CPPS) drives the development of smart industries in providing quick, cautious, and satisfying products and services. This change directly shifts the role of VET by providing the special skills for the application of CPPS, so such graduates can work productively and provide economic benefits after undergoing relevant training. The primary motivation of VET lies in economic benefits for the future in a sustainable manner for industry 4.0 (Grobbelaar & Verma, 2020).

PricewaterhouseCoopers Advisory Services Limited (2021) revisited the role of VPET in the last two decades, rediscovering VPET providers have significantly enhanced youth employability, with unemployment rates for the young people aged 15–19 dropping from 31% in 2002 to 10% in 2019. In contrast, those aged between 20 and 29 remained low (about 6%). VPET is significant to driving Hong Kong's economic growth and development by equipping industries with a skilled workforce critical for Hong Kong's glory and prosperity. Besides, the traditional functioning of VPET providers is to offer lifelong learning opportunities for skilling, upskilling, and reskilling the workforce, improving social mobility and career enhancement which deserves high recognition in society. Against this backdrop, it is recommended that the future direction of VPET development should promote upskilling and reskilling of the workforce by VPET programmes that could be enhanced to develop a strong talent pool of meeting the reindustrialization talents demand. Policy and financial support should be strengthened to encourage more corporates to participate in VPET research and development and nurture a skilled workforce for the industry and enhance recognition of VPET in the local community and worldwide. Another analysis revealed that Hong Kong has to assess its political-economic environment and cultural and historical heritage when we want to borrow successful skill-formation approaches for a successful economic model. The Hong Kong experience proved that developmental, collective, and liberal skill-formation features could be combined to serve the policy agenda of building a high-skills society and enhancing regional competitiveness. However, the challenges potentially brought by misalignment of the skill-formation features with regional contextual factors need to be addressed in the planning and implementation stages (Pan et al., 2020). Therefore, the repositioning of VPET to align with global industry 4.0 trend and local social structure for facilitating reindustrialization should address the following concerns based on Sudria's (2019) observations on Industry 4.0 development with VET policy context:

(1) How does the world of work change in the next five to twenty years, and what is the main function of VPET in Hong Kong?;
(2) How VPET talents from different industries can be able to compete in the world of work and develop their work careers brilliantly in the digital era, the knowledge-based industry, and industrial revolution 4.0?;

(3) What competencies and skills are needed by VPET talents to help them maintain a career for the next few decades?;
(4) How could nurture more VPET talents to adapt to digitized workplace efficiently?
(5) What is the setting of learning environment conditions to realize a meaningful and beneficial learning experience in VPET?;
(6) What is an effective VPET curriculum and pedagogy nowadays and for the next generations?

28.6.2 Incorporating STEM Development with Digitalization and Craftsmanship in Strategic Planning of VPET Direction

It can be seen that the VPET initiative seems unable to connect with economic or technology and innovation policy closely when Hong Kong's economy beyond its service sectors (finance, real estate, trading and logistics, tourism, and professional and producer services) was still accounted for 93.1 percent of Hong Kong's GDP in 2018. Yet, we cannot deny that Hong Kong has preserved significant domain knowledge in the development of textiles and clothing, and other traditional industries, something the world continues to need. The university's role is still prominent because it is a key stakeholder in reindustrialization. On the other hand, as the stepping stone for VPET provision in Hong Kong, VTC can work with technology firms to train much-needed specialists and technicians to design, install, operate, and maintain smart technology solutions and systems. VTC might let the reindustrialization plan and smart city initiatives become underway and nurture sufficient talents to fulfill industries' demands. In the coming future, VET may be more eager to focus on the qualities of work environments that help promote learning for industry 4.0; classifying drawing on the technical potential of digitalization to design work that promotes learning will become helpful. Therefore, the digitalization of learning influences Industry 4.0 development by paying more attention to (a) Learning content by linking it with information on the work process; (b) Learning method gives the learners opportunities to control the learning process themselves; (c) Learning environment by providing contextual information for the learning process beyond the immediate working environment; (d) Learning conditions by creating opportunities for social interaction and (e) Learning development by recording and reporting learning outcomes and using them to select subsequent learning steps (Kuper, 2020, p. 127). In addition, the focus of the future VET curriculum will emphasize the advanced level of digital literacy as well as encourage students to use digital technology proficiently for a flexible and convenient application in the digitalized workplace (Reeson et al., 2016). Grand-Clement (2017) concluded the hurdles of the application of digitalization in VET are (a) systemic institutional barriers, which prevent or impede learning through digital technologies; (b) lack of understanding between education technology developers and VET providers concerning understanding the pedagogy behind the use of the technology and (c) lack of skills development and the imperative to make digital technologies and skills development a greater focus of continuing professional development for VET to adapt in industry 4.0 education. In this connection, the VPET sector could consider how to properly embed the VPET initiative with industry advancement in closer coordination and align with the global industry 4.0 evolution on digitalization.

For the past few decades, academic qualifications were deemed the sole and ultimate aim of education, but the key for the future is fostering the importance of craftsmanship working together with robotics in Industry 5.0. It is described in Japan at first as a super-smart society where robots and humans will work side by side. It will be a revolution where technology such as the Internet of Things (IoT), big data, artificial intelligence (AI), and robots will be a part of everyday life. Teammates and colleagues will be a robot rather than humans. Robots will be intertwined with the human brain and work as a collaborator rather than a competitor. Robots will assist us to upskill but not take our jobs and create more personalized creative experiences for their service provision. Humans may become unique and special as creators of products or services but avoid working in dangerous circumstances. Remarkably, the craftsmanship will bear the distinctive mark of a human being. Products will be handcrafted with the help of automation to customize products with ultimate precision, humans in this sense, can mainly be focused on how to enhance the customer experience (Grenčíková et al., 2021). Hence, it will be imperative to develop students for their future job roles so that they will not only be competent but capable, including the ability to think on their feet and act independently (Spöettl & Tutlys, 2020). Costley (2019) summed up industry 4.0 requires building upon success in life rather than long and drawn-out exams, it will become an ongoing process of continuous improvement and human-based development. Personalized education will be the way to move forward, so students will have flexibility when it comes to education and will be in control of their time management, which means they can learn whenever they want. It is foreseeable that VPET direction has to follow this inevitable trend, linking up the component of VPET to incorporate in digitalization for promoting self-regulated learning in skill enhancement.

Apart from digitalization, Idin (2018) creates a model to map the relationship between STEM education and Industry 4.0. In this model, it is seen that STEM education fosters Industry 4.0 with its aims and twenty-first century skills. It can be understood from the model that STEM education should be enhanced to facilitate high-end industry for a country or region. 21st-century skills are highly compatible with skill enablers for industry 4.0, which aims to facilitate STEM education to have a high-quality industrial system within Industry 4.0 context and infrastructure. Putting into VPET context, when the manufacturing industry can be continuing to be a central driver of growth for economies worldwide and in the Industry 4.0 concept, our VPET talents must make themselves ready for the new fields of modern smart manufacturing and incorporation in STEM skills and literacy, meanwhile for revitalization in traditional industries (Lars et al., 2015). Boyd and Tian (2016) reveal that capable workers, who have expertise in STEM, are deemed the main driver for the researches and development activities that stimulate economic growth. Most educational systems worldwide are still based on a Taylorist understanding of education, making them a problem instead of a solution. VPET should try to align digital transformation for future technical and economical cloud infrastructures in Hong Kong (Schröder, 2019).

28.7 Conclusion

The Hong Kong Government has repeatedly stated its intention to promote reindustrialization and has strived to build a comprehensive policy system for reindustrialization by setting up the ITB to take charge of the work and introducing a number of policies and measures to support reindustrialization. However, the positioning of reindustrialization is queried (Li et al., 2020). The Government has been relying too much on financial and real estate capital for a long time, affecting the irreconcilable conflicts with Industry 4.0 and professional talents under the VPET context. If it carries on, it will be impossible to promote the fundamental rights of Industry 4.0 and sincerely protect the interests of young professionals, or even to unite the youth and empower their involvement in VPET development (Keh & Tang, 2020a). Undoubtedly, the key to the success of VPET is to establish a systematic and sustainable VPET system. When policy alignments with various aspects of industry enhancement and economic development can be improved, the VPET sector may know how to redefine the positioning of VPET in the social structure.

With the advent of industry 4.0, vocational and professional qualifications can lose their traditional power to protect against the precariousness of work due to the spread of automation, digitalization, digital Taylorism, and other "technogenic" changes of work. The emergence of industry 4.0 or 5.0 could exert the extended influence on technologies for the organization of the systems of qualifications, which the regimes of access to qualifications will be changed (Spöettl and Windelband, 2021). For instance, the application of virtual and augmented reality to develop vocational skills as a replacement for work-based learning in real workplaces can increase learners' access to work-based training and apprenticeship (European Union, 2020). It can be shown that the dominant status of the third industrial revolution, which placed significant emphasis on high skills and knowledge as a critical factor of competitiveness, career, and socio-economic status starting to undermine the influence of academic qualifications. Hence, when VPET initiative is regarded as the first stage of a paradigm shift for local modern VET development in Hong Kong, the next phase of a paradigm shift in how to formulate a consensus so a holistic transformation for related VPET sector can be stepped forward to facilitate an effective repositioning of VPET within the whole social system.

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Chapter 29
Globalisation and the Massification of Higher Education in the Hong Kong Context: Dealing with the Challenges of Globalisation

Kwok L. Lee

Abstract This article examines how the concepts of globalisation and neo-liberalisation have influenced Hong Kong's approach to massification of its higher education. It considers the impact on educating a work-force suitable for the much-touted knowledge-based economy. The article approaches this through the review of past and current research covering the subject matter. By looking at the recent developments of Hong Kong education system and around the world regarding the massification of higher education, the article examines the way Hong Kong have dealt with the demands of globalisation without hugely increasing state provisions through the employment of a neo-liberal approach. It focuses on how the Hong Kong government have encouraged the creation of a self-financing higher education sector through community colleges, associate and top-up degrees, by treating education as a tradeable service and introducing the concept of users pay. It will look at its successes to date and its continuing development.

Keywords Globalisation · Neo-liberalisation · Massification · Internationalisation · Higher education · Community college

29.1 Introduction

The concepts of globalisation and the knowledge-based economy has been recognized as having impacted immensely on the character and function of education around the world (Mok, 2015). Scholars have been focused on globalisation's impact on economic, political, social and cultural aspects since the beginning of the 1990s. Like major economies around the world Hong Kong have not been immune to the effects of globalisation. One of its aspects is that higher education is seen as a "tradable service" (Lo, 2017) which can be marketed to consumers of education around the world. The development of the knowledge-based economy, which developed

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economies had been rapidly moving into, made political elites realize that having a well-educated workforce led to the enhancement of its national competitiveness (Lo & Tang, 2017). So, in the early 1990s many Higher Education systems saw themselves transitioned into a "stage of universal post-secondary education" (Lo & Tang, 2017).

After the handover of sovereignty of Hong Kong to China in 1997 successive Hong Kong governments have tried to enhance the city's competitiveness by embarking on the transformation of the local higher education sector through further massification and internationalisation. Using a neo-liberal approach of "users pay" rather than state funding to achieve the massification have led to the enlargement of the private sector (Lee, 2015), which reveals Hong Kong political elite's fear of burdening its finances with reoccurring fiscal expenditure and leads to the question of its commitment to educating its youth and exposing its more capitalistic tendencies. The situation is further complicated by the strategy which the government took in offering Associate Degree programmes, which is an unfamiliar education qualification to most Hong Kong people and employers.

The implementation of the massification of higher education in Hong Kong has largely been successful as it was able to quickly increase the number of students taking part in post-secondary education from 33 to 66% (Wan, 2011) within a very short period, and with minimal government expenditure. As impressive as the numbers are the educational reform has not resulted in the enhancement of upward mobility for most of the graduates of this policy exercise (Lee, 2015).

This paper will look at how the concepts of globalisation and neo-liberalization have influenced Hong Kong's approach to massification of its higher education and its effectiveness in developing a work-force suitable for the knowledge-based economy. This will be approached through the review of past and current research covering the subject matter. It is hoped that new knowledge may be developed that will further the understanding of the subject matter.

29.2 Globalisation

Globalisation has been described as an "ongoing process of intensifying economic, social, and cultural exchanges across the planet" where the expansion in the integration and coordination of markets, the production of goods and its consumption has been a constant (Suárez-Orozco, 2007). It describes a phenomenon that has taken place since the Second World War, where the links between different nations have been continuingly broadened and strengthened, leaving almost no country unaffected, and increasingly making independent national actions to be restricted by international constraints (Stewart, 1996). Paradoxically, the same process has resulted in increased fragmentation and stratification in areas of economy, politics and culture, on some nations, societies and communities as they become more intertwined in this global order whilst some have been pushed to the peripheries (Tikly, 2001).

Since the 1990s, social scientist used globalisation to conceptualize and explain the developments and changes in the economy, technology, culture and politics, and the bringing together of the world. Before the term became popular, the phenomenon was previously described and analysed independently under headings such as international commerce, diplomacy and migration (Stewart, 1996). Some commentators, described as strong globalist, pushes the 'convergence thesis' which describes a bleak and depressing image of the future nation state and its ability for creation of independent domestic policies, while on the other spectrum exist sceptics and transformationalist who query the real extent of globalisation and the actual transformations it has caused (Mok & Chan, 2002; Mok & Tan, 2004). Scott (2000) describes globalisation as a turbulent phenomenon that cannot be seen merely as a higher form of internationalisation for it not only transcends national boundaries but is able to ignore them.

Stewart (1996) suggests that there exist two significant aspects to globalisation that can be used to describe and analyse it, the first being the acceleration of internationalisation of many facets of life, encompassing economics, technology, culture and ideology, and the increasing geographic enlargement of internationalisation. He further highlights the important links between international trade, the movement of money and people, the globalisation of culture and international commerce, which are ostensibly disparate elements, but because they are much more tightly bound by the global net than might be seen it may not be possible to understand globalisation just by looking at the elements individually.

Although there exist different interpretations of globalisation's impact on contemporary societies there is a consensus that globalisation's effect on different aspects of human life and history is a "highly differentiated phenomenon" (Mok & Tan, 2004). In addition, it is generally agreed of the effects globalisation has on public sector management and delivery of public policy (Mok & Tan, 2004). Tikly (2001) suggests globalisation is permanently altering the "politics of the nation-state and its regional sectors, domestic classes and nationally-defined interest groups". Certainly, globalisation is not only altering economic structures and reshaping how people live but is also challenging the power of the nation state (Mok, 2003; Scott, 2000), and increasingly making untenable its ability to maintain cultural coherence and homogeneity (Suárez-Orozco, 2007). Another fundamental aspect of globalisation, as highlighted by Stewart (1996), is that it rewards countries that have human resources which it can exploit, while those without are penalised.

29.2.1 Globalisation and Internationalisation in Education

For any nation education is the key for economic success, and for any nation which seeks to advance it must provide its citizenry with the appropriate level of education required by its stage in development, and failure at this level will result in poor human resources (Stewart, p331, 1996). Stewart further suggests that development failures are usually associated with low quality human resources, that is why education plays a key role since it has always been an important element in any economic and social development. But globalisation has amplified the returns to education by exploiting the global economy, on the other hand, those who fail to invest in their education are as equally penalised (Stewart, 1996). To highlight the importance of education in the era of globalisation, Tikly (2001) suggests that education is not only affected by globalisation but that it has become the "principle mechanism" by which global currents influence the daily lives of people around the world.

As Scott (2000) suggests, globalisation of education cannot be viewed as another form of internationalisation of a higher order, but instead should be understood as a much more tempestuous phenomenon, and that we must understand globalisation and internationalisation are two different phenomena.

The differences between globalisation and internationalisation stems from globalisation being expressed through the contemporary world of global consumerism and capitalism. Internationalisation is principally conveyed through a world containing nation states where diplomacy and culture take place, where it is bounded by national borders reflecting a world order in which they are the principle actors, whereas globalisation transcends and make impotent nation states. Furthermore, the differences between these are heightened due to internationalisation's ability to reproduce and legitimise the existing power structures and dominance between different nation states (Scott, 2000).

As globalisation has freed up access and made it much easier for students and scholars to study and work around the world, universities around the globe have become more active in the international arena through student and staff mobility, in response to the pressure of globalisation. Internationalisation allows for the exchange between cultures and nations, enhancing the competences of students and staff, while at the same time allowing them to interact and work in a multicultural environment, creating an understanding between people of different ethnicities and cultures (Lo & Tang, 2017). It has led to changes in university research, university management and even the design of its curriculums (Ka, 2007).

It has been suggested in Suárez-Orozco (2007) that world economic integration and international mobility of workers is only made possible by the internationalisation of education, a point well understood by forty-eight European countries that have come together through the Bologna Process to improve the internationalisation of higher education.

29.2.2 Internationalisation of Hong Kong Higher Education

As Fok (2007) points out internationalisation was not really something new to Hong Kong, considering internationalisation initiatives already undertaken by church bodies after the British took over Hong Kong after the Opium Wars in nineteenth century. These church bodies set up schools teaching the Western curricula and populating them with teachers from overseas. Most of the prestigious schools still operating in Hong Kong were introduced in this manner.

Similarly, the University of Hong Kong, the oldest university in the region, was founded in 1910 by the local colonial government to provide tertiary education for the British and other expatriates, as well as the small number of local Chinese elites. Like other universities established by the British at the time it was well connected to other universities scattered around the British commonwealth, so in this sense it was already internationalised.

Until the expansion of university places in the 1990s, internationalisation was taken as a given in the development of university education in Hong Kong, however, after the establishment of the Hong Kong University of Science and Technology in 1991, and the upgrading of several polytechnics, colleges and institute in 1994, internationalisation came into focus. It was a way for the newly established universities to garner prestige and be recognised as equals to the more established universities. In less than a decade internationalisation would become hugely important to universities in Hong Kong, even the well-established University of Hong Kong and the Chinese University became as concerned about internationalisation as the newly establish ones as competition between them intensified.

Internationalisation of Hong Kong higher education got a further boost after the handover of sovereignty of Hong Kong from the British to Chinese rule in 1997. The new government of the Hong Kong Special Administrative Region (HKSAR) under Mr. Tung Chee-hwa, Hong Kong's first Chief Executive, attempted to promote internationalisation of higher education by increasing the intake of non-local undergraduates and research students (Lo & Tang, 2017).

In 2004 the Hong Kong University Grants Council (UGC) published a document to develop Hong Kong into the region's education hub, which echoed the previous Tung administration's expressed desire to transforming Hong Kong into "Asia's World City" (Lo & Tang, 2017). Tung's successor, Mr. Tsang Yam-kuen, viewed the education hub strategy as a means to promoting new business opportunities and as a way to increase the city's competitiveness, in response to the financial crisis which happened during 2007–2008 (Lo & Tang, 2017). The higher education sector seen in this context was something that could help advance economic and social development of the city, while at the same time used as a strategy in its transformation into a knowledge-based economy (Lo, 2017).

The Task Force on Economic Challenge established by the Tsang government recognised educational services as one of the six economic pillars of the city's economy and went about to promoting higher education and developing the self-financing post-secondary education sector. Furthermore, the UGC published a report in 2010 recognising that internationalisation was central for promoting the educational hub strategy, and that education was a commodity that could be commercialised to increase the city's share of the global higher education market by increasing its transnational offering.

Subsequently, in 2010 the UGC increased the proportion of non-local students in the undergraduate programmes of the publicly funded local universities by doubling it to 20%. Laws on immigration and employment were changed to allow these non-local students to be permitted to work part-time and to take part in internship programmes during their period of study. After graduation they were also allowed to remain and seek employment in the city (Lo, 2018; Lo & Tang, 2017).

29.3 Neo-Liberalism in Hong Kong Education

Neo-liberalism is the rejection of the Keynesian welfare economics that has served as the standard economic system in developed nations since the end of the Second World War, and the embracing of the ideology born out of Chicago-based neo-classical economists, free-market think-tanks and right-wing political elites (Mudge, 2008). Their ideas are popularly equated with the free market, considered to work best without government interference, which stresses free-trade through economic deregulation, maximum competition, tariff-free trade, and monetary and social policies that are advantageous to business and in general disregards its negative aspects affecting the social, cultural and environmental spheres (Brown, 2003). It is further suggested that in neo-liberalism the rational for cost–benefit and efficiency for practices within governments even takes precedence over democratic values and institutions, leading to the withdrawal of the state from certain spheres and in its place privatisation of functions which had traditionally been provided by governments.

For Mahony and Weiner (2017) neo-liberalism is a theory of political economic practice that suggests society is best served by giving people the individual skills and the freedom to be entrepreneurial within an institutional framework consisting of free markets, free trade and strong property rights. This is also suggested by Tang (2011) who points out that there is a believe that a nation's economic growth is best served by a neo-liberal market-oriented approach consisting of marketisation, performativity and individual entrepreneurship.

So, at the heart of neo-liberalism sits the idea of the free-market, where all activities of life are reduced to economic ones, it is not just an ideology but also a practice (Mcaffee, 2017). Under neo-liberalism political processes are to be weakened and replaced by economic ideologies, here market solutions take precedence as they are seen to be superior to political ones (Mcafee, 2017).

Since the 1980s the restructuring of public service along the lines of neo-liberalism has been a widespread movement across different capitalist societies (Davies & Bansel, 2007), and Hong Kong has not been an exception to this. Within the education sector, neo-liberal values have been the major driving force behind large scale reforms that have involved almost all major aspects of school education. It has led to education policy objectives becoming closely aligned to economic goals, with the aim of meeting the challenges of the global economy by producing individuals who are competitive and able to contribute to the nation's economy (Tang, 2011).

From the 1990s onwards, a series of rapid expansion of activities in internationalisation and privatisation have taken place in the higher education sector in Hong Kong (Lo, 2017). Central to these policies was Hong Kong government's desire for change in the governance model of the local higher education. It wanted to diversify the financial and funding resources, through the inclusion of non-government sectors such as business, community, individuals and family (Mok & Tan, 2004). It is now common to find in every university a Committee of Donation engaged in raising funds with many campus facilities found in higher education institutes being financially supported by the third sector. This is actively encouraged by the UGC as it provides matching grants to higher education institutes that are able to raise funds from non-state sources (Mok & Tan, 2004).

Furthermore, the HKSAR government also introduced market principles and practices into the education sector, in the belief that it would promote competition and lead to improved performance and efficiency (Mok & Tan, 2004). This has resulted in education provision becoming more "market-like and is based on rational choice theory and competition for positional goods" (Mok & Tan, 2004), and clearly reflects the HKSAR government's neo-liberal tendencies. The adoption of community colleges and self-funded sub-degree programmes as the main tool in the HKSAR government's policy of higher education massification in the early 2000s is also another example. This adoption of the users-pay principle means that programmes offered by higher education institutes such as the community colleges are commercialized and have market value as they can be exploited to generate income (Mok & Tan, 2004).

The concept of education as a marketable good was taken up by the HKSAR government when the Tsang administration identified educational services as one of the six new sectors that could be developed to provide new business opportunities, while also enhancing the city's competitiveness in response to the global financial crisis of 2007–2008 (Lo, 2017). With this recognition, it embarked on transforming education into a service industry through the development of Hong Kong as regional education-hub, which further accelerated the neo-liberalism process within education and other aspects of Hong Kong life.

Another important aspect of the HKSAR government's approach to nurturing a more creative and innovative workforce in the face of an increasingly globalised economy, has been the introduction of a policy of decentralization in education, allowing schools and universities more autonomy and be responsible for their own future development (Mok & Chan, 2002). This has been facilitated through the implementation of "managerism" and "new public management" ideas (Mok & Tan, 2004). Thus, allowing the government to further distance itself from the responsibility in the provision of public goods, therefore minimising political participation which is central to neo-liberal ideology (Mcafee, 2017).

29.4 Massification of Higher Education in Hong Kong

Before the 1970's tertiary education was an experience to be had only by the privileged few, served by two universities—the University of Hong Kong and Chinese University of Hong Kong (O'Sullivan & Tsang, 2015). Unsurprisingly, the number of places were limited, and the programmes considered to be elitist (Wan, 2011). Between the 1970s and the 1980s, the proportion of students who manage to get into a local UGC funded first year degree place rose from 3 to 5% (Wong, 2014), and after graduation would have had good career prospects and high recognition in society, with real opportunities to do well in organizations, affording them social mobility, and the possibility to move up the social strata (Wan, 2011).

During the 1960s and 1970s the colonial government massified primary and secondary education through state-sponsored compulsory education, which created a rise in demand for post-secondary education. As a result, the colonial government, under the tenure of Governor Sir David Wilson, was forced to act. After the Education Commission Report No. 3 (1988) and in recognition of the changes taking place in the economy, where a better educated workforce made up of capable and knowledgeable people were now required by businesses (Wan, 2011), it was proposed to boost the number of places for students going into higher education, on the proviso that resources were available. So, in his policy address of 1989 it was declared that the number of UGC funded degree places would be raised to 18 percent (around 14,500 places) for the 17–20 age group from 1991 (Wan, 2011), and has remained relatively at this level since. As a part of this massification programme, the University of Science and Technology was established in 1991, and colleges and polytechnics were permitted to offer degree programmes, and eventually with four upgraded to university status in the mid-1990s.

After the change of sovereignty in 1997, another review of the education sector was commissioned by the new HKSAR government under Mr. Tung Chee-hwa, conducted by the Education Commission. Following the review, the government proposed education reforms in September 2000, encompassing primary through to the tertiary education. Included were two key proposals that affected higher education, with the first being the target of progressively increasing access to post-secondary education to 60% of secondary school leavers in 2011–12 school year, and the second, to promote the development of the private higher education sector (Wan, 2011; Wong, 2014) as part of the regional education-hub strategy. At the same time, the government decided that the numbers of places for UCG funded first degree places would not be increased.

29.4.1 Community Colleges and Associate Degrees

After the reforms, the city's education sector saw the rapid emergence of community colleges and the development of associate degree programmes. To bring about the massification of higher education in the city, the government adopted a user-pay approach (Lo & Tang, 2017), and encouraged the development of community colleges, a concept originating from the United States (Wong, 2014). Several were developed from existing post-secondary colleges while others developed from UGC-funded establishments and their continuing education units, or in conjunction with charitable organizations (Lo & Tang, 2017; O'Sullivan & Tsang, 2015).

From 2001 onwards, these newly established community colleges began to offer associate degree programmes, which were a form of sub-degrees. The associate degree (AD) programmes were different to the existing higher diploma (HD) programmes, available since the colonial era, for these were predominantly focused on imparting general knowledge to students rather than equipping them with knowledge in specific and professional domains, as were the case of the HD programmes (Pavlova, 2017; Wan, 2011). Also, unlike their HD counterparts which were mainly subsidized by the government, the user-pay model of AD programmes meant students paid much more for their studies.

29.4.2 Overseas Intuitions and Top-Up Degrees

Apart from the development of the community college and associate degree sector the HKSAR government also encouraged the development of self-financing top-up degree programmes to cater for the demands from graduates of sub-degree programmes for articulation opportunities to full degree programmes. These demands were acknowledged by the second Chief Executive of the HKSAR government, Mr. Tsang Yam-kuen when he announced the creation of a HK$2.5 billion Self-financing Post-Secondary Education Fund in his 2010–2011 Policy Address (Lo, 2017, p. 766).

The self-financing top-up degree sector is operated by higher education institutions from both local and overseas, but mostly are run jointly by a local and an overseas institution. Overseas collaborators will usually have lower academic standing compared to the local institutions especially when these programmes are offered by one of the UGC-funded institutions. While several UGC-funded universities do operate such top-up programmes they are usually operated by their self-financing business units (Wong, 2014).

Compared to regular degree programmes, the duration of top-up programmes is much shorter, usually two years and some even offer one year programmes, and tuition fees are much higher. Top-up degrees do not normally enjoy the same level of academic support nor supporting facilities. Equally, students undertaking such studies are not eligible for the government financial support schemes which are offered to students on UGC-funded degree programmes. Top-up degree programmes are generally considered to be inferior to those offered by UGC funded institutions, leading to qualifications with lower social recognition (Wong, 2014).

With the development of a two-tier system, Hong Kong managed to very quickly massify its higher education, within 5 years the rate for students in the 17–20 age group participating in post-secondary education doubled from 33 to 66% (Wan, 2011), ushering in the era of post massification in higher education at little cost to the HKSAR government (Kember, 2010).

29.5 Conclusion

To cope with the challenges of globalisation the HKSAR government responded by massifying its post-secondary education sector to create the workforce for the knowledge economy by employing a neo-liberal approach. This was managed mainly through sub-degree programmes, and to some extent self-financing top-up degree programmes, by adopting the users-pay principle. Clearly the HKSAR government have benefitted from this approach as it has managed to raise the education level of its workforce with minimal financial cost. It also shows a government very much in touch with globalisation, its ramifications and the need for life-long learning skills (Kember, 2010), by embarking on the upgrading of its workforce through the continuous changes and improvements it makes to its education sector.

However, the neo-liberal approach of treating education as a tradable service rather than as a public good, has created much dissatisfaction amongst those who fail to gain a place at the much sought after publicly funded programmes. Students who have graduated from AD programmes in the past have not found themselves to be any better off when entering employment than secondary school graduates (Yip, 2018).

Furthermore, most Hong Kong students aspire to gain university degrees and those who fail to articulate onto degree programmes is further dissatisfied, as they view sub-degree courses as paths to under-graduate education (Kember, 2010; Lo & Tang, 2017). At the same time, this approach puts greater financial burden onto families who typically have less financial and social capital than those who manage to gain places at publicly funded programmes.

Altogether, the massification of higher education in Hong Kong can be said to have been quick and successful, but only in that it has managed to increase the number of graduates who have post-secondary education. But often these qualifications have not resulted in better prospects for the graduates, furthermore it has increased the financial strain on families through the higher cost of the programmes. Higher qualifications used to provide a route to social mobility, but this has not been the case. One can see that there are no winners in this situation except for the government to be able say to its constituents that it is actively engaged in countering the effects of globalisation, but if the workforce that it wishes to create does not materialise then for what purpose is the massification?

To address some of these issues the HKSAR government introduced the Study Subsidy Scheme for Designated Professions (SSSDP) in 2015, generous grants for secondary graduates undertaking self-funded degree programmes covering mostly professional sectors considered short of skilled manpower, at first providing only 1,000 places but now covers more than 3,236 places (Hong Kong Government). Most recently, it has begun providing non-means subsidy of up to HK$30,800 a year to secondary school graduates and graduates of sub-degree programmes who enrol on self-financing Top-up degree programmes (Yip, 2018). Only time will tell how well these initiatives help Hong Kong cope with globalisation, create a more equitable society and balance the effects of its neo-liberal policies.

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Chapter 30
Facilitating *Transformational Change* in Applied Degrees in Engineering: A BRAVE New World

Robin Clark and Jane Andrews

Abstract This chapter introduces an innovative and transformational model of applied engineering education, the BRAVE Model of Educational Transformation. Incorporating five distinct concepts, Belonging, Relationships, Authenticity, Variety and Employability, the model is introduced and discussed in detail. Set within a prestigious Russell Group University, WMG is one of the largest Applied Engineering Faculties within the UK; it is home to five distinct Research Directorates, fourteen applied graduate programmes and five work-based undergraduate programmes. Written during a time of unprecedented social crisis, in terms of the global Covid-19 Pandemic, this chapter outlines how transformational change has been brought about within WMG (formerly Warwick Manufacturing Group) through the development and application of the BRAVE Model. Students' perspectives are provided through the use of a short survey examining their views of some aspects of each strand of the model. The impact of using the model as a basis for transformational change on colleagues' approaches to education is also discussed.

Keywords Authentic learning · Education framework · Employability · Transformational learning

30.1 Introduction

At a time of unprecedented social, economic and industrial change, whereby reliance on a range of accessible, digital communication tools indicative of Industry 4.0 (Marr, 2018) has seen significant growth globally during the Covid-19 Pandemic, the need to build a connected and cohesive academic community has possibly never been quite as important. This paper is grounded in the application of the findings of our ongoing

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research into learning and teaching practice within applied engineering education. In considering how we, the chapter authors, approach education it is fair to say that we are both *pracademic* in our approach. That is, practical, practice focused, applied university teachers who wholeheartedly believe transformational change in higher education needs to encapsulate a cyclical process of empirical research, critical evaluation and evidence-based decision making.

The idea that research should form the backbone of transformational change in learning and teaching is not new; indeed, in discussing the need to better understand higher education practice, Tight (2004a) argued:

> I would, therefore, like to register a plea for continuing and more critical, challenging and theoretical research into higher education.
>
> Such research, by establishing and developing the overall framework of our understanding of higher education, feeds over time into both higher education practice and the more immediate and common forms of higher education research. We need it for the sake of our minds and souls (pg. 12).

Picking up the gauntlet thrown down by Tight's plea, we describe in this chapter how organisational change in applied engineering degree level education can be brought about in a way that is both empirically grounded **and** transforming for all concerned.

30.2 Case Study: WMG, University of Warwick

The largest Department in the University of Warwick, WMG was founded in the 1980s with the intention of linking industry with academia through the introduction of a collaborative research approach in which academic and industrial researchers and engineers work together to identify and solve some of the most challenging problems faced by wider society. Synergetic working between industrial and academic researchers quickly expanded into learning and teaching, with WMG launching a small number of bespoke applied engineering and management degree courses purposefully designed to address the complex and quickly changing needs of industry. Since this time the faculty has exponentially grown to become one of the largest in the UK focused on engineering, applied science and management education. Currently employing over 800 full-time staff as well as a comparable number of sessional lecturers, researchers, supervisors and other colleagues, WMG is home to five distinct Research Directorates, 14 applied postgraduate degrees and five work-based undergraduate degree programmes. It also offers executive training and short courses on a global scale.

In terms of applied education, WMG currently has around 1,500 students enrolled on its 14 fulltime postgraduate courses, each one grounded in an ethos of applied practice and professionalism. Additionally, the faculty has just over 280 PhD students and 700 part-time MSc students. At undergraduate level there are 800 students enrolled on Degree Apprenticeships in areas as diverse as general engineering, digital technology and healthcare. Degree Apprenticeships provide educational opportunities for people who are in fulltime employment. The modules that make up the course of study are carefully designed so as to meet the needs of the sponsoring industry. The study is combined with work-based activity that ensures the application of learning is a key focus of the whole experience.

In the last year, following the appointment of a new Dean, an organisational approach has been introduced in which colleagues are supported through a process of evidence-based change that is grounded in education and management research. This chapter considers the challenges, trials and triumphs of transforming education within WMG. In doing so it introduces the BRAVE Model of Educational Transformation; showing how the faculty is *growing* collegial and organisational capability and capacity whilst continuing to ensure that students receive an excellent, applied and industrially relevant education.

30.2.1 Why is Transformative Change Needed?

In looking at learning and teaching within WMG objectively, one of the most notable features is its massive international cohort of graduate students. A solid core of 250 part-time graduate students join with our annual intake of around 1,300 full time graduate students from around the globe to make the Graduate School an excellent example of 'globalisation' in action (Lanzendorf, 2013). Each graduate student enrols upon a vocationally-focused higher degree programme that will equip them with new lifelong skills, knowledge and competencies. Additionally, like universities everywhere, friendships made at WMG form the basis of future professional networks meaning that our students graduate equipped with the industrial and social tools needed for success (O'Day, 2009).

Such a diverse and large student body is not without its challenges. The heterogenous nature of the cohort, both academically and ethnically, makes benchmarking and planning difficult. Like cohorts of graduate students everywhere, our students bring with them different prior experiences of learning and life, with individual expectations reflective of a range of cultural backgrounds; hence, establishing a common starting point can be a challenge (Van den Beemt et al., 2020). Yet the internationalisation of higher education is not a new phenomenon. Almost two decades ago, Tight (2004b), suggested that the demographic makeup of postgraduate education in the UK had markedly altered due to an increase in overseas recruitment. As we progress through the 21st Century, how we as university teachers take account of and plan for diversity in our classroom is becoming increasingly more important to our students' success (Schram et al., 2017). In WMG this means looking closely at our values and strategy, moving forward whilst making sure that all our students experience learning and teaching that is holistically relevant but personal in nature.

WMG's faculty is unique in the depth and breadth of industrial and managerial experience that our colleagues possess. Indeed, our fulltime teaching staff reflect the global nature of today's workforce, with colleagues recruited internationally; many directly from industry. In some respect this places WMG at an advantage in designing learning *for* a global work environment. Learning materials are drawn from a range of international settings and the curriculum content purposefully designed so as to proactively expand students' ontologies and epistemologies whilst building their discipline-specific skills and competencies (Bird, 2017; Kingston & Forland, 2008; O'Reilly et al, 2013; Wang, 2012).

Whilst the pedagogic and cultural heterogeneity of the WMG graduate cohort is one of its key strengths, the homogeneity of the student body in terms of the familiarity with digital technology is another. In terming those born after 1980, 'the net-generation', Limniou and Smith (2010) argue that this *generation 'have a fundamentally different way of processing information and the way they communicate* (p. 646). Yet digital competency and familiarity is only one piece of the puzzle when designing transformational education. Years of experience, supported by evidence-based educational research, tell us that for meaningful learning and teaching to occur within engineering and applied science, colleagues need to develop active learning experiences (Lima et al., 2017; Christie & De Graff, 2017).

Constructively aligning learning to meet the needs of industry whilst meeting academic standards and individual student expectations (Chan & Lee, 2021) is not easy and in WMG has required something of a paradigm shift. This paradigm shift, whilst underway at the outbreak of the pandemic, was hastened when all face-to-face and traditional teaching methods were suddenly cancelled in March 2020. It was at this time that the BRAVE Model of Transformational Education came into its own. Already in development, the BRAVE Model (depicted in Fig. 30.1 and discussed in detail later) provided a framework to support colleagues through the enforced changes in how we teach brought about by Covid. Grounded in both the chapter writers' own and others research, BRAVE places the students at the heart of everything we do; providing colleagues with a solid framework within which to create applied learning and teaching experiences.

30.3 The Time for Transformation is Now! The BRAVE Model of Applied Engineering Education

30.3.1 Lockdown, the Pandemic and Pedagogy in WMG

In the midst of a global pandemic when international society is unsure of whether the crisis has reached *the beginning of the end, or the end of the beginning*, other omnipresent political unanswered questions augment the situation we are working within in the UK Higher Education Sector. Uncertainties regarding the impact of Brexit haven't gone away (Eggins, 2019), they've simply been put on hold. Likewise, political vagueness regarding educational funding, policy and practice continue to

Fig. 30.1 The BRAVE model of educational transformation

make planning difficult. Yet such uncertainty pales into insignificance when considering the potential difficulties that the next few years may bring as cohorts of students, who have not been in school for significant amounts of time due to 'Lockdown' during the pandemic, enrol in university. More than ever before, educators need to embrace carefully planned, strategic change (Jick, 1993; Kotter, 1996, 2008). The question of how we support and encourage colleagues to do this is one that we are taking seriously.

Drawing upon previous scholarship (Andrews et al, 2019; Clark & Andrews, 2014), steps are being taken to bring about effective and transformative organisational change. In a typical university setting faculty experience tends to be centred around academic disciplines—with certain disciplines previously being dominated by a particular 'type' of person. Indeed, in the UK, Engineering Education is often criticised for an over reliance on colleagues who are male, white, middle-class and middle-aged (Carter-Black, 2008). This stereotype does not fit WMG where a global recruitment policy has resulted in many of our teaching-focused colleagues being recruited directly from industry (as opposed to joining the faculty via traditional academic routes). Such colleagues bring with them a dualistic expertise, both in terms of their subject knowledge and their first-hand experience of the concepts and theories they teach and how they are applied in the real world. One of the disadvantages of this is that expertise in a particular area often brings with it a particular way of doing things, manifested by a resistance to change (Nyamapfene, 2018; Tennant et al, 2015). Up until recently this didn't matter so much, yet, as the challenge of the pandemic dawned, a notable minority of colleagues were identified as having adopted the same teaching approach for many years. Such colleagues were generally disorientated by the move to online teaching caused by the pandemic and as such were very reluctant to consider how to teach differently.

30.3.2 Introducing the BRAVE Model of Educational Transformation

Bridging the 10 steps of successful organisational change introduced by Jick (1993) and building on the work of Kotter (1996, 2008), the BRAVE Model of Educational Transformation Change has been developed out of our previous work (Andrews et al., 2012, 2020; Andrews & Clark, 2012, 2016, 2017, 2018, 2019; Clark & Andrews, 2010, 2012a, 2012b, 2014; Clark et al., 2013a, b). It brings together five the five distinctive, yet interlinked, concepts depicted below in Fig. 30.1.

30.3.3 The BRAVE Project: Researching the Student Perspective

Continuing our previous published work in which we critically discuss the need for a new approach to engineering education (Clark & Andrews, 2014, Andrews & Clark, 2018), and continuing to follow an Action Research approach (McNiff & Whitehead, 2006), a short survey was conducted examining students' perspectives of the five strands of the BRAVE model. The survey was disseminated to 1245 students and completed by 959 (a response rate of 77%). Aimed at gauging students' perceptions of the value of pedagogical change made under the auspices of BRAVE, the survey was administered towards the end of the taught period of the academic year. A series of questions were asked within each conceptual strand using two, three-point, Likert Scales (helpfulness and importance). The questions, together with the students' responses are discussed in the following section which critiques and explains the basis for each concept within the model.

Belonging*: Our Starting Point.*

Bounded by the notion of active scholarship within a positive learning community (Boyer, 1990), the concept of *belonging* within WMG is articulated as: *The embedding of a sense of acceptance for students and faculty alike in an environment where individuality is valued and team cohesion and synergetic working nurtured. Each person is encouraged to achieve self-actualisation through active engagement and membership of our community of scholars.* In practice, this means making sure that all our students are given the wherewithal to quickly enculturate themselves as they arrive for Welcome Week to begin their learning journey. To do this, an effort is made to ensure that colleagues and students are supported in five distinct areas (Bird, 2017):

- **Academic Expectations:** The high standards expected of WMG students with regards to academic, professional and personal conduct are made clear with all colleagues communicating a standard message in respect of academic practice, policy and procedures to all students. With regards to student wellbeing, colleagues work hard to encourage students quickly develop a sense of pride and ownership of their particular discipline field, university programme, department and cohort. This in itself impacts positively on academic behaviours.
- **Academic Conventions:** Experience tells us that regulatory frameworks can quickly baffle and confuse the best of students. Colleagues are given regular mandatory training and updated about university regulations so that they are in a position to provide clear guidance regarding how the 'academic system' works to the students. A consist approach is adopted across WMG so as to assure students become familiar and at home with the academic culture.
- **Internationalisation & Globalisation**: The value and benefits of living, studying, working and socialising with an international group of people is celebrated within WMG and colleagues encouraged to share their first-hand experiences of different cultures. Social events are held to celebrate cultural holidays and significant days in the year with students and colleagues jointly sharing in what is often a rich cultural exchange.
- **Local Culture:** Students are introduced to University and Faculty values in the first week of their education. Interwoven into our strategy, our values are divided into three interlinked strands in that in WMG we are: Customer-Focused: Innovative and Collaborative: and, Professional and Respectful. Our values encourage colleagues to develop positive working relationships across the wider university, within our local community and within discipline groups. Our students are encouraged to play an active role in the numerous opportunities afforded by the Student Union in addition to getting involved in local community based initiatives and employment opportunities.
- **Thinking Forward:** Professional Development is key to our success and continual training opportunities are offered to all colleagues—irrespective of their role, responsibilities and experience. For students, the notion that education forms the foundation of their future lives is central. Across WMG our applied approach to education is conceptualised as a flexible and continually changing "3-D Puzzle", with students encouraged to develop their own future pathway and colleagues supported to think and act 'out of the box'.

How helpful have you found the following WMG Practices & Policies in enabling you to feel part of a proactive and positive learning community?			
	Very Helpful	Moderately Helpful	Not Helpful
The requirement that I attend every lecture, tutorial or lab session	54%	43%	3%
Working in small groups within the classroom	57%	39%	4%
Being allocated to the same group of students to work with outside of the classroom throughout each module	42%	48%	10%
Having a named Personal Tutor who I am able to contact if I experience any personal or course-related problems	56%	40%	4%
Having a course rep who will speak on my behalf	41%	46%	13%

Fig. 30.2 Belonging questions: students' perspectives

In addition to the above policies and practices, a number of purposefully designed measures have been introduced to promote and nurture a sense of **belonging** throughout the academic year. These measures include guidance about student attendance in lectures; groupwork, the provision of individual tutorship and the appointment of student reps for each course. Figure 30.2 provides an overview of how helpful students have found these.

Encouraging colleagues to take steps to enhance student belonging represents an important part of the BRAVE approach. Central to this within WMG is an emphasis on student attendance and engagement; something that is widely acknowledged to be linked to student success (Büchele, 2021; Dębiec, 2019; Karnik et al., 2020). Whilst it was initially thought that students would resist any attempt to enforce attendance in lectures, the results from this study suggest that this was not the case and that most learners find the expectation that they will attend every educational opportunity helpful. Alongside an emphasis on attendance, active pedagogies, including the use of groupwork within the classroom, are encouraged with students placed in small classes of thirty students (often spanning disciplines) and divided into class-based teams of around 5 or 6. Although groupwork is known to bring with it a number of academic, cultural and managerial difficulties (Duty & Analoui, 2016; Hacaoglu, 2015), the low percentage of students stating that working in groups is not helpful indicates that its benefits outweigh the disadvantages. That placing students in groups has been found to increase feelings of inclusivity, particularly amongst diverse groups of students (Long et al., 2017; Nisbet et. al., 2016), is particularly relevant in WMG, where the heterogenous nature of the student body means that individuals may become isolated if left to their own devices in the classroom.

Reaching across two of the BRAVE concepts, **Belonging** and **Relationships,** the role of Academic Tutors in supporting student wellbeing (McIntosh et al., 2020) is key to WMG's approach. Whilst issues around workload and gaps in tutors' skill sets are acknowledged (Chadha et al., 2020), a proactive strategy of training and the introduction of a 'Learning Agreement' signed by each individual student in the presence of their Academic Tutor is beginning to prove successful. It has led to students and tutors meeting regularly to discuss academic progress as well as student wellbeing.

The final question depicted in Fig. 30.2, which focuses on how helpful students find the system of 'course-reps', indicates that this part of the policy, whilst important, is not particularly a priority for some students. The use of Course Reps has not been greatly researched, although it is documented in Quality Assurance Agency guides and local practice documents (see, van der Velden, 2013 for example). During the Covid-19 Pandemic, course-reps have played a vital role in ensuring communication lines have been strong between students and staff as decisions have been made on how to progress learning.

***Relationships**: Scholarly, Professional & Individual*

Closely linked to the concept of belonging, the need to build scholarly, professional and individual academic relationships that engender trust, and promote cohesive working, represents the 'glue' holding the BRAVE Model together. One of the most notable changes brought about recently and indicative of the transformational paradigm shift currently underway within WMG, has been a deliberate opening up of internal governance. The most high-profile change is the launch of the WMG Assembly, an elected body of colleagues from faculty and support staff, representing all levels and roles. The Assembly, which was launched in the Spring of 2021, provides colleagues with the opportunity to have their voice heard, not only by the Executive, but across the WMG and the wider university. This in itself represents a noteworthy and substantial shift in organisational thinking, culture and practice.

By actively listening to others' perceptions and experiences, traditional barriers between researchers and teachers, academics and support staff, professional colleagues and ancillary workers are being broken down. In opening up WMG to a new level of peer scrutiny and discussion, the Assembly is, in itself, beginning to prompt a change in culture and morale, enabling colleagues to build relationships whilst promoting belonging.

With regards to the student experience, a number of distinctive bespoke operational practices and policies work together to promote solid and long-lasting scholarly relationships. Of particular note is the 'week-long' block learning module, which provides an intensive and highly interactive experience shared by a group of 30 students.

In seeking to understand students' perspectives of WMG's operational approach, four questions were asked looking at class and tutor group size and also about how the timetable is scheduled. The responses to these questions are given in Fig. 30.3.

How helpful have you found the following WMG Practices & Policies in supporting you in developing useful scholarly relationships with fellow students and faculty?			
	Very Helpful	Moderately Helpful	Not Helpful
Being in lectures of 60 or more students	10%	52%	48%
Being in lectures of around 30 or less students	60%	32%	8%
Being allocated to a tutor group of less than 6 students	60%	17%	23%
Studying in intense week-long learning blocks with the same cohort of students	32%	38%	40%

Fig. 30.3 The BRAVE approach: relationships and students' perspectives

Whilst the above data suggests that WMG students generally support the practice of placing students in classes of 30 or less, and of being allocated into tutor groups of around 6, the impact of class size on student learning is somewhat contested within a relatively small body of literature. Although the relationship between class size and the student experience is important, there is little doubt that the multifaceted nature of education makes the impact of class size a controversial matter (Bean, 2001; Krueger, 2003). In discussing this, Bandiera et al., (2010), suggest that optimal student performance is achieved in classes of 1–19; whereas classes of between 20 and 32 students see a marked and significant drop in the achievement of learning outcomes. Somewhat surprisingly, Bandiera et al. (2010) continue to suggest that the point at which class size no longer impacts learning outcomes is 33 + ; and somewhat controversially, it is higher ability students who benefit the most from small class sizes (Bandiera et al, 2010). In WMG the questions identified in the literature raise important questions about how to manage a sizeable cohort within the permitted resources. The decision to retain class sizes of less than 30 students for all face-to-face and most blended learning has proved popular with the students.

Moving forward, a number of lessons, practices and principles have been put into place so as enable colleagues support students in developing meaningful, supportive and long-lasting academic and social relationships whilst studying at WMG. These include:

- **Welcome Week:** This has been redesigned and elongated over a two-week period. Previously this was mainly the responsibility of support staff, but academic colleagues are now encouraged to get involved. Discipline-specific academic events are interspersed with wider social events and networking opportunities. For students, the opportunity to familiarise themselves with each other and with their lecturers in week 1 means they are able to start building supportive, forward-looking academic relationships right from the onset of their learning journey.

- **Individual Academic Tutoring:** The role of the individual academic tutor has become increasingly important over the past two years. Colleagues are provided with training and support to ensure that all students receive a similar experience in terms of tutorship. Each student is allocated to a named academic colleague who is responsible for their wellbeing during their time in WMG. Over a period of one to three years, strong relationships, built on mutual respect and trust, develop in which learning becomes a two-way experience whereby students and tutors share life in WMG.
- **Timetabling:** Timetabling is complex and difficult with around 1,300 postgraduate students and a limited number of classroom space. The largest programme has 300 students whilst the largest module is offered to all 1,300 students. To ensure a consistency of approach and to enable learning communities and scholarly relationships to develop and grow, students are placed into study groups for allocation into modules. This means that students spend most of their time in WMG with the same small group of around 30 students.

All of the above measures enable scholarly relationships to develop and grow, providing a solid foundation for a coherent learning community in which authentic learning is pivotal. It is such authenticity that provides the central strand of the BRAVE model.

Authentic Learning*: The Backbone of the BRAVE Model*

Intentionally designing a curriculum that is based upon learning experiences that embed authenticity into every task, point of knowledge and learning outcome provides a challenge that colleagues enthusiastically accept. WMG students are provided with the means to develop and hone *problem*-f*inding* and *problem*-s*olving* skills in such a way that engenders confidence in their own learning abilities (Nicaise et al., 2000). In real terms this requires approaching education differently. As discussed in the previous section, one of the challenges of managing high numbers of students within a single cohort is that large class teaching is often associated with lower quality learning outcomes (Ehrenberg et al., 2001). More recently, quantitative research by Huxley et al. (2018) found that whilst class size is an important variable impacting how students' experience university, the exact nature of the link between class size and performance in ambiguous. In WMG, this makes the need to actively promote authentic learning even more important and faculty-wide guidance about assessment, feedback-feedforward and the setting of learning outcomes represents an important aspect of how the BRAVE Model is being implemented.

In the survey, students were asked about how important some of the key faculty-wide policies, put in place to promote authentic learning, are in helping them learn. Figure 30.4 shows that such steps have been well received.

One of the key benefits of assuring an authentic curriculum is the opportunity for students to develop and improve their transferable communication skills, whilst also growing cultural competencies and critical and independent thinking skills (Lillyman & Bennet, 2014). In WMG professional academic student relationships and networks are developed by a small, but dedicated, team of support

How important are the following WMG Practices & Policies in helping you learn to the best of your ability?			
	Very Important	Moderately Important	Not Important
Detailed guidance on the assessment	67%	32%	1%
Detailed feedback on my assessed work	73%	25%	2%
Being able to contact the module tutors (subject specialists) when I need to	66%	32%	2%
Having clear learning outcomes	70%	24%	6%
Being able to use my personal technology (laptops / devices / phones etc) during lectures	68%	26%	6%

Fig. 30.4 The BRAVE approach: authentic learning and student perspectives

and academic colleagues working together. Here the holistic nature of the BRAVE Model becomes important. Students are encouraged to develop strong relationships within their cohort, whilst colleagues nurture authentic learning relationships within the classroom. The unique mixture of academic, industrial, professional and personal experience has become central to learning, with 'real-life' examples and experiences being used to illustrate and authenticate theory.

One particular pedagogical challenge in designing authentic learning that is applicable to the WMG Postgraduate cohort reflects the international nature of the student body. In discussing this, Wang and Shan (2006) argue that one of the key problems faced by international students is their misunderstanding of UK academic conventions relating to academic practice in general and plagiarism in particular. This perspective is widely supported across the literature with a number of studies highlighting how stressful and confusing international students can find UK academic conventions (see for example, Bamford et al, 2006; Kingston & Forland, 2008; Bird, 2017). The interlinked nature of the BRAVE Model means that authentic learning is promoted contemporaneously alongside efforts to engender a sense of belonging and to encourage scholarly relationships. With authentic learning centrally placed in terms of curriculum content, variety in pedagogic practice becomes increasingly important.

***Variety in Learning**: The Spice of Life*

The pandemic has highlighted the importance of embedding a variety of different teaching and learning approaches into the curriculum. For many colleagues in WMG, the need to implement a Blended Learning approach as the Pandemic hit, was a significant culture shock. Having no option but to move all learning and teaching online pushed many colleagues and students out of their comfort zones and benefited those modules and courses already adopting a blended approach.

In defining Blended Learning as *"a coherent integration of e-learning and traditional learning to meet our educational goals*", Yigit et al. (2014, pg. 808) describe the starting point that colleagues in WMG found themselves at when the pandemic struck. That many had already looked at introducing *variety* into their pedagogy through the introduction of online quizzes, short films and some pre-recorded learning proved to be an advantage. The introduction of the BRAVE Model built on this, enabling colleagues to further develop and embed *variety* in their learning approaches, course content, learning opportunities and in the wider context of the programmes.

Figure 30.5 highlights students' responses to questions regarding four distinct yet interlinked aspects of the move to embed more variety within pedagogic practice. The first question revealed that only half of the cohort identified 'learning new topics and concepts' as being very important to their learning; whilst the second question looks at one strand of the student experience, study support. This found that whilst additional support is very important for around half of the cohort, it is less so for the rest. Conversely, the two questions focusing on pedagogic practice, one about the use of role-play teaching and the other about case-study learning, proffered very different responses.

In WMG one of the benefits of embedding *variety* into educational design is that students are often encouraged to tailor their own learning to their own requirements and learning style (Heaton-Shrestha et al., 2005). In practical terms, throughout the pandemic and also moving into the future, the requirement to include a variety of pedagogies in curriculum design has a number of implications for colleagues:

- The continued use of interactive and collaborative learning activities, both synchronous and asynchronous will be essential as we move into the future.
- Team building and teamwork both, within and across teaching groups, is actively encouraged; whilst changes to the curriculum mean that groupwork is becoming increasingly embedded into assessment, enabling students to learn from and with each other.

How important are the following WMG Practices & Policies in helping you learn to the best of your ability?			
	Very Important	Moderately Important	Not Important
Learning a number of different topics and / or concepts over a term	52%	36%	12%
Being able to access additional study support when I need it.	52%	37%	11%
Taking part in role-play during lectures	45%	34%	21%
The use of real-life case-studies	82%	12%	6%

Fig. 30.5 Variety in learning: a snapshot into students' perspectives

- An ethos of 'feedback-feedforward' is being adopted in all areas of the student experience and popular mantras such as '*you asked—we did'* and *'you asked—we listened'* are changing the culture, with colleague and students feeling increasingly assured that their voices are being heard.
- More directed interactive and immediate feedback has been introduced in some modules via learner response systems and online assessments, including computer marked class-tests and examinations.
- 'Academic Integrity' has been embedded into the curriculum and students are taught how to write academically and reference correctly.
- Colleagues are required to check all students' work for plagiarism.
- Many colleagues embed videos, recordings and other simulations into learning materials.
- Across the modules a range of journal articles, academic papers and other learning materials have been brought together in a single portal (VLE) and a greater emphasis on independent learning has been made.

From an academic perspective, the proactive act of embedding 'variety' into an authentically designed blended learning curriculum has positively encouraged student engagement; motivating individual learners to take more responsibility for their own learning, by setting their own goals and cognitively engaging with the learning outcomes (for further reading see: Heap et al., 2004; O'Connor & Ross, 2004; Ngai et al., 2007; Blas & Serrano-Fernández, 2009; Limniou & Smith, 2010; Yigit et al, 2014). Authentic learning is a vital part of the BRAVE Model. Running through all aspects of the student learning journey, authenticity is also strongly linked to the final concept in the BRAVE Model, that of Employability.

Embedding Employability*: Linking Industry and Education*

As previously stated, one of WMG's key strengths lies in the wide range of industrially focused expertise, cultural experiences and ethnic mix of our faculty. The added value that international colleagues bring to the classroom was noted by Bird (2017) who, in citing one of her research participants, wrote: "*Having a global perspective is useful, whether you intend to bring it back to your own country or whether you intend to stay on in the UK"* (pg. 337). The BRAVE model places much emphasis on providing an internationally relevant curriculum. Whilst WMG's long-standing industrial links provide all colleagues with the wherewithal to offer relevant learning experiences, our international colleagues give WMG an 'edge' in terms of global insights and experiences. Moreover, colleagues who have joined WMG from overseas bring with them a distinctive understanding of our students' ontology and epistemology in terms of having personally experienced the cultural shock that goes alongside moving abroad to study or work (Gu, 2009, 2011; Wang, 2018).

Student employability now forms a key part of the University of Warwick Education Strategy (University of Warwick, 2021) with a range of transferable skills being both embedded into the curriculum and provided through the University's careers service. Yet within the wider UK, the notion of graduate and student employability received little attention before the turn of the Century with many Higher Education Institutions preferring to focus on employment and work-readiness (Little, 2003). Conducted at the brink of the 21st Century, a longitudinal study by Smith et. al (2000) developed a series of employment outcomes and found that employability is influenced by a range of different variables including the subject studied, pre-university education and social class. Since this time a considerable body of work has identified and analysed the key drivers underpinning student employability which include work experience and extra-curricular activities (see for example, Irwin et al. (2019), Jackson and Tomlinson (2021). Other recent studies however, highlight the importance of curriculum design and embedding employability within modules and in all aspects of the student learning journey (Campbell et al., 2019; Williams et al., 2021). Hence, in proactively considering how employability can be embedded across WMG, a universal module design approach is currently underway whereupon student employability is considered as a high level learning outcome. Additionally, every degree programme hosts a number of industrially focused and highly experienced guest speakers. Sourced from our research and business collaboration, external speakers provide a first-hand perspective and current insight into what businesses want from graduates. They inform our students about the steps needed to upskill themselves whilst highlighting the importance of gaining work experience. Additionally, the University Careers Service provides a range of applied training and other opportunities, including the chance to get involved in volunteering, opportunities to find local employment through a student job shop (unitemps, 2021) and an invitation to receive support from the professional careers service (University of Warwick, 2021).

How important are the following WMG Practices & Policies in helping you gain key employability skills?

	Very Important	Moderately Important	Not Important
Doing an industrial or 'real-life' project for my dissertation	72%	26%	2%
Taking part in active, team-based learning activities	63%	25%	12%
Visits to industry and other fieldtrips	57%	18%	25%
Studying independently	39%	44%	17%
Attending guest lectures when the speaker is from industry	65%	23%	12%
Presenting my work in front of my classmates and teachers	49%	35%	16%

Fig. 30.6 Employability: students' perspectives

Figure 30.6 reveals students' responses to six questions that focused on some of the measures put in place to assist them in gaining key employability skills. Whilst some of the responses were predictable, it appears that in WMG at least independent study is not identified as being important in developing employability skills. Conversely, the act of presenting work in front of classmates (thereby developing presentation skills) was only identified as very important by half of the sample, whilst students clearly viewed 'real-life' learning such as that experienced whilst doing their project as very important.

For colleagues, looking holistically across all of WMG's learning and teaching, global employability and citizenship represents a growing part of each module and programme. The BRAVE Model means that students are actively supported to engage in extra-curricular activities such as volunteering and student clubs. Additionally, career advice and support is provided throughout the student learning journey, with sessions such as CV writing, applying for jobs and interview skills forming an important part of WMG's educational portfolio.

30.4 Being BRAVE: Educational Transformation in Action!

The BRAVE Model of Educational Transformation outlined in this chapter represents what is very much a work in progress. Whilst this paper has focused on the use of the Model to enhance student learning, it is equally applicable to professional academic development. For faculty, support staff and students alike, the importance of nurturing a sense of ***Belonging*** and building professional learning ***Relationships*** has recently come to the fore during the Covid-19 Pandemic, with lockdown forcing everyone to *'stay home'* to *'stay safe'*. Having the BRAVE Model in place at the beginning of the pandemic provided a clear framework for combatting the early confusion and disorientation experienced by many students. Whilst in 'normal' circumstances the international nature of our cohort brings with it a set of complicated problems that many feel are outside their range of expertise (Briggs & Pritchett, 2010), the adoption of the BRAVE Model provides a solid framework for building and transforming the academic experience for colleagues and students alike. Indeed, the ***Authentic*** learning aspect of the Model encourages colleagues to accept that all areas of the student experience are the responsibility of all academic and professional support staff. Making sure our learning is authentic is central to WMG's ethos. This means acknowledging that learning which occurs in the classroom or lecture (whether synchronous or asynchronous) is only the tip of the iceberg; most applied learning at university occurs out of the formal educational setting. Whilst it's clear that more work needs to be done globally to encourage academic colleagues to better engage with the wider student experience, the BRAVE Model provides an ideal framework on which to promote transformation through the construction of strong and vibrant learning communities.

Moving onto the concept of ***Variety*** within the BRAVE Model, it is this that is perhaps the most controversial element of transformational change. Even planned and carefully introduced change has the potential to cause some colleagues anxiety as they struggle to come to terms with a new way of teaching. Likewise, being faced with new learning approaches may also put students under additional stress; particularly those from overseas who already find themselves having to learn the opaque rules of British Educational culture (Bird, 2017).

For colleagues, embedding variety into learning and teaching means looking not only at what we teach, but also at how we teach. It also requires the question of 'why' we teach in a certain way to be addressed. Encouraging faculty to think out of the box with regards to their teaching has not been easy. It has however, resulted in a plethora of different pedagogical approaches and learning and teaching tools being developed, trialled and evidenced. Each new pedagogy is purposefully constructed so as to engender learning. Educational Transformation has become an organisational mantra—with each aspect of learning representing a small piece of the bigger picture.

Finally, the concept of ***Employability*** is possibly the least controversial aspect of the BRAVE Model. Running through and across all aspects of what we do, the need for engineering and applied science and management education to produce 'employable' graduates, able to hit the ground running, has possibly never been as important as it is today. Working with industry, professional bodies and individual discipline experts, colleagues' adoption of the BRAVE Model reinforces extant links across academia and industry.

30.5 Conclusion/Recommendations

At this point in time there is little doubt that the pandemic has left many students and academic colleagues feeling isolated and insecure. As we move forward into the future, the ongoing development and instigation of the BRAVE model represents one aspect of a multi-faceted organisational strategy. Transformation is beginning to happen and as we emerge into the future colleagues and students are positive that the lessons of the past two years will not be forgotten.

In conclusion, Applied Degree Education has never been more important than it is today. As education providers we are increasingly being challenged to make clear the purpose and value of our courses and demonstrate how graduates will be able to impact industry and wider society. The BRAVE Model provides a framework within which to develop appropriate courses, keeping a keen eye on what is most important to achieve our goals. In addition, we are seeing a diversity in how education is delivered that caters for an increasingly diverse student body. This breadth and multiplicity of options is both a challenge to the educator and institution and also an exciting opportunity. Seeing learners achieve their aspirations and go on to have meaningful careers is a major driver of why we do what we do. At this point in time, we now find ourselves able to offer a range of ways in which to make this a reality. By adopting the BRAVE Model we can be both creative and also ensure our students' learning experiences are engaging and meaningful. The future of learning is upon us, it is time to embrace change!

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Correction to: Creativity Under COVID-19: How Technology Has Enhanced and Promoted Student Engagement Online

Katrine K. Wong and Michael Zihao Li

Correction to:
Chapter 6 in: C. Hong and W. W. K. Ma (eds.), *Applied Degree Education and the Future of Learning*, Lecture Notes in Educational Technology, https://doi.org/10.1007/978-981-16-9812-5_6

The original version of the chapter 6 was inadvertently published without page range in the reference Polkinghorne, D. E. (1995) on page 136, and this has been included now as in below:

Polkinghorne, D. E. (1995). Narrative configuration in qualitative analysis. International Journal of Qualitative studies in Education, 8(1), 5–23.

The chapter and book have been updated with the changes.

The updated version of this chapter can be found at
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