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Christina Hong
Will W. K. Ma *Editors*

Applied Degree Education and the Shape of Things to Come

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Preface

This edited volume seeks to evolve a global community of practice to share case studies, engage in critical discussion and spearhead thought leadership to address the paradigm shift in next generation educational practice.

Whereas Education 4.0 refers to the shifts in the education sector in response to Industry 4.0 where digital transformation has impacted the ways in which the world of work and our everyday lives are becoming increasingly automated. In the applied degree sector, change and transformation is occurring as leaders, educators, start-ups and industry partners collaborate in more integrated and mutually beneficial ways to co-create opportunities for skilling and reskilling for the benefit of the circular economy.

The use of advanced technologies and Ai is enabling students and academics working in close collaboration with industries and tech start-ups to engage in collaborative applied research to posit project-based learning with a focus on problem-solving for value-creation. While digitalization and workforce re/skilling has been a recent catch-cry, an emergent focus on the interrelationship between humans and technology in the workplace and learning experiences that foster the enduring capabilities of human-workers such as creativity, imagination, empathy, resilience, adaptive thinking and social intelligence are coming to the fore.

The call for papers began in January 2022. The theme of the call is "Applied Degree Education: The Shape of Things to Come." We received 43 papers from a variety of areas, such as Mainland China, Ecuador, Germany, Hong Kong, India, Macau, New Zealand, Singapore, the United Kingdom, etc. Following a double-blind review, 18 papers were chosen for inclusion in this edited edition. They were divided into four major categories: Part I: New Realities: Blended Learning, Hybrid Learning, Virtual Learning, and Technology-Enhanced Learning; Part II: Human Touch: Knowledge, Skills, and the Future of Education; Part III: Learner Transformation: Active Learning, Deep Learning, Engagement, and Student Success; and Part IV: Higher Education Ecosystem.

We value the contributions of all authors, including those who were chosen and those who were not. We appreciate their time and effort in preparing the entries. This contributes to the success of the volume being edited.

We wish to convey our gratitude to the International Programme Committee for their time and effort in reviewing the papers. This crucial phase helps maintain the work's quality and the volume's central theme.

The COVID-19 epidemic still affects the entire globe. In these trying times, it is even more important to discuss the future of education. We hope that this initiative will create a forum for international academics and practitioners to share their knowledge, discoveries, and ideas for a better future.

Brisbane, Queensland, Australia
Hong Kong, China
December 2022

Prof. Dr. Christina Hong
Prof. Dr. Will W. K. Ma

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Prof. Dr. Christina Hong Ph.D., Hon. DA., is the Deputy Vice President, Education and Quality, Central Queensland University (CQU), based at the CQU Brisbane Campus, Brisbane, Australia. Christina is the immediate past-President, of the 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, industry linkages 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 Applied degree education and the future of learning* (2022).

Prof. Dr. Will W. K. Ma Ph.D. is currently a Professor of Teaching and Learning, at Tung Wah College. Prior to this, he was the Head of the Learning Commons and Digital Innovation at the Technological and Higher Education Institute of Hong Kong (THEi), where he was responsible for providing physical learning space, information technology services, and physical and online learning resources to staff and students in order to promote applied research and enhance learning. He was also the

Chairman of THEi's Learning and Teaching Committee, where he assisted the President with digital transformation and staff development, particularly in technology-enhanced learning. Prior to the work at THEi, Dr. Ma was an associate professor at Hong Kong Shue Yan University's Department of Journalism and Communication for more than thirteen years. Dr. Ma's research focuses on the use of information systems for communication, knowledge sharing and knowledge creation. He has publications in *Computers and Education*, *Computers in Human Behavior*, *Journal of Computer Assisted Learning*, *International Journal of Communications, Law and Policy*, and *Information and Management*. He is co-editor of the *Journal of Communication and Education* (2015–Present), and was editor of Cogent Social Sciences, Taylor and Francis Online (2017–2019). He is the Editor of Springer's *Educational Communications and Technology Yearbook* series.

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Chapter 1
Applied Education Futures and the Shape of Things to Come

Christina Hong

Abstract Skills development across industry and professional sectors is identified as one of the essential drivers of recovery and growth to address the fragility and volatility of post-COVID economies. The window of opportunity for the applied degree sector, to rethink, reset, and ride the skilling and reform agenda to help accelerate economic recovery, business transformation, enhance digital skilling and competences to enable sustainable transformation is in play. This chapter highlights the emergent smart education approaches, intelligent technologies, and opportunities that may be considered critical and transformational in future-shaping a more sustainable, value-added, applied degree sector.

Keywords Applied education and future skills · Smart education · Sustainability · Industry 5.0 · Education 5.0 · Intelligent and immersive technologies · Lifelong learning

1.1 Introduction

The world is currently undergoing some of the most significant socio-economic shifts in history, including labor shortages, the so-called *big resignation*, a transition to hybrid work models, a rise in geopolitical tensions amid resurgent nationalism aka new nationalism, and the ubiquitous expansion of digitalization and automation. Innovations in technology are profoundly altering the way we operate. As economies emerge out of the pandemic and transition to the next normal, there is an increasing focus on planning for and implementing reforms across multiple sectors and jurisdictions, including across post-secondary tertiary education. As governments rethink, refocus, and seek to deliver the workforce skills deemed necessary to aid economic recovery, both immediately and into the long-term future, the professionally and vocationally orientated applied degree and sub-degree sectors are being critically positioned as change drivers.

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1.2 Future Skills Powering Post-COVID Economic Recovery

Skills it seems is the 'new black'. 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 significantly. Countries around the globe are convening 'Skills Summits' that bring together business, government and related stakeholders including the tertiary education sector, with a focus on exploring and determining how this crucial acceleration of skills may be promulgated. Such Summits are addressing the requisite shifts in policy gearing necessary to support such acceleration. Skills development across industry and professional sectors is identified as one of the essential drivers of recovery and growth to address the fragility and volatility of post-COVID economies. Concomitant with this, is the desire to rebuild and reshape workforce needs both now and into the foreseeable future. As part of this endeavor, Governments are also seeking to redress the imbalance wrought by the skills mismatch and skills shortages in many workforce sectors (Hong, 2022).

The first *World Economic Forum (WEF) Jobs Reset Summit: Post-Pandemic growth needs new skills for new jobs that are open to all* held in October 2020, launched public–private collaborations to mobilise job creation and skills development to shape a new agenda for growth, skills, and equity. The Summit was designed around four pillars: (1) economic growth, revival, and transformation; (2) work, wages, and job creation; (3) education, skills, and lifelong learning; and (4) equity, inclusion, and social justice. The WEF's *Future of Jobs Report* (2020), released during the Summit, highlighted the 'double disruption' faced by workers in the face of the pandemic recession, coupled with accelerated automation. The second *Jobs Reset Summit* held in June 2021, highlighted that the equivalent of 255 million fulltime jobs across the global workforce were 'lost' in 2020, and again sought to accelerate investment towards the reskilling and upskilling of workers and the imperative to plan for global jobs recovery. The Summit looked particularly at areas of new jobs growth, such as in the area of new tech-enabled jobs, where 150 million jobs are expected to be created over the next five-years. As the examples in the following section will indicate, countries around the globe also continue to pursue discussion at the highest levels, positioning economic recovery via skills agendas.

In recent years, China has actively promulgated successive plans for national technical and vocational education and training (TVET) reform to deliver the skills needed for a modern, digital, postindustrial economy, including, setting national standards, and deepening the integration with industries. The Chinese government released a five-year blueprint in August 2021, to boost employment and further expand the vocational education system to drive domestic demand and upgrade industry. This blueprint, identifies steps to address the gap between the demand and supply of skilled workers comes in addition to a plan previously set in 2019, which placed workforce upskilling at the core of its reform agenda.

The United Kingdom (UK) hosted an international skills summit in May 2021, bringing together a range of countries, to share experiences and learnings on how higher technical skills are, for example, powering advanced manufacturing and delivering zero carbon. The Government of Columbia together with the Organization for Economic and Co-operation and Development (OECD) hosted a Skills Summit in March 2022, with a key focus on equity and sustainability. South Africa similarly convened a Skills Development Summit in April 2022, which addressed the need for investment in skills development in the face of new trends, economic challenges, and skills shortages across almost every workforce sector. Likewise, Switzerland held a Skills Summit in June 2022, with a focus on the changing nature of jobs and the widening digital skills gap, amid not only rapid but also short cycle technological advances in AI, robotics, and process automation.

In Australia, the Skills Summit took place in September 2022, with the goal of recommending immediate actions and opportunities for medium and long-term reform to address economic challenges. The two-day summit set out a reform roadmap, including 36 immediate actions and 30 areas for further activity. Steps to immediately strengthen the vocational education and training (VET) sector, enable more training to address skills gaps, while also addressing the longer term structural, systemic, and cultural changes were tabled. Incentives announced at the Summit, included the government's decision to provide 180,000 fee-free TAFE i.e., public-funded (VET) places at a cost of $Aus1.1 billion commencing in 2023. Agreement was also reached to review VET qualifications, overhaul apprentice support, and grow the VET workforce.

The key themes and insights from the above skills summits and related exemplars indicate the criticality of the 'window of opportunity' to deliver education and training reform to boost economic recovery. Similarly, activity is also evident in education systems more broadly, as part of post-pandemic recovery. Higher education systems globally, are following suit and are rethinking, reimagining, and resetting strategies related to education futures which further leverage technological and pedagogical innovation characterized by Education 4.0 (Hong & Ma, 2022). Amid this post-COVID activity there is the tacit recognition and resurgence at the highest of government levels, in addressing skills development. As a corollary, therefore, the vocational and professional applied degree sector, as a key contributor and driver towards supporting economic recovery, must position itself accordingly.

The obvious imperative for the global applied degree sector is to be actively involved and cognizant of these discussions, with sector representation as appropriate. The sector must engage purposefully, yet flexibly, with the strategy drivers and action plans once formulated. Moreover, the value-added opportunity for the applied degree sector is to not only support *economic* recovery, but also, *social* recovery, as it commonly pertains to institutional mission statements across the sector. The applied degree sector within jurisdictions, and/or institutions, should seek to contribute to and partner in impactful ways in providing community development, *vis a vis* lifelong learning (of which more will be said) as well as enabling the skilling solutions in tandem with government and industry and professional sectors moving forward. As we contemplate and plan for this contribution. What indeed are the key global themes, innovations and shifts that need to be made by educators, institutions, and agencies to transform the future of learning in order to help shape the needs of the future workforce?

1.3 Education Futures

1.3.1 Digital First Transformation

As education providers consider the next normal, it almost certain that implementing strategic action to embed digitalization as well as accelerating the process of digital transformation in education will remain high on the agenda. On-going digital transformation, based on both digitization (of analogue information) and digitalization (or processes), is a key impetus to drive, inform, and shape the future of applied degree education.

> In the context of sweeping social, economic, technological, and demographic changes, digital transformation (Dx) is 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)

Referencing the description above, digital transformation (Dx) in higher education learning and teaching is therefore, committed to (1) consolidating a digital foundation that is deeply embedded and coordinated within organizational culture; (2) building smart learning environments; (3) promoting the co-creation and co-sharing of quality digital educational resources; (4) exploring personalized models for cultivating students and the professional development of teachers; (5) improving the digital literacy and digital skills of teachers and students; and (6) iteratively enhancing digital awareness, thinking and capabilities throughout the digital transformation journey as technologies continue to evolve.

1.3.2 Smart Education

As a result of ongoing digital transformation, *smart education*, is a term used to describe learning in a digital age. It refers to those educational approaches and environments with the characteristics of high touch learning experiences, learning content adaptation, and teaching efficiency supported and informed by digital technologies. In smart education, intelligent technology such as AI is used to provide diversified support and on demand services to enhance the quality and ultimately, equity of education. From this perspective, smart education has the potential to further act as a breakthrough approach that continues to support and integrate intelligent technologies as we rethink and reset opportunities for next-generation applied degree education futures.

1.3.3 Artificial Intelligence (AI)

Artificial Intelligence (AI) is one of the fastest growing and arguably, one of, if not *the* most, societally impactful industry worldwide. AI and its multiple subdomains, including Machine Learning (ML) algorithms and Natural Language Processing (NLP), is changing the way we live, work and study. It is increasingly pervasive in our daily lives, likely more than we, the general public may perhaps even realize. AI is utilized via facial recognition when unlocking mobile phones and in various security and surveillance systems. AI has been an integral to search engines like Google and Bing, for quite some time, as well as in navigational way-finding apps like Google Maps. Likewise calling an Uber or booking a flight ticket uses AI. Social media accounts like Facebook, Twitter and Instagram are customized by AI working behind the scenes to provide curated feeds. AI powered digital assistants like Siri, Alexa and Google Assistant are readily responsive and support many routine activities and ad hoc queries. Entertainment streaming giants like Netflix and Spotify use ML algorithms to create seamless user experiences. AI-driven personalization solutions, based on customer data, are used by global brands to drive more personalized engagement. AI-powered automated Chat Bots provide quick turn-around responses to customer enquiries with 24/7 access to business information, including within education institutions.

AI is fast becoming an essential component of any competitive business or organisation. Indeed, by 2025, it is projected that some 70% of workers will utilise data to a more significant extent to inform their work. As one Accenture Insights Report states, ‘In short, advancing AI maturity is no longer a choice. It’s an opportunity facing every industry, every organization, every leader’ (Vohra et al., 2022, p. 4). Furthermore, the report states that projections from Accenture’s machine learning models suggest that the share of AI achievers globally, i.e., those organisations where AI is championed by leaders as a strategic priority, where there is talent investment to leverage AI investments; where AI tools and teams are industrialised to create a strong AI core, where AI is responsibly designed and where AI investments are prioritized over the long and short term, ‘will increase rapidly and significantly, more than doubling from the current 12–27% by 2024’ (ibid).

The potential extent of the impact and opportunity related to the AI industry is being projected through various research undertakings and data insights. According to a McKinsey report (Shen et al., 2022), which examined the use and impact of AI across key industries in China, if strategic cooperation and capability building can occur across multiple dimensions, then AI is expected to add upwards of ~ $US600 billion to the Chinese economy by 2030. McKinsey’s research indicates that this growth will come as a result of innovation and R&D spending to generate AI-enabled offerings that will disrupt automotive, transportation, logistics and other key sectors, like manufacturing, enterprise software and health and life sciences.

As AI and Robotic Process Automation (RPA) and allied digital transformation for business applications automate the more routine manual handling tasks previously done by humans, jobs will be eliminated. This is certainly going to be true of the global manufacturing sector, where jobs are already being lost to AI-powered robots. However, while on one hand job losses will occur, on the other, it is also predicted that ~ 97 million jobs involving artificial intelligence (AI) will be created and new workforce required between 2022 and 2025 (World Economic Forum, 2020).

The most successful organisations will therefore, be those whose employees are empowered with the skills to make better decisions using data. However, workers are currently not receiving the training that they need and require. There is a growing skills gap which the applied degree sector can help to address, through pre-service and in-service training. Areas that may be identified for qualifications innovation and development in terms of up-skilling and re-skilling within in a life-long learning paradigm include the new AI workforce jobs requirement for specialists in AI and machine learning, process automation, big data, data engineering and data analytics. for. Just as AI is impacting workforce sectors, so too, AI will be increasingly utilized as a value-driver across education sectors.

1.3.4 AI and Education

UNESCO released the *Beijing Consensus on artificial intelligence and education*, at the International Conference on Artificial Intelligence and Education held in Beijing in May 2019. This consensus, further facilitated the implementation of the *Education 2030 Agenda* (UNESCO, 2015) supporting and accelerating progress towards the United Nations Sustainable Development Goal SDG 4: 'Ensure inclusive and equitable quality education and promotes lifelong learning opportunities for all.' Moreover, it serves as a definitive example of a commitment which both anticipates and acknowledges an era in which AI, as a convergence of emerging technologies, will play out across education sectors. The conference included some 50 government ministers and 500 international representatives from more than 100 member states, United Nations agencies, academic institutions, civil society, and the private sector. The Beijing Consensus states that the systematic integration of AI in education has the potential to address some of the biggest challenges in education today, as it innovates teaching and learning practices.

Global Market Insights Inc. (2022) predicts that the AI education market could have a market value projection of $US80 billion by 2030. Growth drivers include increasing venture capital investment in AI and EdTech, the exponential growth of digital data and integration of ITS in the learning process, coupled with partnerships with education content providers and adoption of cloud-based services. AI will therefore continue to be deployed and certainly impact the applied degree sector across all facets of business operations.

1.3.5 Equity of Access

The World Economic Forum's (2022) Insight Report, *Catalysing Education 4.0: Investing in the Future of Learning for a Human-Centric Recovery* is a call to action to global leaders to leverage the COVID-19 learning crisis into an opportunity for radical education transformation to ensure primary and secondary-school systems are future ready. As a 'white paper' the publication identifies key themes and insights and suggested areas of interaction informing strategic discussion and action planning, including, the United Nations (2022) Transforming Education Summit in particular. A key observation is the recognition that the skills needed to succeed economically in the Age of the Fourth Industrial Revolution (4IR) are not being taught and that the pandemic and consequent rapid technological acceleration, has further compounded the inequalities in schooling quality and attainment (World Economic Forum, 2022, p. 4). Addressing the teaching of skills for success, ensuring greater access and equity is therefore another key factor informing the 'shape of things to come' in applied degree education. Rigorous and continued efforts are necessary, not just in general schooling, but also across the post-school tertiary education and applied degree sector.

1.3.6 Enabling Sustainable Futures

Deploying a more socio-ecological imperative that fosters sustainability as a core organizational driver has increasingly been put on the agendas of organisations, enterprises, and governments as the world pivots with heightened urgency and commitment towards a net-zero agenda. Decarbonising the nine key sectors, e.g., power, oil, and gas, automotive, aviation and shipping, and steel production, that produce most global greenhouse-gas emissions, calling into frame Environmental, Social and Governance (ESG) enterprise accountabilities and audits, and embracing the circular economy at the local community level are coming to the fore, as more focused affirmative action is taken. The opportunity for the applied degree sector to contribute to this vital and globally impactful transformation lies, not only in identifying as *sustainable universities* and reducing institutional carbon footprint, but also in deploying governance practices, teaching and learning approaches, and programme innovation that enable the skilling, upskilling and reskilling of the workforce in this key area. Additionally, engaging in consultancy and applied research agendas specifically and related to the broader fields of sustainability across sectors should also be embraced.

Programme developments, across the domain fields, whether long or short term and 'bite-sized' that are responsive to learner needs are to be anticipated. These may include, for example, green business programmes that support organisations to respond to the green-imperative, the skilled use of advanced technologies will be critical to effectively and efficiently reducing climate change, programmes that support environmental or green engineering and sustainability that can leverage existing technologies and provide zero-emission options are therefore anticipated to be in high demand. Likewise, programmes of study that focus on the intersection of a specific industry, e.g., fashion, culinary arts, and sustainability and technology should be explored. Innovation and problem-solving *with* and *for* industries, employing applied research and the investigations of innovative applications that may provide real-world solutions, such as in hydrogen energy or battery-technology research, sustainable agriculture, food manufacturing by-products utilization and bio-products processing, will provide multiple transdisciplinary sets of opportunities for the applied degree sector to explore.

1.3.7 Life Long Learning (LLL)

Lifelong learning (LLL) as identified in the UN Sustainable Development Goal (SDG 4) exhorts countries to 'promote lifelong learning opportunities for all (United Nations Department of Economic & Social Affairs, 2015), thereby establishing LLL as central to a sustainable future. Richards (2020) proposes a new *global network* model for learning and teaching that serves a lifelong learning curriculum. This network model enables and requires the ability to learn continually and to adapt to new and unpredictable situations. It embraces 'an andragogy that includes collaborative problem solving with the objective of developing transferable competences'. It is a model where:

> Learning is just-in-time, depends on transferable skills, and has ready access to endless content and processing tools. The student is an entrepreneur-consultant working on multiple ad hoc teams with changing membership. The teacher is a coach who provides continuity, perspective, and methods. Performance assessment focuses on the project deliverable. (2020, p. 151)

Widening access and increasing participation through the skilling, upskilling, and reskilling of students throughout their lifetimes across both formal and non-formal credentialling in a range of modalities and purposes is, and will continue to transform providers into LLL institutions. This implies a fundamental shift in the concept of higher education and by implication applied degree education and applied professional learning. It will incur an increasingly focused shift from learning that is directed at undergraduate and postgraduate education in a more commonly held, formal credentialing sense, to a more continuous staircasing process that iteratively, addresses the needs of diverse learners through various types of accredited and non-accredited learning blocks at different ages and stages of their personal and professional lives. Institutional structures and resources will inevitably follow to ensure both comprehensive and properly delivered LLL programmes (UNESCO Institute for Lifelong Learning, 2022).

1.4 The Future of Jobs: From Industry 4.0 to Industry 5.0

Characteristically, the applied degree providers across the globe are positioned as contributors to a sector that is industry and professionally aligned and largely workforce demand driven. As a corollary, the applied degree sector's value proposition and sustainability is therefore, dependent on working in tandem with the industries and professions to examine and address projections regarding the future of jobs. This includes identifying the jobs that do not yet exist, in evolving areas where new skills areas and new job creation will be required. There are certainly some key areas of opportunity where new qualifications, inclusive of micro learning are likely to occur, relative to the local needs of industries and professions. One of the keys that will inevitably shape the future of the applied degree education sector will be its response to the shift from Education 4.0 to Education 5.0, as the transition from Industry 4.0 to Industry 5.0 occurs.

1.4.1 Industry 5.0 and Education 5.0

Whereas Industry 4.0 is driven by digitalization, intelligent environments, automation and the convergence of IT and operational technologies, Industry 5.0 aka 5th Industrial Revolution, re-engages with the human, social, and environmental dimensions as a complementary and contiguous focus within and across industries. Industry 5.0 refers to the ways in which humans will work alongside advanced technologies and AI powered systems across industries to drive tech-driven economic and social transitions via a sustainable, humancentric and resilient approach, providing solutions to societal challenges including the preservation of resources, climate change, and social stability.

Similarly, whereas Education 4.0, refers to the shifts in the education sector and the integration of digital transformation and therefore smart education in response to Industry 4.0 and its corresponding focus on digital transformation and automation. Education 5.0 looks to the evolution of an educational paradigm that more overtly seeks to engage with the realm of ethics and humanism, towards a quest for a more sustainable, equitable, and caring future.

1.4.2 Ecosystem Approach

In the applied degree sector, change and transformation is, and will continue to occur as leaders, educators, start-ups, and industry partners collaborate in more integrated and mutually beneficial ways to co-create opportunities for skilling and reskilling in green technologies and sustainability for the benefit of the circular economy. The use of advanced technologies and AI is enabling students and academics working in close collaboration with industries and tech start-ups to engage in collaborative applied research to posit project-based learning with a focus on problem solving for value-creation. Non-traditional education providers, such as corporates (Hong, 2022), are increasingly creating academies to deliver higher level technical skilling and professional development opportunities to ensure the requisite skills for their workforce. The pragmatics of this shift implies that advantage may be gained through purposeful ecosystem collaboration to deliver optimized skilling and domain knowledge.

1.4.3 New Jobs in AI Systems

Certainly, and as already discussed, one key new job cluster area will be in the new field of AI systems. McKinsey (Shen et al., 2022) for example, likens the skills necessary in AI experts and knowledge workers as resembling the Greek letter *pi* (π). These skilled individuals, need not 'only a broad mastery of general management skills (the horizontal bar) but also spikes of deep function knowledge in AI and domain expertise (the vertical bars)' (Shen et al., 2022). This talent profile signals opportunities for the applied degree sector to consider as curricula and delivery modes are reframed and reset. The provision of degree qualifications in management, AI and contextual domains will remain prevalent in higher education systems. Importantly, it also signals that the greater opportunity resides in the intersection of all three domains coupled with authentic work integrated learning. In this regard, the competition to draw students from schools into the undergraduate study and from the in-service job market into further studies including life-long learning and post-graduate studies has become increasingly contested.

1.4.4 Human Touch Skills

While digitalization, automation, and workforce re/skilling has certainly, as discussed, been the recent catch-cry within an Industry 4.0 frame of reference, there is also an emergent and as already identified, a complementary focus coming to the fore. This Industry 5.0 space, relates to the interrelationship between humans and technology in the workplace and learning experiences that foster the enduring capabilities of human-workers such as creativity, imagination, empathy, resilience, adaptive thinking, and social intelligence. In this regard, and as Beard (2018) writes,

> And if robots do take the jobs, it's our human qualities that will count … The greatest impact of technology on learning may paradoxically be to push us towards the human (p. 306).

Such perspectives on the relationship between human and machine and the interplay between the individual, the group and societies with contemporary technology identify the need to further strengthened the development of powerful human skills. Future proofing against the realities of the digital age is therefore about strengthening our distinctively human capabilities. Qualities such as the knowledge, skills, and attitudes required to not just communicate and work in teams in routine and fundamental ways,—as these may indeed be computerized, but to engage in *complex* communication and work together with resilience and in often ambiguous situations that require *expert* thinking and problem-solving need to be enhanced.

1.4.5 The Future of Jobs in Higher Education

It is not surprising that as a result of the pandemic, that the higher education sector has also experienced significant disruption and change. The shape of things to come in relation to jobs and skills within the academic and non-academic workforce is also in flux. Digitalisation, business process redesign, Robotic Process Automation (RPA) and the implementation of AI Chatbots, data informed decision-making, utlilising data visualisations, business and learner analytics, and next generation learning and teaching technologies has meant that both academic and non-academic staff are facing significant changes and challenges to their working environments.

The *Great Resignation* has also impacted the tertiary sector just as it has other workforce sectors. Across the tertiary landscape staffing complements and profiles have shifted as staff are retrenched or reposted to secure organizational efficiencies, or decide to retire or leave to pursue other jobs and areas of passion outside of the education sector. Staff have discovered the possibilities and ease of e-meetings and digital collaboration as well as newfound productivity in the time that may otherwise have been taken up by commuting. The tertiary workforce experience has traditionally been in-person and on-campus, however, given the experience of remote work during iterative waves of the pandemic, it is likely that, while on-campus work and activities will continue to be important, that the benefits of virtual meetings and hybrid/remote options may also be deployed to retain and maintain organizational culture to rethink and adapt to the changing demands of the workplace.

Commentators and position papers currently abound as to the future of work. McGowan (2020) has more recently commented, ‘Where we once saw the future of work unfolding over years, we now believe that with coronavirus as an accelerant, everything we’ve predicted about the future of work will unfold in months.’ This new reality which is indeed seeing change in many, if not all, workforce sectors as a result of business and industrial transformation will likely test the existing model of multi-year degree education. Current qualifications development and delivery relies on the scaffolding and codifying of subject content knowledge into a curriculum, which is then taught in blocks of theoretical and/or practical knowledge to students so they come to know the knowledge and skills within the domain field(s) and can then over time, contribute to the workforce productively. Such a model may not be as easily supported, or indeed as efficient and effective, in a rapidly changing world where new knowledge is continuously created and new skills are required to capture business and market opportunity. What then might be some alternatives to this dominant model? How might the expected on-going shifts in the future of work be accommodated within tertiary education? What changes to the traditional paradigm will be put in play to optimize student access, engagement, and success?

1.5 Future Learning: Eco-System Approaches, High Tech High Touch, Intelligent Technologies and Immersive Spaces

The pandemic unintentionally become a change agent that has activated, accelerated, and continues to re-shape the future of learning. Institutions and educators have and continue to transition and adapt to new ways of engaging with learners and industries in response to Industry 4.0 (with Industry 5.0 on the horizon) and the need to upskill and reskill in the context of lifelong learning. As has been discussed, local, national, and global themes such as sustainability, innovation and technology, entrepreneurship, and the need for future ready skills and multiliteracies have and will continue to be advanced and integrated into curricula and institutional reform agendas.

1.5.1 Teaching and Learning Practices

The *2022 EDUCAUSE Horizon Report (Teaching and Learning ed.)* (Pelletier et al., 2022) provides some indicators as to the shape of things to come for learners and educator/facilitators in the tertiary sector. Based on the perspectives of a global panel of experts, the report profiles the trends and key technologies and practices shaping the future of learning and teaching. The six key technologies and practices identified include: AI for learning analytics, AI for learning tools, hybrid learning spaces, mainstreaming of hybrid/remote learning modes, micro credentials and professional development for hybrid and remote teaching. The indicative practices identified will be familiar to most, however, for the purposes of this chapter, there are certain ones that warrant more attention.

Certainly, as has already been discussed, AI and its' generative AI systems subvariants, machine learning, deep learning, natural language processing, are the key technologies anticipated to exponentially expand higher education futures. The launch of ChatGPT in late November 2022, or example, quickly garnered and polarised higher education sector attention with its potential to upend teaching, learning, and assessment practices. Operationally, higher education institutes are already deploying AI to assist with course recommendations, managing administrative processes and utilising AI-based learning platforms, virtual facilitators, and intelligent tutoring systems to improve learner engagement and the learning experience. Institutions have started to harness the power of data and analytics to inform activities to build capabilities in terms of the student access, success, and overall student experience. A McKinsey

Insights article (Brasca et al., 2022), reports that those at the forefront of this trend are 'focusing on harnessing analytics to increase programme personalization and flexibility, as well as to improve retention by identifying students at risk of dropping out and reaching out proactively with tailored interventions.' Other areas, with discussion following, that are likely to impact the shape of things to come, include: partnering with the EdTech eco-system, shifts in credentialling and pedagogical practices and engagement with virtual immersive and adaptive learning spaces.

1.5.2 EdTEch Ecosystem

While AI and other intelligent technologies will impact higher education as SMART tools, an important corollary to be aware of, is that EdTech companies are also increasingly proliferating education sectors with enterprising and innovating developments, including enterprise training. EdTEch companies are not only developing next-generation technologies, but are also providing and/or aggregating tech-courses creating new markets outside of the traditional provider base. This trend has the potential to disrupt not only the undergraduate degree market but also the post-graduate and in-service market. In some industry and professional sectors, the threshold requirement of an undergraduate degree is giving way to a focus that is more dependent on skills competencies and soft-skills. Companies like EY, Google and IBM have embraced hiring practices that not dependent on applicants having a degree as a threshold entry point. Indeed, the Burning Glass Institute (Fuller et al., 2022), write of the 'Emerging degree reset' and the shift to skills-based hiring, drawing attention away from bachelor degree entry requirements to address growing workforce shortages. Based on trends in the US, the Institute projects that an 'additional 1.4 million jobs could open to (US) workers *without* college degrees over the next five-years' (p. 3). With such changes in the wind and as has been written in previous editions of this book series (Hong & Ma, 2022; Hong, 2022), the future of learning, specifically in the applied degree sector, lies in shifting thinking and fostering the development of a high-performing and collaborative digital education ecosystem with multiple contributors to benefit the learner and learner outcomes for the future of work.

1.5.3 Qualifications Scope Shift

As has already been discussed, in the wake of a shifting economy and non-traditional offerings provided and powered by EdTech companies and entrepreneurial aggregators, higher education faces a risk to the traditional bricks and mortar and multi-year degree structures that have been the accepted norm. Ironically, the mega-providers of massive open online courses (aka MOOCs) such as, Coursera, edX, and Udacity, emerged from university environments around 2012, i.e., Stanford, Harvard, and MIT in the USA, leading to similar MOOC building activities in other countries. Essentially MOOCs established the beginnings of a ‘next-generation’ wave of credentials, namely, micro credentials, and are part of a larger disruptive innovation now proliferating the education market.

Given the pressures on governments and the emergent shifts in employer perspectives away from degree requirements as threshold entry points, the business model of higher education may well dramatically and irreversibly change. MOOCs have certainly served to widen access to higher education, supporting the democratization of higher education, making knowledge from universities, including from the most world-renowned institutions and elite professors around the world, more open and accessible to anyone who wishes to engage. As a form of open education that may be accessed for free through online platforms, MOOCs enable and support Goal 4 of the United Nations 2030 Agenda for Sustainable Development. As the credentialization of both online learning as well as hybrid and face to face learning delivery by non-traditional providers continues, collaboration and partnerships between traditional providers and EdTech providers to acknowledge aggregated learning or stackable credentials as a verifiable approach, with more granular recognition such as certifications for specific knowledge and skill sets registered across digital wallets aka block chain registers may well become the next normal.

1.5.4 High Tech High Touch Learning

High Tech High Touch (HTHT) can be traced back to *Megatrends* (Naisbitt, 1982) and speaks to the need for balance in our relationship with technology. For education, HTHT reframes and challenges educators to reflect on where the educator’s effort is best spent. The HTHT model of learning combines classroom technology (High Tech) with hands-on learning, guided by educator/experts (High Touch). Base line level activity, such as the initial engagement with new subject knowledge and initial skills mastery can now, quite readily be outsourced to AI-assisted adaptive or personalized technologies. Thus, allowing the educator to focus on co-creating and co-constructing more tasks involving active learning such as the application of knowledge and skills in more complex problem solving and team-based learning. HTHT adaptive learning platforms offer learning at the right pace and at the right level. While this has clear benefits for the school system, it must also be recognized that adaptive learning is also highly relevant to degree-level education. Particularly to address knowledge and skills gaps, providing a personalized approach to learning which can bring benefit to students with identified content or special learning needs where a more self-paced might enhance student success.

1.5.5 Metaverse: Immersive Learning Spaces

Another new technological reality that will have a likely impact on the future of learning and teaching in the tertiary sector, is the Metaverse. While very much a current 'buzzword', it is however, the next evolution of digital interaction encompassing extended reality (XR) experiences as a persistent virtual environment shaped by many people. Extended Reality (XR) is the new umbrella term for all the immersive technologies including Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR) that alter our notion of reality through the combination of real and virtual environments. According to KPMG (Ireland) the global XR market size was valued at US$31 billion in 2021, and is expected to rise to US$300 billion by 2024, (Hardy & Clarke, 2021). Alongside the emergence of the metaverse, other technologies, such as blockchain, non-fungible tokens (NFTs) and 5G are critical to its development.

Whether or not tertiary education embraces metaverse XR technology is no longer in question as these experiences are indeed already being explored. Educators who recall the university islands and the virtual classrooms of *Second Life*,—an online multimedia platform that allows the creation of avatars, user-generated content and interaction within a multiplayer virtual world launched by Linden Lab in 2003—will readily acknowledge that the virtual classroom of the metaverse is not an entirely new concept. While the metaverse may present potential benefits, it is also not without controversy. Concern and speculation, being raised, in relation to such factors as, data privacy and the risk of cyberbullying, online abuse and exploitation of individuals, and the potential vulnerability of corporate networks and exposure to cyberthreats.

The higher education sector has however, begun to explore the opportunities that the metaverse may offer to enhance learning and teaching activities. D'Agostino (2022) shares that some US-based students will have the opportunity to attend metaverse classrooms at 10 *metaversities*—a portmanteau of 'metaverse' and 'universities'—launched for the Fall semester 2022. Other early adopters, include Queen Mary University of London, Tec de Monterrey, MIT, the University of Glasgow, Korea Advanced Institute of Science and Technology, Tsinghua University and the Hong University of Science and Technology. It may therefore be generally acknowledged, that the metaverse, and its experiential virtual learning platforms will have a role to play in shaping and enabling learning in the applied degree sector, now and into the future.

1.5.6 Digital Twinning

Digital twins are virtual models of physical object(s), product(s), or process(es) such as the creation large-scale models in industries like manufacturing and construction within the metaverse. As industries continue to increase digital adoption, the digitalization of factories and the use of Internet of Things (IoT) sensors, as for example, across manufacturing equipment and production lines, companies will amass the data necessary for digital twinning.

Within higher education, the adoption of digital twin technology has the potential to carry forward into every field of study, exponentially advancing new models for how learning is defined, valued, delivered, credentialled, and supported. At the same time, digital twin technology supports and enhances opportunities for personalized learning. Enabling learners to access learning at their own pace.

1.5.7 Emotion AI

An emerging AI sub-application area of interest that may well impact learning and engagement in education, is *Emotion AI* which originates from the field of Affective Computing, the study and development of systems and devices that can recognize, interpret, process, and simulate human affects. It is an interdisciplinary field spanning computer science, psychology, and cognitive science. While not yet as mainstream as other AI applications, Emotion AI, picks up facial expressions to identify mood and intention to gauge human emotions and customer experience. From a learning and teaching perspective, this area, using eye-tracking, voice analysis and facial-coding and gesture analysis might well be developed to assist educators to gauge and optimize each students learning.

A Hong Kong-based start-up, Find Solution AI, https://www.findsolutionai.com/ has developed 4 Little Trees https://www.4littletrees.com/ software and patented an AI-driven motivational model with emotional analysis that has been trialed during online learning during the COVID pandemic by students at Truelight College (Hong Kong):

> The system monitors how long students rake to answer questions, records their marks and performance history, generate reports on their strengths, weaknesses, and motivation levels; and forecasts their grades. The program can adapt to each student, targeting knowledge gaps and offering game-style tests to make learning fun. https://edition.cnn.com/2021/02/16/tech/emotion-recognition-ai-education-spc-intl-hnk/index.html.

Emotion AI, provides an adaptive and personalized learning experience for students and the opportunity to better understand learning needs and increase engagement in online meetings and webinars. The use of such technology is however, not without its critics in respect of privacy issues and similarly, at this point in its development, human bias challenges, when reading ethnically-mixed student populations.

1.6 Future Students

As institutions 'open up' campuses and resume face to face teaching, enabling student engagement at optimal levels to reconnect and reinvigorate a sense of belonging and social engagement with peers and the institutional community will be a key imperative for most, if not all, tertiary providers in a post pandemic environment. As Hattie (quoted in Wasik, 2020) observes,

> One of the biggest factors that influences student engagement and performance is their sense of belonging in their higher education experience. This is what has suffered the most as a result of COVID-19. They no longer have the same sense of belonging that they used to have. (p. 10).

Engaging with and deploying strong campus support services will be vital to fostering student well-being and success, especially as the pandemic has had the tendency to exacerbate mental health crises, including anxiety and depression, particularly, amongst young adults. Not only will students look to engage on-campus, but providers will also need to provide on-demand access to online services through integrated multi-cloud environments.

Digital technologies enable the blurring of the boundaries between physical and virtual learning, so that flexible learning is therefore made possible, enabling opportunities for ubiquitous learning anytime, anywhere. Similarly, digital technologies enhance more opportunities to deepen a student centric or learner centric focus. Learning can be further customized and personalized to the needs of the individual learner. A key area that institutions will undoubtedly need to grapple with is how delivery will occur in the next normal. While the rapid pivot to fully remote learning accelerated a wholesale shift in delivery mode, as institutions look to recover and transition into the next normal, what delivery mode or combinations of modes, including face to face, remote, hybrid or hyflex might best be utilized and what will be required to ensure institutional frameworks and infrastructures optimize learning in the longer term?

Bridging the digital divide to engage students in applied degree education by its very nature will likely require a multi-modal approach. Not only the integration of flexible learning models but also, the even stronger alignment between learning and the workplace, a sharper focus on addressing the issues of skilling and reskilling, of equity, and inclusion, and effective strategies to customize student learning needs. Each of these characteristics will need to be supported by tools and strategies that recognize and value learning regardless of how or where that learning is acquired.

1.7 Futures Thinking: Thought Leadership

While the pandemic highlighted the dramatic transformation in the education sector in rapidly pivoting to online learning and teaching, other factors also came into play, including significant issues around global student mobility patterns that resulted in financial pressures for those institutions with a strong reliance on high international student admission numbers. As institutions transition out of and into post-COVID environments, the recognition that a transformative approach needs to be sustained to enable institutions to operate more flexibly and resiliently in the face of adversity will be part of contingency planning moving forward. Shifts will require the shaping of transformation goals, the unifying of key stakeholders, what Kotter (1996) terms the 'guiding coalition', the group of individuals within an organization who are the social leaders of the change initiative. What were the biggest challenges and opportunities for institutions and how are leaders now planning on navigating the future?

In the following section, thought leadership perspectives shared by three leaders from the applied higher education sector provide some indication of what is 'top of mind' in their thinking as they reflect upon, navigate, and work purposefully towards the future.

Professor Joachim James Calleja, President, European Forum of Technical and Vocational Education (EfVET) and Principal/CEO Malta College of Arts, Science and Technology (MCAST), writes with deep commitment and passion, about the socio-economic, environmental, and political contradictions that persist in society. Extolling us to take and act upon the important lessons learned through the pandemic … *that in a globalized society no one can feel secure unless everyone else is*. That the *future of learning must offer skills of resilience, solidarity, and inclusion*, and that we as educators can only embrace, *persistent change in society by seeking liminality as the pedagogy of transformation.*

Professor Robin Clark, Dean and Director of Education, Warwick Manufacturing Group (WMG), Warwick University, UK, challenges us to think more critically about what we mean by the term 'applied' education. We are encouraged to step away from conventional approaches to reconsider what a model of applied learning might really look like to craft more *appropriate educational experiences for learners and work at the cutting edge of applied education provision.* Six main elements that together create impactful applied education are suggested for consideration.

Associate Professor, May Lim, Assistant Provost (Applied Learning) and Director, Centre for Learning Environment and Assessment Development (CoLEAD), Singapore Institute of Technology, questions how educators can keep pace with the rate of change and transformation occurring in industry to produce not only graduates with the requisite workforce capabilities, but to also upskill and reskill existing employees to address workforce skills gaps. Trends in the sector, such as corporate universities and immersive industry-driven bootcamps provide both challenges and opportunities. A paradigm shift to build new workforce capabilities requires traditional providers *to self-examine what we are not yet providing*, and suggests that *a mindset shift is perhaps timely.*

The main themes of the three thought leadership pieces certainly resonate with the impetus for change and the culture of care and sustainability for humanity, and a critical questioning of currently held assumptions and perspectives which may indeed lead to mindset shifts.

1.8 Summary: The Shape of Things to Come

In contemporary idiom, 'the shape of things to come' refers to trends or development indicators that signal how things may evolve or what things in the future might be like. In the applied degree sector, the economic fallout from the pandemic has likely detrimentally affected most, if not all institutions and the window of opportunity to ride the skilling and reform agenda while accelerating business transformation, enhancing digital skills and competences to enable sustainable business process transformation is in play. To keep pace with changes in the future of jobs, the need to upskill and reskill will become a regular part of lifelong learning, this paradigm shift will contribute to institutional strategy within the sector, and increasingly be regularized as a defined market segment and revenue channel supporting more sustainable institutional business models.

Other future-shaping themes include, the new forms of credentials emerging, that may include credentials that are more, short-term, competency-based, and stackable. Applied education product innovation aligned with new areas of high workforce demand will continue to be brought to market, such as the requirement for specialists in AI and machine learning, process automation, big data, data engineering and data analytics. Smart education and the use of the products and services linked to a range of intelligent technology applications, are also highlighted as breakthrough approaches, which are predicted to exponentially enhance learner engagement and success. Likewise, an eco-system approach that leverages delivery by both traditional and non-traditional providers and a focus on connecting and integrating work and learning with authentic workplace experiences, thereby ensuring that students can apply their academic learning to real world contexts will remain.

This chapter has, therefore, highlighted the emergent opportunities and the work institutions are already doing to review and reset a transformational vision and strategy, to redefine the applied degree sector value proposition, and reshape institutional business models and culture to anticipate and serve the current and emergent needs of learners, communities, industries, professions, and employers. It remains to be seen as to how efficiently and effectively such transformation agendas will play out. The key imperative however, is that institutions in the applied degree sector, must transition and transform if they are to keep pace with changes in the industries and professions that they by their very nature, serve. Applied degree institutions must continuously evolve to remain current and relevant both in regards to their purpose-driven educational delivery for the learner community, as well as, keeping abreast of workforce shits with their strategic partners with the industries and professions. And, as a vital corollary, remain mindful of their requirement to value-add and contribute to the economies and societies within which they reside. To ignore the call to action, is to risk becoming outdated, irrelevant, and unsustainable, and to ultimately, face *extinction* as a bleak prospect.

As Mezirow (1996, 1997), writing on transformative learning theory has asserted. It is only through reflection, active learning, and placing ourselves in an uncomfortable situation are we fully able to develop our understanding of the world and ourselves. In facing the 'uncomfortable situation' post-pandemic, that the applied degree sector, like other sectors and industries, currently finds itself, there are however opportunities to be taken and new insights to be leveraged. There is the potential to shift our frames of reference, to change our perspectives and reframe thinking. Harking back to the skilling agendas now prevalent around the globe, governments are relying on the applied education sector to stand up and deliver future focused, equitable, and sustainable outcomes. The opportunity to *ride the wave* is very clear and very present. The future, while challenging and continually evolving, is nevertheless promising for those who have the foresight and the courage, to work collaboratively with next-generation mindsets, intelligent technology tooling, and across eco-systems to shape it.

1.9 Thought Leadership: The Pedagogy of transformation—Embracing Liminality in Education

Joachim James Calleja

We live in an age of speed and contradictions. Everything changes swiftly and most manmade inventions are rapidly becoming obsolete while new machines and mechanisms rise. As life is increasingly hectic, more sophisticated and complex in the affluent world, there are however, millions of other people who fight for their lives and their obscure living conditions.

While we witness enormous technological progress globally 25,000 people are still dying of hunger every day; 854 million are under nourished; 100 million people in developed countries are negatively affected by high prices in food and basic needs; 72 million children are still not in elementary education; 795 million adults are illiterate and 37% of the world population or 2.9 billion people have never had access to internet.

These contradictions weigh heavily on the responsibility of educators. Yet no matter the increased numbers of official declarations in international institutions, research findings, international events and timely interventions by voluntary and governmental organizations, the gap between those who have and those who have not continues to widen.

In such socio-economic and political conditions, young learners are still largely educated in formal education at the various levels of elementary, vocational and professional training as well as university education. Young people will be the policy-makers, decision-makers, the consumers, the conformists, the rebels, the employers,

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the employees, and the researchers of tomorrow. However, the world we manage today will be the world they will live in tomorrow.

In our efforts to save our planet and provide the essential education of the future, COVID19 has taught us a few important lessons. The first is that in a globalized society no one can feel secure unless everyone else is; that the quality of life is much more than what can be consumed and thrown away; that the more we negatively exploit nature the more we suffer the repercussions; that humans, animals and plants must live together and not one at the expense of the other; that digital and green skills must be the foundations of tomorrow's economies.

When faced with the dilemmas of COVID's lockdowns, educators (and other sectors of employees) offered resilience, solidarity and inclusion. Much of what has been learnt cannot be unlearnt. Neither can it be forgotten.

The future of learning must offer skills of resilience, solidarity and inclusion in a changing social contexts that put liminality and transformation as pedagogical processes. Liminality implies a threshold at an intermediate state of affairs—an in-between states; a process of transformation from the old to the new, from the usual to the innovative, from the known to the unknown. With the advancements in technology and the changes in lifestyles and values, educators struggle to address the old (the customary) with new values and mechanisms established by the use of technology by the masses such as the social media. For millions of young people, the language of digitalization is their value system, their mode of interaction, their means to move either towards the Centre or the periphery of society.

Educators can only embrace this persistent change in society by seeking liminality as the pedagogy of transformation—challenging status quos by building consensual paradigms in society based on resilience, cohesion and inclusion. This implies more work-based learning, more applied/impact research and more community work as integral parts of adult learning.

1.10 Thought Leadership: Understand the Need and Execute Well

Robin Clark

As educators we often believe that the learning we facilitate is 'what is needed by employers', but in reality, the dynamic environment of modern society requires us to be more critical, innovative and agile of and in what we do. We use the word 'applied' too easily when we describe the learning experiences that we offer, but what does 'applied' really mean? Is it the readiness of graduates for their first job

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post university, is it the way in which the learning takes place or is it the learning material itself? I would argue that to be truly ‘applied’ it is all of these and more.

We need to take a step back from many of the conventions that further and higher education have imposed over the decades of their existence and ask ourselves, what should a model of applied learning really look like? As an engineering educator, I will use that as my starting point but here comes the first challenge. I am starting with a disciplinary focus but today the applied disciplines we consider are nothing like as pure as they were in previous years. With each passing year, disciplines flex and working across disciplinary boundaries becomes increasingly important. Real world issues do not fit the nice boxes we offer in higher education, they straddle and penetrate to varying degrees a broad range of subject areas combining to form something that is both complex yet authentic. Siloed educational experiences are less valuable than ever, especially when change is present wherever we look.

So how can we craft the most appropriate educational experiences for learners and work at the cutting edge of applied education provision? I would suggest there are 6 main considerations where the last can then cycle back to the first for the sequence to be repeated. These 6 elements are:

(1) Listen to the relevant voices
(2) Create together and flexibly
(3) Focus on connections
(4) Deliver authentically and with passion
5) Evidence decisions with DBER
(6) Embrace continuous improvement—reflect and listen.

Taking these in turn.

Listen to the relevant voices and then synthesise the inputs along with the appropriate educational expertise. Needs and practicalities need to be clearly identified but options should be left on the table as clients and alumni, for instance, may have very different thoughts.

Create together and flexibly to optimise the design. Certain voices may be willing participants in the process so they should be capitalised on. These voices will likely challenge, encourage the use of technology and help create a more authentic experience. This is where micro credentials and a more creative approach to course structure and academic award can and should be openly discussed.

Focus on connections in both design and delivery. The RVS approach developed in 2014 (Clark and Andrews) prompts educators to consider the before, during and after of an educational experience in higher education. This will allow the refinement of a design to ensure inclusivity, support for learners, relevance of the teaching approach and the value of the experience to the learner’s ambitions.

Deliver authentically and with passion to engage the learners and enable them to see how the learning can be transferred into future roles that they will fulfil. This draws on the ‘Variety’ in RVS which is intended to be a liberating opportunity for the educator but informed by the voices and design. This should also empower learners to chart their own learning journey within a framework that better meets their needs.

Evidence decisions with Discipline Based Education Research (DBER) to both reinforce design and delivery decisions and learn for the future. We are developing a growing body of literature and a range of expertise in this area, so it needs to be visible and utilised to inform choices and proposed changes to educational offerings.

Embrace continuous improvement—reflect and listen As reflective educators we are encouraged to consider the effectiveness and impact of the learning opportunities we design and deliver. To do this we need to go beyond the immediate cohort of students and supporting colleagues and revisit the voices. That way we have the potential to generate meaningful metrics and lay a solid foundation for the next cycle.

The preceding narrative may be something that you read and say, of course we do that, it is straight forward. But ask yourself the question—is that really the case? I started by suggesting we need to take a step back from conventions and that we truly need to understand what we are setting out to achieve. In order to do that we should embrace the 6 elements articulated here to their fullest. Whether considering the development of a short workshop or the design of a new Masters course, for applied education to be impactful, it is sometimes simply about doing all of the basics well.

1.11 Thought Leadership: Paradigm Shift in Building Workforce Capabilities

Lim Sok Mui

The post-pandemic world is made increasingly complex with the geo-political situations, climate change, and worldwide economic challenges. As the world struggles to adapt and innovate to meet with the various demands, university needs to adapt too. University has always been seen as the place that prepare young people for their career, building capabilities that the industry needs. However, with the speed of industry transformation, existing jobs are rapidly disappearing or being transformed. How can our curriculum adapt in time to produce graduates that can still meet the workforce needs? What about the existing employees that need to be upskilled or reskilled in other to stay relevant in the industry?

University should not limit our focus to developing people for their first career. Recognizing that many employees at the workplace will have to reskill and upskill to adapt to the era of innovation, we seek to partner businesses to advance workplace learning. We need to find ways to recognize and measure prior learning, some of

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which are skillsets developed at work, instead of formal curriculum. We can help employees identify their skills gaps and subsequently provide what is needed for them to either stay relevant or pivot to a new job. We see the future in creating stackable certificates for adult learners through a competency-based learning pathway. Adult learners can earn new credentials through competency assessments, rather than traditional knowledge-based examination. They can receive coaching to identify a preferred upgrading path while balancing work and family demand. Through workplace learning, access to high quality on-demand learning resources, and regular blocks of practical skills training, workers can develop new skillsets while earning income.

In 2024, Singapore Institute of Technology will be physically situated in the heart of a smart business district. Our centralised campus will play an integral role in the ecosystem and facilitate innovation, research and development, and knowledge sharing. With the proximity between the academia and industry, our collaborations will not stop with placing a student at a company but work with these businesses on innovative projects and capability building. Our ambition will be to turn the new campus into a 'living lab', which will provide students and companies with an authentic environment for testing new ideas for working, living and studying. Staying close to the industry help us stay updated on the emerging skillsets needed and do our part as an academic institution to ensure that our curriculum is relevant to support industries as they change.

There is the evolution and increasing trend of corporate universities (e.g., Google's Googleplex, Apple University) as well as the rise of bootcamps that are intensive, immersive programs that pursue industry-driven curricula. Traditional universities need to self-examine what we are not yet providing that could expand the influence of our missions in building workforce capabilities. A mindset shift is perhaps timely. If we don't catch up with providing what the world needs, the usefulness of a degree certificate may rapidly become obsolete.

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Part I
New Realities: Blended Learning, Hybrid Learning, Virtual Learning and Technology-Enhanced Learning

Chapter 2
Challenges and Opportunities: Dance Education in the Digital Era

Zihao Li (Michael) and Katrine K. Wong

Abstract Because of the COVID-19 pandemic, dance education, which is heavily dependent on a face-to-face model, had to change and continue in a virtual environment. How did the rapid adoption of online technologies affect tertiary dance educators' teaching? More importantly, what were the practical ideas and effective tools/strategies learned to move dance scholarship and practice into a post-pandemic era? This study investigates nine tertiary dance educators from Europe, Oceania, North America, and Asia, who conducted online dance classes during the pandemic. This study has utilized multiple sources of data (images, videos, and writings) from dance educators to explore the challenges, benefits, and innovations in the context of virtual dance teaching. Dance educators have shared their views on teaching dance online: tools they have utilized as well as pros and cons with regards to different pedagogies and learning spaces. Findings indicate that the present online model will have a significant impact on future dance education. This article shares lessons and insights on tools, pedagogies, and strategies, which not only support dance education in a post-pandemic era but can also benefit other practice-based subjects at large.

Keywords COVID-19 · Dance education · Digital era · Online technology · Post-pandemic · Higher education

2.1 Introduction

The Internet, mobile applications including social media, and the fast-paced evolving technologies have created a perfect tsunami of resources and tools, as well as open

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and free information access. Such a phenomenon has not only resulted in a change in what individuals of dance programs study, but how, why, and where they learn, process their learning, and create dances. The COVID-19 pandemic is the start of all kinds of paradigm changes. The COVID-19 pandemic has created a significant impact on all sectors, including education across the globe. As of 19 September 2022, there were 608,328,548 confirmed cases and 6,501,469 deaths in the world, according to the World Health Organisation (WHO September, 19 2022). The pandemic came in waves and shut down schools and universities as face-to-face teaching became unavailable.

Just as any other disciplines at virtually all universities, tertiary dance programs in different countries have adopted a different format of delivery, namely, online. For this study, the researchers interviewed eight tertiary dance educators from Europe, Oceania, North America, and Asia, and analyzed their responses. The goal was to investigate how tertiary dance teachers in different countries responded to and overcame challenges encountered when teaching during the pandemic and how they could enhance dance education in the future. In this study, dance educators have shared their views on teaching dance online: tools they have utilized as well as pros and cons with regards to different pedagogies and learning spaces. They have also revealed insights into their accomplishments, challenges, and discoveries when teaching during the pandemic. Scholarship on dance education during the pandemic is growing, however, studies that focus on dance teaching and learning from different countries *during* the same period is rare. This study contributes to dance education scholarship by including perspectives and recommendations from dance educators from different continents. Their lessons in different settings, utilization and engagement with technology, as well as how they overcame the many challenges in virtual dance teaching can further enhance and strengthen dance education for post-COVID-19 era.

2.2 Literature Review

In a fast-changing world of technology, scholarship on the use of technology in dance education has been growing steadily. Leijen et al. (2009) explore the use of online streaming videos for ballet students' self-evaluation. Stancliffe (2019) discusses the use of annotating pre-recorded video footage for training analytical eyes. Dania looks at how teachers use technology on motor skills with an emphasis on physical and dance education (Dania et al., 2011). Parrish (2007) has suggested ways for dance educators to implement technologies in dance teaching. She also advocates the use of online tools and platforms such as MOOC (Massive Online Open Courses) for students to take charge of their own learning (Parrish, 2016). Li's research finds that dance students are not only ready for new pedagogies, but they are also exhibiting a shift in their learning tools from desktop computers to mobile devices (Li et al., 2018, 2020). In addition to teaching and learning, live-streamed performances (O'Hagan & Borowiecki, 2021) and sporting events (Ordway & Anderson, 2022) such as Beijing Winter Olympic and Paralympic Games are taking place recently. Audiences of all ages and backgrounds watch them on digital devices, a phenomenon that is becoming ubiquitous. In fact, many students in developed and developing countries have grown up with the latest digital technologies (Robinson, 2011). Students are proud to share their creative works and dance performances on social media channels (O'Hagan & Borowiecki, 2021; Li, 2021a, 2021b). As technology advances and infiltrates all sectors, the larger dance community is gradually embracing it.

Dartnell (2020) asserts that COVID-19 has changed our personal lives and that businesses and employees are adapting to the new workplace. The prevalence of technology and the application of technology in dance teaching is widely recognized (Li et al., 2018, 2021, 2022a, 2022b). In recent years, personal computer sales have dropped significantly, while mobile devices become increasingly popular, especially among the younger generations (Li et al., 2018, 2022a; Lim et al., 2014). Mobile technologies are ubiquitous in many affluent countries and they are wildly utilized in education (Kaliisa et al., 2019; Li et al., 2022b; Lim et al., 2014), including dance education (Li et al., 2018; Zhou & Li, 2019; Li, 2020, 2021b). Technology-integrated pedagogy has been generating momentum over the years. Students are able to apply technology to develop creativity and nurture critical thinking skills while educators scaffold and moderate the learning process (Robinson, 2011). The COVID-19 pandemic provides an opportunity for dance educators to move dance teaching and learning to a hybrid mode.

Schmid and McGreevy-Nicholas (2021) write about new initiatives that the National Dance Education Organization (NDEO) has taken during the pandemic. They include gathering questions, ideas, concerns, challenges, and problem-solving strategies through various channels, such as online chat sessions, webinars, and meetings. With three key questions on "good practices, learning options, and modifications," NDEO is able to gather enough insights to create a guideline, based on scientific evidence from the dance community (p. 4). Similarly, a group of Brazilian researchers provide safety guidance for people to practice dance activities at home during the pandemic (Rodrigues-Krause et al., 2021). Based on webinars and networks organized by NDEO, Gingrasso (2020) put together some practical resources regarding online dance teaching. In Gingrasso's study, eleven participants at various levels ranging from private dance studios to university programs in U.S.A. share their pandemic dance teaching experiences.

Weber (2021) elaborates how Project Trans(m)it connects dance educators from different places. It originally started as a technology-enabled dance collaboration project. During the pandemic, Project Trans(m)it becomes a virtual hub, where dancers and dance lovers continue to explore choreography, improvisation, and practices. Li (2020) shares his experience of leading a live-streamed dance class in a tiny apartment for students in general education programs. Students utilize various spaces for dance practice, performance, and final projects. During the pandemic, a surge of creativity among dance students is shown through classes, choreographies, and performances. Some dance educators admit that student works during the pandemic are some of the best works they have received. Baker (2020) states that an event such as COVID-19 could be a once-in-a-generation opportunity to reimagine society and build a new future. All these in fact provide a great opportunity for dance educators to rethink, reflect, and modify pedagogies in dance education. The crisis may most likely lead to innovation and change in terms of how dance is taught in the future (Li et al., 2021, 2022a, 2022b). This research shows how instructors from different continents have engaged with technology and how they have inspired students to use technology for meaningful objectives. We hope this rich data-based study provokes more questions and generates fresh ideas and practical strategies among dance educators to push dance education to the next level.

2.3 Methodology

This research has utilized multiple sources of data from dance teachers to explore the challenges, benefits, and innovations in the context of online dance teaching. This approach has enabled the researchers to gather multiple forms of data from dance educators (Lim et al., 2014) and provide rigor and integrity to the qualitative research process (Cohen et al., 2012). Methodological pluralism rather than methodological monism is the ideal option to which research on artistic practices and approaches subscribe (Cole & Knowles, 2000; Eisner, 2002). Eisner (2002) writes that "looking through one eye never did provide much depth of field" (p. 74). Additional data collections include online class observations and recordings made of choreographic or rehearsal work that took place after regular dance lessons. Some dance educators share screen-captures of online dance classes and works by their student.

In order to fully capture the online experience of dance teaching during the pandemic period, multiple rounds of interviews were conducted at various times. Cole and Knowles (2000) assert that speaking directly with dance educators is to break the "theory–practice gap" so that others would benefit from a research (p. 9). Interviewees were encouraged to reflect, compare, and discover new insights and understandings about dance teaching at various times. Griffin (1996) writes: "we live in the present time, where the past and future are tangled and intertwined lines composing and creating who we are today" (p. 149). This study provides participants an opportunity to share their practical recommendations, methods, and applications regarding dance teaching during the pandemic.

2.4 Participants

Nine dance educators (4 women and 5 men) from Australia (Adrian), New Zealand (Nolan), the United States of America (Phil, Jenny & Amanda), the United Kingdom (Polly), Canada (Candy), Vietnam (Victor), and Hong Kong (Tom) have participated in this study. All names are replaced with pseudonyms. They are highly respected individuals in the field and have actively been involved in dance education at the tertiary level for decades. One of the researchers has met these individuals at various dance conferences and collaborated on dance projects in the past. One of the researchers has sat with several of these dance educators on a major dance education network committee in North America; they have organized multiple dance events and conferences in Taipei, New York, Hawaii, and Vancouver. Some of these dance educators are keen on using technology in dance teaching and others disapprove and reject it. They teach contextual and practice-based dance courses at both undergraduate and postgraduate levels. Some of them are from conservatories while others teach at universities where dance is offered as general education courses.

The selection of participants was made based on willingness and availability, rather than how much they use or know technology. Although participants' backgrounds seem to be diverse enough to represent different types of tertiary dance educators, the study should not be taken as evidence of general understanding owing to small sample size. There is a sense of trust and openness between the participants and the researchers. With that in mind, participants feel comfortable revealing their "failure" as well as sharing their success stories. Of the nine dance educators, two were recommended by individuals who could not participate in the study because of unavailability. During the pandemic, all nine dance educators have taught technique, improvisation, choreography, somatic, dance education, screen dance, and theory-based dance courses to both undergraduate and postgraduate students in their respective institutions. In terms of course level, these educators have taught both dance major students as well as minor and/or elective dance courses for students with little or no dance background.

2.5 Procedure

In summer 2021, an invitation email about the study was sent out to fifteen dance educators in different countries. It was assumed that by then, most of the dance programs at the tertiary institutes would have concluded. Ten dance teachers responded that they were either about to finish their teaching or had already completed their teaching. All of them indicated that they had taught dance classes online at one point. Follow-up interviews were conducted in the fall of 2021. Participants were informed that due to uncertainties during the pandemic, they could withdraw from the study at any time and that their identities would be protected. Out of the ten dance educators, five confirmed their participation right away, one could not make it but recommended another dance educator working in the same country. The rest of the participants responded soon after, but some sent in incomplete responses or later informed the researchers that they were not available for interviews. As a result, two individuals have been excluded from the study. In total, nine dance educators from different continents participated in this study.

Because of the very reason that face-to-face interactions were unavailable, semi-structured online interviews with nine dance educators were conducted. Virtual interviews were conducted on Zoom[1] and time was arranged based on the interviewees' availability. The virtual interviews varied in duration: they were anywhere between thirty minutes to an hour and half. Flexibility in time arrangement for interviews proved to be effective and, thus, the participants were less likely to reject the interview request. For instance, the researchers had to conduct an interview at 1:30 AM (Hong Kong time) with a participant from U.S.A. during her lunchtime (1:30 PM). All interviews (virtual, textual, and mobile messages) were transcribed, archived, coded, and analyzed. In the end, four themes emerged: reactions, actions, transition, and perspectives.

2.6 Findings and Discussion

Findings are organized in three parts: (1) Actions taken; (2) Views on technology; (3) Looking ahead.

The majority of the nine dance educators carry leadership responsibilities in addition to their respective teaching responsibilities. Nearly all participants indicated that resources and support from their home institutions were extremely limited, since the negative impact on businesses and other fields has also severely affected tertiary dance education (Dartnell, 2020; Heyang & Martin, 2021). Being leaders, they had to be "innovators" while going through steep learning curves to maintain the operation of their dance programs. Many of these dance educators learned and used some practical resources about online dance teaching (Gingrasso, 2020). They were able to connect with other dance educators who were in a similar dilemma (Weber, 2021). The growing scholarship (Schmid and McGreevy-Nicholas, 2021; Li, 2020, 2021a, 2021b) and professional network provided more support than their universities could offer. Nonetheless, the pandemic forced all nine dance educators to modify their pedagogical approach, particularly that in practice-based dance courses such as technique and choreography.

2.6.1 Actions taken

Dance teachers' initial reactions varied when they switched the mode of dance teaching from face-to-face to online. Four of them experienced stress in the transition while the other five had easier transitions. Some of them quickly adapted to the new model and discovered new insights and strategies in teaching dance.

[1] Two dance teachers used social media (FaceTime and Facebook Messenger) as means to complete the virtual interviews. Since these two technologies function similarly to Zoom interviews, the researchers decided not to treat this data differently.

Nolan (New Zealand), Adrian (Australia), Victor (Vietnam), Phil and Jenny (U.S.A.) shared similar difficulties when online dance teaching took place.

Nolan is originally from Australia and has twenty years of teaching and research experience in dance. He is the Head of Dance Programme at a liberal arts university in New Zealand. He asserted:

> I found it very stressful. We had to work very quickly to get all staff and all students on to the same technology so we could all connect online. Teaching became one dimensional, and in order to animate a lesson I had to exaggerate ideas and actions so that my intent got across the digital screens.

Jenny is the Director of a dance education program at a university in a large city on the east coast of U.S.A. She has been teaching dance for more than 30 years. She described her initial feeling as a "crazy transition filled with anxiety." Victor and Adrian experienced similar chaos as they were in the middle of their holiday when the change of teaching model took place. In Adrian's case, he could not come back to campus until much later because he had to spend two additional weeks in quarantine. Adrian stated:

> [T]here was almost no time to prepare as the impact of the pandemic was fully realised and things were changing quickly worldwide. I was actually in Melbourne, Australia when it was decided that the institution would close. I was unable to go back until face-to-face teaching resumed.

Adrian and Victor shared similar comments in terms of their teaching environment. Adrian is an administrator who teaches in a performance-based tertiary dance program in Australia and Victor is a professional dancer and choreographer from Vietnam. Victor teaches mostly dance technique and somatic courses at a conservatoire in Vietnam. They both have over twenty years of teaching theory and practice-based dance courses at various institutions around the world. In follow-up interviews, Adrian and Victor talked more about the current state of dance education. They shared similar comments that in this new hypercompetitive world, educators could not afford to be complacent. Innovation and adaptation are new survival strategies, particularly during the pandemic, as said by Victor:

> For years, we are avoiding something that is hard but necessary. We are shrinking from rather than rising to the challenges and opportunities of the digital age. My students, on the other hand, are coping well. They have submitted some of the most creative works I have ever seen in my entire career.

Victor's comment about an increased level of creativity among student works was echoed by other participants in follow-up interviews and relevant scholarship (Li, 2020; Weber, 2021). Here are a few student dance works that show how they have worked with alternative spaces and technologies (Fig. 2.1).

To some extent, restrictions brought about by the pandemic have forced students to think outside of the box. Students have started to observe carefully what they have, where they are, and how they can better engage with the spaces around them creatively. On this topic, Jenny shared:

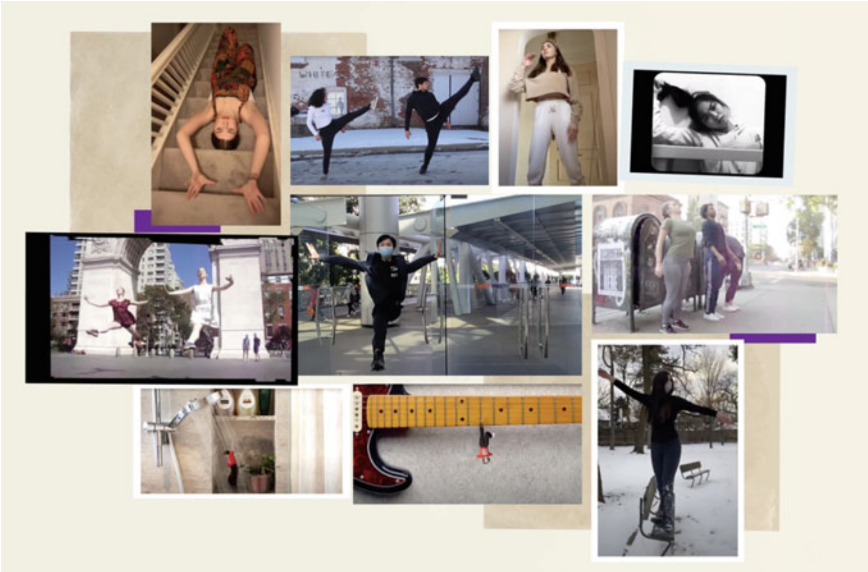

Fig. 2.1 Sample student works

> One of my students has set up a YouTube channel (Fig. 2.2). She teaches online ballet classes to students of all ages who cannot afford to take classes or cannot attend classes in studios due to COVID-19. She has hundreds of online subscribers and with that, she secures her own unique YouTube channel title. Her ballet classes are designed for people with limited space and she hosts regular online discussions with students and friends.

Victor, Jenny, and Tom indicated that their students welcomed and exploited the influx of digital technology and social media to promote their dance works, a theory supported by studies (Li, 2020, 2021a, 2021b; Li et al., 2018; Lim et al., 2014; Zhou & Li, 2019). With that, the researchers would encourage dance educators to reflect on what have prompted students to become so engaged in completing their dance works. Dance educators can also ask questions such as what tools their students have used and how such tools have promoted learning in the virtual environment. This kind of reflection would help teachers better prepare students for future changes. Despite all negativities associated with the pandemic as identified by educators at the present moment, the outburst of creativity, innovation, resilience, and the use of technology have been evident among teachers and students. According to the participants in this study, students have adapted to online teaching much better than teachers have done. Dance students have figured out screen-sharing, chats, and breakout rooms without anyone teaching them. Furthermore, some students have actually acted as "teaching assistants" during online classes; they have helped their teachers work with various functions found in, for example, video-conferencing tools.

Five dance educators have experienced relatively easier transitions to online teaching with their prior knowledge and institutional support. Before the pandemic,

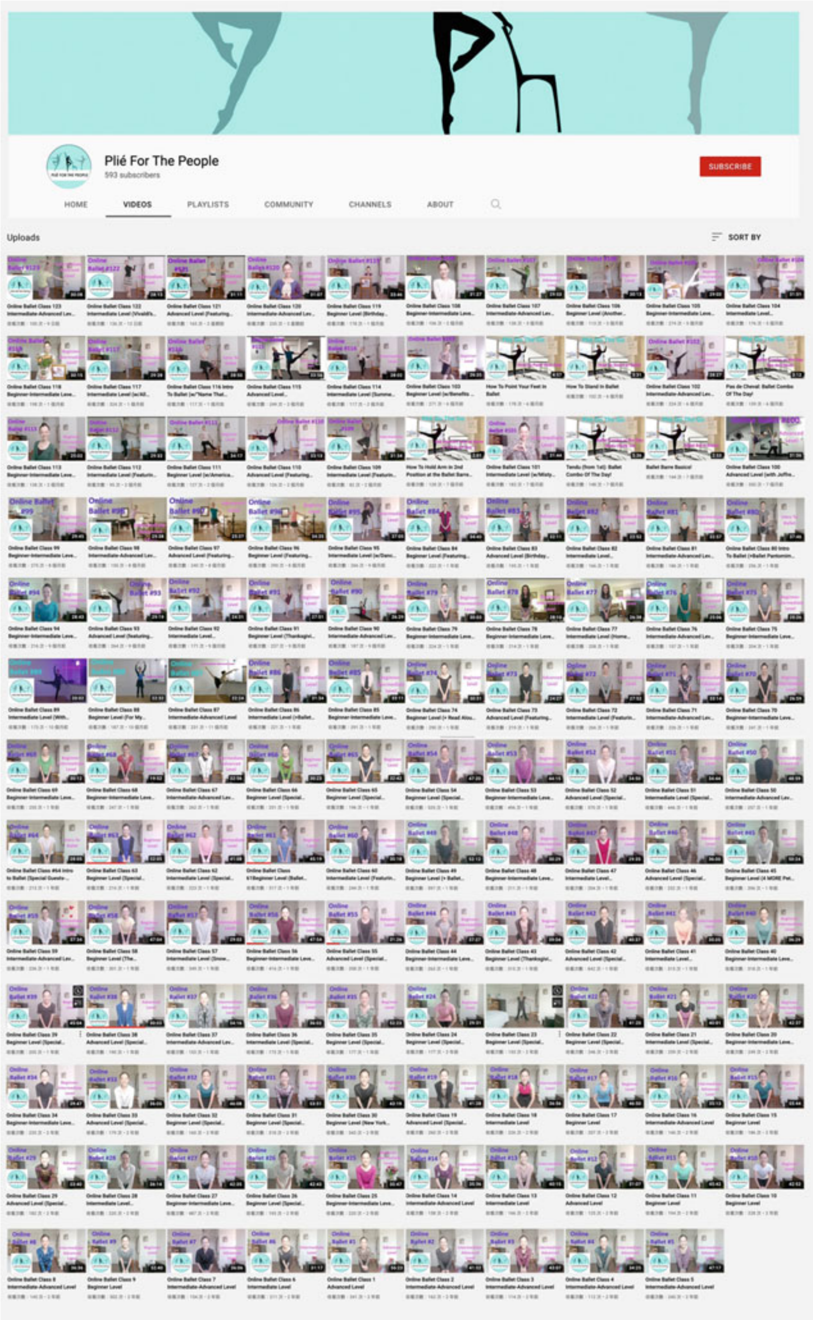

Fig. 2.2 Plié for the people on YouTube

Candy (Canada) was used to eLearning. She frequently uploaded her courses onto an online platform which she also used for communication with students and assignment grading. For over 25 years, Candy has been teaching ballet and dance education at a comprehensive university in Toronto, Canada. After receiving a Ph.D. in Education, she continues to explore various ways to integrate technology with her dance classes. She is familiar with the online learning management system at her home institution and considers it an effective online tool to assign readings as well as distribute and collect assignments. For her, the transition was "a piece of cake." Sharing similar thoughts in the transition to online teaching is Amanda (U.S.A.), who has years of experience of teaching modern dance technique, improvisation, and choreography at a liberal arts university in the northwestern part of U.S.A. Amanda is also a professional videographer, editor, and teacher of screen dance. With her expertise in digital media, she has experienced a smooth transition: "I have constantly dealt with people online in teaching and research. It's not a big deal and it should not be."

Phil (U.S.A.), a former principal dancer with Bill T. Jones/Arnie Zane Dance Company, has taught dance at several universities in U.S.A. He is passionate about the use of multimedia, film, video projection, lights, and shadow in dance performances. In recent years, he has become interested in utilizing mobile devices to create dance films. One of his award-winning works was featured in the New York Times (Fig. 2.3). Transitioning to online teaching was natural for Phil as he often encouraged his students to use technology: "Dance opportunity is not as vast as it used to be. Try something new, even if you don't like it."

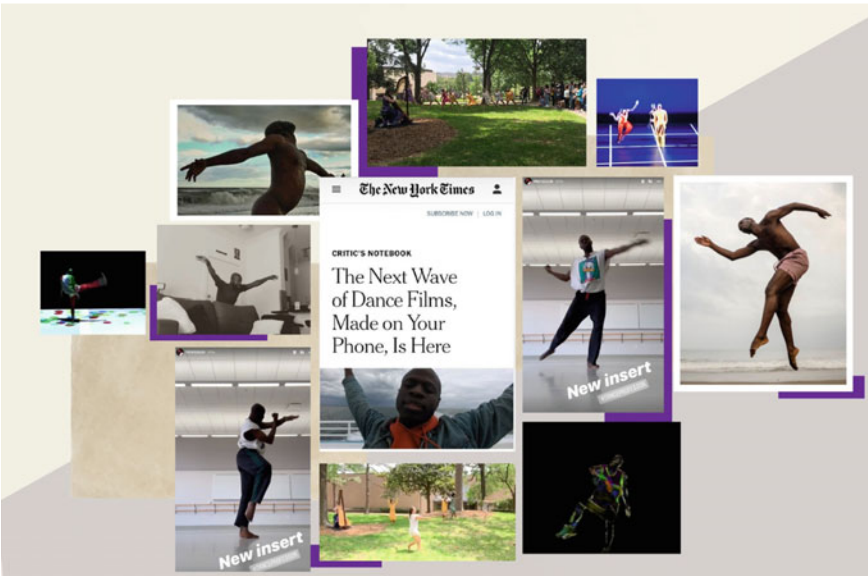

Fig. 2.3 Phil's dance works

While serving as a full-time faculty member, Jenny also works on her doctoral degree at a research-oriented university in New York City. She commended her Ph.D. supervisor on actively using Canvas (a learning management system), online videos, and Google workspace in teaching. Jenny also teaches courses on utilizing technology to enhance dance teaching for various age groups and levels. She asserted: "These explorations have prepared me with the confidence and hands-on experience to believe [that] effective teaching and learning could be combined with meaningful engagement for both students and instructors." Likewise, Polly (U.K.), a London-based dancer, choreographer, and producer who has performed and taught dance at reputable conservatoires worldwide, described the transition as straightforward because she had received good technical support from her institution (Figs. 2.4 and 2.5).

Unlike Polly, Tom (Hong Kong) has used a blended model to teach dance since 2015. Typically, in the same class, half the class would attend online while the other half joined in person. The experimental approach initially shocked many students and colleagues. It received good feedback from learners nonetheless. Tom was not teaching this academic year (at the time of writing), but reported that one of his colleagues shared similar approaches during the pandemic. Figures 2.6, 2.7 and 2.8 highlight a blended teaching model in modern dance and ballet classes.

Tom recalled that many students valued the blended model and commented positively on its convenience and accessibility. His blended approach was also used by instructors who taught physical education (PE) and teacher training programs; the majority of students would become PE teachers upon graduation. Tom quoted one of his students who said: "It's a fun approach, but I don't see it ever happen in real life." In 2020 and a good portion of 2021, almost all classes were delivered online.

Fig. 2.4 Polly teaches virtual ballet technique class

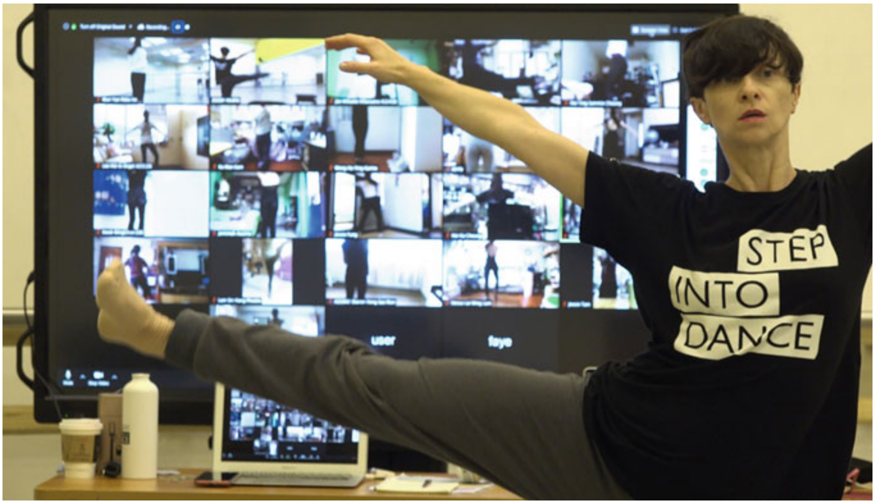

Fig. 2.5 Polly demonstrates in a virtual dance class

Fig. 2.6 Tom teaches a blended dance class in 2015

Fig. 2.7 A blended ballet class in 2021—stretching exercise

Fig. 2.8 A teacher monitors a barre exercise (online & F2F) during a blended ballet class in 2021

Polly and Tom admitted that the digital skills students learned from virtual teaching might not seem to be relevant to dance students or PE teacher candidates. However, the reality is that the majority of dance students who graduated from their programs would not get into professional dance companies. There is a need for dance students to upskill digital literacy and look beyond dancing professionally. For example, Hong Kong Dance Company recently recruited staff for dance education outreach. In addition to dance training, which is listed as optional, digital media, branding, project creation, and social media skills are some of the must-have prerequisites in the job advertisement. Students who aspire to become independent dancers and studio teachers would also need technical skills in graphic design and digital promotion of their dance projects. Tom added: "Many dance students teach dance in a variety of settings after graduation, the skills such as media creation, promotion, digital marketing, and website design [that] they have learned from taking classes during the pandemic would certainly support their future career development."

2.6.2 Views on Technology

Dance educators used different tools, applications, and devices to conduct online dance classes, particularly during the initial phase of the pandemic. Such tools and applications shared similarities and each had its own pros and cons. Because of that, several dance educators kept using their preferred video-conferencing tool even after face-to-face classes resumed. Some tools come with geographical restrictions, such as Google Hangouts (Google) and WhatsApp (Facebook), which are prohibited in certain regions. This study has found that dance educators chose their tools based on three factors: compatibility, user-friendliness, pedagogical features. The number of participants (dance students) allowed in a single session was also an important factor of consideration. The researchers have compiled a list of popular video-conferencing tools and applications currently available in the market. These tools and applications (Fig. 2.9) are free with conditions (restrictions regarding length of time or number of participants), which constantly change over time.

The study has also found that the dance educators did not just rely on one device. Instead, they used several of them when teaching dance and consolidated their tools and applications into one toolkit—the innovative use of devices and Apps for different purposes. Such a toolkit usually comprises three features: video-conferencing tool, LMS (learning management system such as Canvas or Moodle), social media App. Each of these devices or apps has its own limitations, but the combination of all three makes online dance teaching effective and engaging: the video-conferencing tool enables online teaching and the LMS is used for assessment and assignment distribution, whereas a social media App (such as WeChat, WhatsApp, or Facebook Messenger) is used for effective communication. A few of the dance educators later confessed that they continued to use these approaches even after their classes returned to face-to-face mode. "It works and my students respond much faster via social media than email," one said.

Fig. 2.9 Tools and applications

The use of a toolkit is proven to be effective. At the beginning of the pandemic, eight out of the nine dance educators used a variety of different video-conferencing tools and applications. Later, all nine of them switched to Zoom because of its user-friendliness and compatibility with different devices. Among all Zoom features, Breakout Rooms and Polls were rated high. According to Nolan:

> [Zoom] was very good as it was relatively direct and easy for the students and myself to enter and manipulate. It was good, in that you could have Breakout Rooms, and rearrange teacher moments via video.

Phil divided his dance students into breakout rooms and encouraged them to share pre-recorded footage, concept, and music with each other. In small groups, these dance students discussed entering and exiting (the screen), transitioning between clips, and the quality of their movements on camera. They also talked about using different devices for capturing images and videos and discussed various factors such as time of shutter/exposure, when to turn on/off camera, camera to move with the bodies and/or dancers to follow the camera. Phil challenged his dancers to fit their bodies into available technologies, in other words, exploring the body and working around and with the technology. "How can you dance with the camera, interact with online viewers, and promote your work virtually?" This was a question that Phil asked his students.

Jenny (U.S.A.) used Breakout Rooms for students to share COVID-19 stories at the beginning of each dance class. Her classes were two hours and thirty minutes long and breakout-room sharing sessions usually took the first five to fifteen minutes. Candy (Canada) and Adrian (Australia) also used Breakout Rooms often for student engagement. Adrian stated:

> When using Breakout Rooms, it appears that smaller groups were more constructive. The most satisfying course was working with my MFA student who was working on a Professional Practice Choreographic Performance.

In Repertoire (dance production), a third-year major course for dance students majoring in Fine Arts, Adrian was able to conduct dance rehearsals via Zoom.

Because he had been traveling, Adrian was quarantined while his students were able to return to studios at the university where he worked. He described:

> A camera was set up in the dance studio where all the dancers (maintaining social distancing) could be seen by me and they watched me giving them instructions from my apartment. Students worked hard and they asked me direct questions, as if I were in the room.

Adrian's comments were later echoed by similar stories shared by Amanda, Tom, Phil, and Jenny in follow-up interviews. Students would be focused and they would practice diligently as long as the instructions were clear. In some cases, multiple devices were utilized for small-group rehearsals and dance instructors would visit virtual groups (breakout rooms) to monitor their progress. Virtual performances took place and students combined both pre-recorded materials along with live-streamed parts. Students were able to use materials that they had at home or outdoors to enrich their dance performances. In Phil's virtual performance, some dance students moved in front of a piece of green fabric in their own room. With Open Broadcaster Software (OBS) multimedia software, the performance seemed as if it took place on Mars as the green background was replaced with an image of Mars. Phil was able to "clone" some dancers with OBS and achieved the effect of dozens of dancers performing together. The entire process, from discussion of choreography to practice and rehearsal, took place in breakout rooms and was staged virtually on OBS. Phil added that most of the student dance works were filmed on smartphones and were submitted with mobile devices. Phil then created dance series based on submitted dance works from students, which he later shared on Instagram and Facebook. These videos generated tens of thousands of likes.

2.6.3 Looking Ahead

The impact of COVID-19 pandemic still lingers and it continues to cause different waves of concern on various continents. In Spring 2022, the researchers received news from dance teachers in Hong Kong that their institutes had finally reopened after months of shut-down because of the fifth wave of outbreak in the city. Meanwhile, situations were improving as most of the European and North American countries reopened. The pandemic has posed both challenges and opportunities for dance educators to tackle and respond to in the future. Valuable lessons learned from the pandemic could be adapted to post-pandemic dance teaching and learning.

Before the pandemic, dance educators were accustomed to teaching in face-to-face environments. Not all dance educators were comfortable with using various technologies for hybrid or online teaching, especially for practice-based lessons. Some of them admitted that they had experienced a steep learning curve when they had to teach dance online. The challenge was more on the teachers' side and teachers could even develop a feeling of "losing control." Regular face-to-face dance classes, which were usually teacher-centered, subsequently became different virtual learning communities: breakout rooms, exploratory initiatives, and cyberspace collaborations.

There was a breakthrough in terms of where the dance took place, who made dance, with whom students created dance, and how dance was watched, assessed, and shared via social media. All these changes were taking place rapidly within a short period of time. Many dance teachers used words such as "shocked," "chaotic," and "lost" when referring to teaching dance online, especially at the beginning when they could not see what their students were doing, where they were going, and what the outcome would be. Nevertheless, students, regardless of their disciplines, were not as pessimistic and many actually benefited from such change in the mode of teaching and learning.

While some dance educators were caught off guard, their students took advantage of technology and pushed dance learning beyond studios and regular stages. The roles of teaching and learning at certain points were swapped as students got used to the new environment quickly and a few of them helped their teachers in transitioning to online teaching. Students took bold steps in creative works and explored new territories and genres. For instance, it was impossible for students to dance on rooftop or in a tunnel, therefore, they chose to use various technologies to capture and animate their dances and eventually share them with friends and families anywhere in the world. They were no longer confined by a studio or a stage. This would not have happened, at least not to this extent, if dance classes were held in a typical physical studio. The pandemic forced everyone to re-examine technology and explore its role in dance teaching and learning. Technology was no longer an additional or optional accessory in dance teaching. It became an enabler and booster in transforming how dance lessons were delivered.

One of the participants, Tom, concluded: "Utilizing technology is like using fire. Fire can cook food and it can burn down a house. We leverage technologies to connect, teach, and inspire others." This is especially evident in the student- or learner-centered approach, one that several dance educators had to adopt during the pandemic. They had to "let go of control" and had students "sit in the driver's seat." Phil worked with others in an interactive technology lab, which processed, coded, and sketched a dancer's movement. Multiple sensors were attached to the dancer's body and the camera was equipped with a face tracking feature, that drew with precision a space map on the screen. Phil then applied glitch, loop, and repetition effects on the collected data, the product of which was projected on the stage and then interacted with the moving dancer. It was a complicated project and challenged dancers to respond, reflect, and make decisions on movement, energy, direction, and timing. Such an approach sparked his students' interest and imagination, forcing them to think beyond just movement and studio space. Phil stated:

> Technology is now forever ingrained in our societies. Technologies in some ways have transformed everyone from kindergarten all the way up through college, and so for me, it's just another something to sort of like pique my creative interest. When we use it well in performance, it's great. If not, at least it's another form of expression, or, as we say, integration.

The majority of dance educators in this study confessed that many of their students took the lead in coaching others (teachers and peers alike) on how to use the latest technologies or "older models," collaborating with each other on various projects, utilizing various devices to enhance their works, acquiring new skills such as movie editing, and sharing creative projects to a much wider audience base via social media channels. It was evident that when technology was well-used in virtual classes, teaching was enhanced, students were empowered, and learning outcomes, such as reflective thinking, creative works, and performances were improved. Such valuable lessons should not be forgotten or discarded once the face-to-face model is resumed. In fact, insights and strategies developed from teaching during the pandemic should be adapted in the post-pandemic era because they help dance educators move forward with a more dynamic and engaging curriculum.

2.7 Limitations and Conclusion

This study does not claim to have covered all the issues and problems during the pandemic, nor does it claim to have exhaustively examined and discussed effective tools, applications, and pedagogies. The study sample is small and methods used are limited. However, the intention of this study is to share timely lessons and innovative ideas with dance educators across the globe. Researchers find that when technology is well utilized, virtual dance classes can also be interactive, engaging, and productive. Students seem to get ahead in this respect when they leverage technology to connect, innovate, and push boundaries. This student-cantered approach with open-minded utilization of technology could be further explored and developed. Dance education continues to evolve, so do the advancement of technology and the way people learn and communicate. Recently, the Beijing Winter Olympic and Paralympic Games live-streamed for the whole world their opening and closing performances as well as their competitions (Ordway & Anderson, 2022), while Paris Opera staged its latest production in Paris for Hong Kong audiences (HK Arts Festival 2022). We are now more receptive to hybrid conferences and streaming events than ever. This study invites educators and institutions to reflect and explore what a desirable future could look like for dancers. By envisioning the roles dancers could play in future dance classrooms, we could imagine their involvement in our society in the year 2030. The landscape of teaching and learning is adapting to the new world. It is time for us to rethink teaching, learning, and research for a changing world of education.

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Chapter 3
The Future of Education Utilizing an Artificial Intelligence Robot in the Centre for Independent Language Learning: Teacher Perceptions of the Robot as a Service

Frankie Har and Bruce Wai Leung Ma

Abstract This book chapter provides an overview of Temi, an autonomous, video-oriented personal assistant robot which was deployed within the Centre for Independent Language Learning (CILL) at The Hong Kong Polytechnic University. The artificial intelligence robot was chosen principally because of its role as a *Robot as a Service* (RaaS). Such a service can deliver greater self-improvement and better learning strategies (e.g. Cohen, A. D. (2014). Strategies in learning and using a second language (2nd ed.). Routledge., Dörnyei et. al., 2015, Wenden, Learner strategies for learner autonomy, Prentice Hall, 1991, Yang, Frontiers in Psychology 12:600, 218–600, 218, 2021) as well as foster beneficial attitudes and skills towards the users' long-term language learning success. Through its cloud-based system, Temi offers users access to dynamic interactions and enhanced CILL services, during the COVID-19 pandemic. As a whole, it appears that the introduction of Temi has proven to be an effective strategy to augment learners' autonomy. It further allows administrators to rethink how CILL services are conducted during human resource shortages.

Keywords Centre for Independent Language Learning (CILL) · Robot as a Service (RaaS) · Artificial Intelligence · Cloud-based system · Personal assistant robot · Learners' autonomy

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3.1 Introduction

Artificial Intelligence (AI) has been promoted as a remarkable gamechanger that will have enormous impacts on global society, industry and even education. AI can be briefly defined as a device that makes intelligent decisions autonomously (Ginsenberg, 2012; Jackson, 2019), however Baker and Smith (2019), offer a more comprehensive definition as "computers which perform cognitive tasks, usually associated with human minds, particularly learning and problem-solving" (p. 10). As an umbrella term, AI also encompasses technologies and embedded methods such as machine learning, adaptive learning, natural language processing, data mining, crowdsourcing, neural networks, and algorithms (Pokrivcakova, 2019), all which can influence AI's use within various sectors.

In regards to AI's employment in education, Rohalevych (2020) stated that language learning supported by AI would revolutionize education for students and teachers. Adding to this tremendous potential, Pokrivcakova (2019) remarked that AI-powered tools have recently risen to its prominence in educational technology. Therefore, in an effort to field test AI's usefulness in education, the authors of this study have utilized an AI-powered chatbot named 'Temi' to simulate a CILL ambassador. Temi would serve as the first-point-of-contact in responding to students' basic queries about language courses, language learning, and even offer advice on how to make use of the available resources and services at CILL.

Despite the fact that the applications of AI seem ubiquitous across various domains, its use in foreign language learning is still in its infancy. In fact, there is a general lack of research studies investigating the pedagogical effects (e.g. students' language uptake) of AI on language teaching and learning, as well as student and teacher attitudes towards the use of AI tools (Pokrivcakova, 2019). Thus, this study seeks to evaluate the perceptions of teachers on the impact of using artificial intelligence at CILL. This was undertaken via online surveys with seventy-seven language instructors and twenty semi-structured interviews at a Hong Kong university. The results suggest that language teachers are positive towards the AI robot service.

3.2 Literature Review

While there has been a growing interest in the applications of AI in language education, little empirical research has been done regarding the pedagogical effects of using AI-powered tools in second language teaching and learning. There is also an absence of data on learner responses and teacher attitudes towards the applications of AI tools (Aljohani, 2021; Pokrivcakova, 2019) in an ESL context. Therefore, it is first essential to briefly evaluate some frequently used AI tools for their efficacies in language teaching and learning. Then, it is possible to discuss the integration of AI tools into specific roles, such as that of CILL Ambassador, but also in broader roles, acting as a supplementary *teacher* in the education process.

3.2.1 Studies on AI Tools

The following is an overview of previous studies exploring the effects of AI tools which sought to improve English language learning. They involve the applications 'Google Assistant', 'Replika', and two voice command devices; 'Google Home Mini' and 'Amazon Alexa'.

The first AI-powered tool, 'Google Assistant' is analogous to a 'living encyclopedia' which can answer oral questions in a conversational manner. Essentially, the user can obtain information by directly speaking to the application rather than manually searching for the information on the internet. This is a good resource to train speaking skills as the learner needs to properly formulate the questions. Ahmed-Ali (2020) investigated the effectiveness of 'Google Assistant' in the development of oral language skills in forty 6th year primary school students in Egypt. The results revealed that the group which had undergone the AI training performed better in the post-test, compared to the control group, taught by traditional methods. It was found that not only had the AI students improved their listening and speaking skills, but they had also increased their confidence and proactiveness in seeking further improvement in these areas.

The second AI tool is a chatbot called 'Replika' which analyzes the users voice/text/images/uploads and responds accordingly with relevant, but not always accurate, information. The response given by 'Replika' is either in a speech-to-text or a text-to-speech format (audio file). Furthermore, it is capable of reacting to the user's manner in order to maintain a sense of rapport and harmony. If, for example, a user demonstrates a bright and cheerful personality to the chatbot regularly, the chatbot will engage conversation with the speaker in a similar manner. If the user demonstrates a sharp or curt personality, the chatbot will replicate this in its responses. Kim (2019) investigated the effectiveness of 'Replika' in the development of grammar skills in seventy Korean university students. The results indicated that the experimental group, which had taken the AI training, exhibited noticeable improvement over the control group, in pre-test and post-test results. However, it should also be stated that the control group, learning the same grammar skills by talking to other students, also showed improvements.

The next tool utilized AI in a 3D virtual environment to teach English to medical students. This study, conducted by Soliman (2016), was in response to previous data indicating a lack of learner comprehension of medical-English language. Twenty-nine faculty members from Bisha University were invited to complete a questionnaire on educational, technological and artificial intelligence needs. The findings suggested that the incorporation of AI into teaching medical-English was well received as the VR environment was more conducive to clearer explanations of the medical-related content.

The final AI tools tested in educational settings were voice command devices. 'Google Home Mini' is a voice activated speaker that can respond to simple questions, play music and videos, manage home smart gadgets, create a calendar, and do online shopping. Similarly, 'Amazon Alexa' is an AI-based voice command system which can issue instructions to an entire smart device ecosystem. This AI system not only responds to simple questions but can also give instructions to perform regular personal routines such as checking for weather and news updates, securing your home and communicating with friends and family. Obari and Lambacher (2019) investigated the effectiveness of 'Google Home Mini' and 'Amazon Alexa' in improving the English language skills of forty-seven Japanese undergraduate students. The results suggested that the Google group showed improved listening and speaking skills, while the Amazon group progressed more in listening comprehension and vocabulary skills.

Considering the above studies, it can be concluded that the intelligent features offered by these AI tools are conducive to the development of ESL learners. Furthermore, AI applications may have offerings beyond the student learning level as they have shown potential in pedagogy and material design of language courses.

3.2.2 AI Tools Supplementing Human Teachers

A study was undertaken at the English Language Centre of the Hong Kong Polytechnic University with respect to student opinions on CILL services. The results indicated that the self-access services were not living up to the Centre's notion of independent learning resources. This was due to the fact that there remained a great deal of dependence on teachers to handle many of the student's learning issues. It is quite difficult for human teachers to analyze the outputs of every student, diagnose their individual needs, adapt the learning materials accordingly, and give feedback to students on a consistent basis (Pokrivcakova, 2019). Accepting that human teachers are simply not capable of catering to a whole student population's diverse language needs, this opens the door to further AI applications.

The adoption of such AI technology offers more immediate, individualized and personalized language support that can work in tandem with human teachers to remedy service shortfalls. More research in this area is certainly needed in order to clearly understand AI's complimentary role in pedagogy.

3.3 The Institutional Context

(1) This study was conducted at The Hong Kong Polytechnic University (PolyU) where English is the medium of instruction across all of its eight faculties and schools. A wide range of academic programs are offered such as applied science, business, construction, engineering, etc. which are all supported by the English Language Centre (ELC). The ELC's goal is for CILL to be a resource for students which supports creative learning methods. The main objectives of CILL (Morrison, 2008) are:

(1) to bring together language learning and independent learning
(2) to improve linguistic proficiency and independent learning skills
(3) to provide the necessary resources to accomplish these goals
(4) to provide students with learning assistance when necessary

Prior to the covid pandemic, CILL offered face to face services to students that sought assistance at the help desk counter. However, these students still needed to do their own independent research about learning a foreign language. In a recent survey conducted by CILL, students reported that CILL was seen primarily as an "English library" resource (Kongchan & Darasawang, 2015). Participants further conveyed that they had only a vague notion of CILL's stated goals and services for independent language learning. With these survey results, CILL began considering innovative ways to empower learners through the use of technology while also increasing their autonomy and interaction.

In summer 2020, CILL launched Temi, the humanoid robot, with the aim of harnessing the benefits of AI for independent language education. Temi is fully programmable and is powered by 5G, 3D mapping, as well as Natural Language Processing by Google and Alexa. Temi currently remains a pilot programme and is acting as a tour guide at CILL for students looking for English courses, workshops, and study programs that are relevant to their own needs.

3.4 Necessity for Innovation

According to Campbell-Howes (2019), incorporating AI tools into language education is beneficial because it can be tailored to the individual learner's needs as well as reduces frustration, time and costs associated with online or app-based courses. Beyond these conveniences, Campbell-Howes suggests that the true strength of AI lies in its ability to foster a more personalized learning experience for the user. It enables students to identify their weak areas in speaking, writing, reading and listening, and then to focus their efforts on the tailored feedback provided by the AI. It further allows students to be more creative in their work, rather than conforming to generic model answers which usually accompany traditional lessons.

This mode of learning, which promotes autonomous, personalized and flexible language learning, aligns itself well with the service goals of CILL. The installation of the AI robot at CILL was justified by three driving ideas: principle, research and practice.

Principle refers to the overall desire to place the power of learning within the hands of the student. This concept is supported by Pokrivcakova (2019) who postulated that AI based systems can cultivate an environment where language learners are given an autonomy in deciding on the path and pace of their learning. In such a circumstance, students would be expected to proactively take charge of their own learning, with the AI assuming an auxiliary role; providing guidance and facilitating the learning process.

Research refers to a considerable number of relevant studies in recent years. This research shows that learner-centered pedagogic approaches, scaffolded by AI-powered tools, have had moderate success within classroom settings (e.g. Ahmed-Ali, 2020; Kim, 2019; Obari & Lambacher, 2019; Soliman, 2016). The research further reveals that AI may also present pedagogic value, as is the case at CILL.

Practice refers to the practical problems of providing learning assistance with a finite amount of manpower. CILL concedes that it does not have sufficient human resources to handle the language queries of a large student population, provide facility introductions and tours to various student groups or departments, and still allow teachers time to deal with basic English learning issues.

For all of these reasons, CILL purchased and deployed Temi to serve students and teachers. Temi leads guided tours of the facility as well as provides students with information about courses, workshops, and language enhancement activities offered by the university's English Language Centre.

3.5 The Innovation Aspect

This section elaborates on the use of Temi and highlights the importance of interactivity and collaboration between teachers and peers in using this AI tool. As Temi is a Robot as a Service (RaaS) solution, it is designed to provide independent English language learning strategies, resources, and advice that can be employed on-demand by students. This has the effect of increasing student engagement while also addressing the diverse needs of students with regard to language learning. It should be noted that when teachers use Temi, they must first access the control panel before selecting the corresponding course module (see Figs. 3.1 and 3.2).

Fig. 3.1 Temi in self-access centre

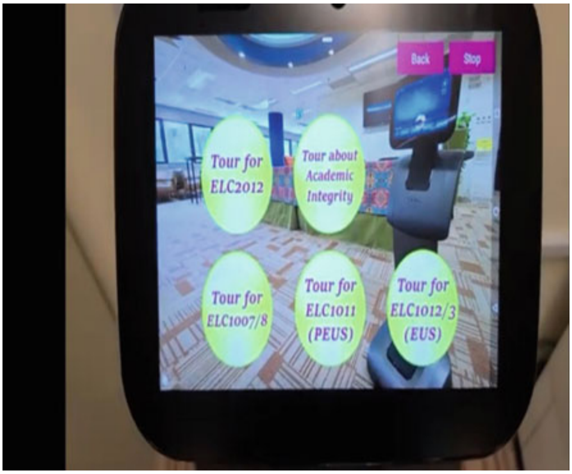


Fig. 3.2 Temi's multi-touch interface

With assistance from Temi, teachers are able to show their students any useful tips, available hardware or software resources, and other materials that self-access centers can provide. This assists students in becoming independent English language learners. Figure 3.2 shows Temi's multi-touch interface with an intuitive user experience. It displays examples of different facilities within the centre including individual consultation rooms, books and multimedia sections, and the Virtual Reality (VR) Space that students can visit to learn English on their own (see Fig. 3.3).

Apart from acting as a tour guide, Temi freely interacts with CILL visitors by responding their enquires. It can provide details on elective courses, Massive Open Online Courses (MOOCs), upcoming workshops and language enhancement activities offered by English Language Centre.

This level of service is possible once the advanced question and answer bank is established within Temi's cloud-based system. This specialized language interface with dialogue function allows the user to converse directly with the machine. Having extracted the text from audio, the transformer-based chatbot then infers what the user is trying to convey and responds to it accordingly because of its default Response-Specific API (see Fig. 3.4).

3.6 Methodology

3.6.1 Participants

A questionnaire was distributed to 77 teachers in an English Language Centre with an aim to determine whether this new educational reform has been effective. It sought to quantify the experiences of these teachers with the AI robot at CILL. The volunteer

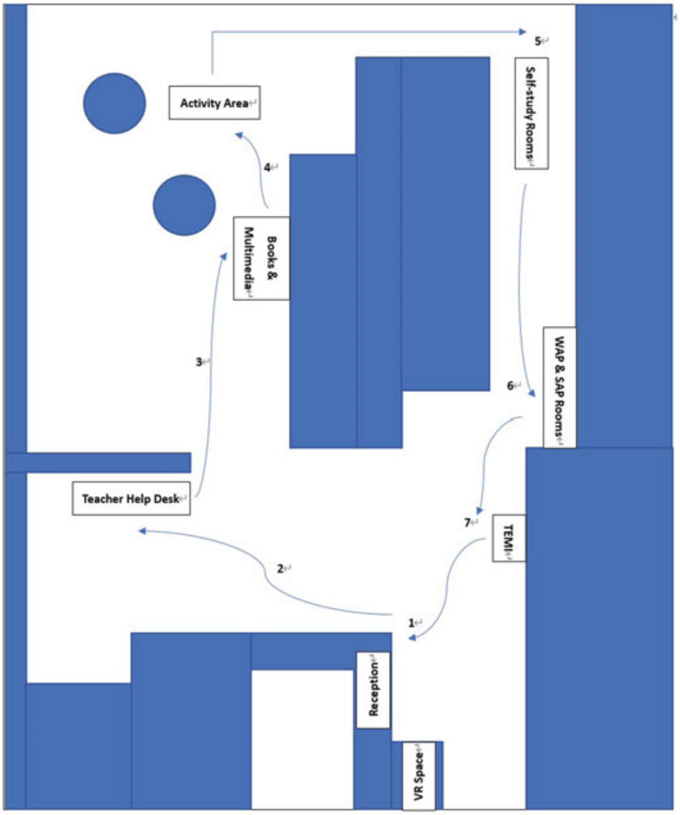


Fig. 3.3 Robot-assisted tour route

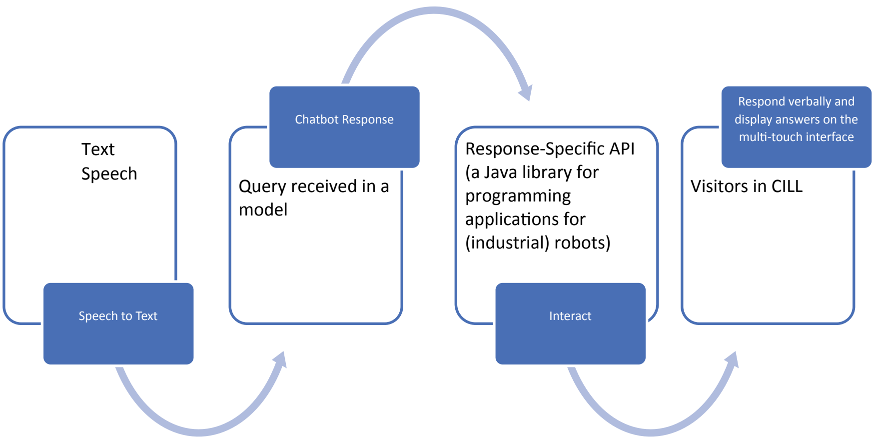


Fig. 3.4 Diagram of human-temi interaction pipeline

participants in the semi-structured interviews included sixteen Hong Kong English teachers and four teachers from various regions: Mainland China, England, Scotland, and Germany. The respondent's anonymity was preserved by using pseudonyms, and it was possible to withdraw from the study at any time.

3.6.2 Data Collection and Analysis

This study has gathered data from 20 individual semi-structured interviews, recorded and transcribed, with English teachers working at the Hong Kong Polytechnic University. These in-depth interviews ranged from 15 to 22 min and produced rich responses regarding the teachers' experience with the AI robots at CILL. In general, the teachers reported feeling comfortable interacting with the robot and that it had enhanced their teaching abilities.

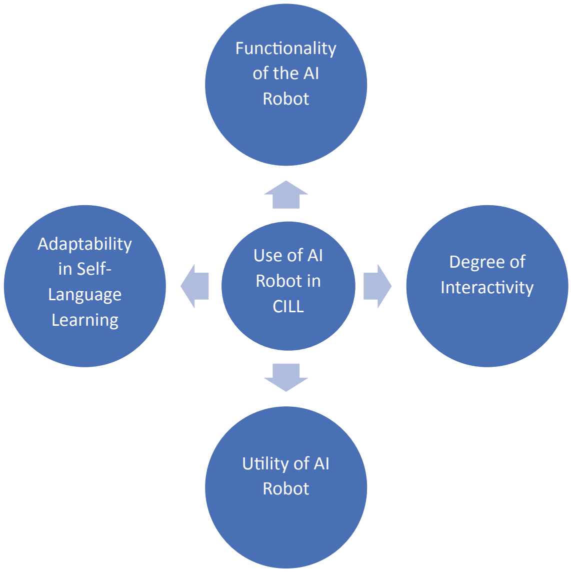
The data was checked by members (Thomas, 2017) and each participant approved the transcripts of their interview without revision or reservations. Given the relatively small sample size, the data was manually analyzed using Braun and Clarke's (2006) six-step framework for thematic analysis. Following the completion of the first member check, participants were asked to complete a second member check when they received the final results and a discussion of the research (themes and representative quotes). It was confirmed by the participants that the information accurately reflected their learning experiences, and they did not request any further changes to the information. The following questions were asked:

(Q1) How would you rate the Artificial Intelligence Robots?
(Q2) When compared with traditional services offered by the Self-Access Centre, do you think Artificial Intelligence Robots can bring you a better teaching experience?
(Q3) Did anything make you engage with the Artificial Intelligence Robots during the tour at the start of the semester?
(Q4) Did anything make you not engage with the Artificial Intelligence Robots during the tour at the start of the semester?

To ensure the validity and dependability of the data over time, several precautions were taken. Two investigators evaluated the interview data using thematic analysis (Nowell et al., 2017) and the data was coded following the coding guidelines of Denzin and Lincole (2013). Two independent coding sessions were held as a part of the study, with the second session occurring two weeks after the first. It is interesting to note that the two rounds of coding resulted in nearly identical data.

Since the researchers selected quotes from the interviewees (Merriam & Tisdell, 2016) to use in their report, it was necessary to conduct two-member checks to ensure the reliability (Crawford et al., 2020) before releasing the data. The interviewees were provided with an English translation of their interview transcripts and no amendments were requested to the drafts.

Fig. 3.5 Thematic map



After thematic analysis and coding, four themes were identified from the responses. Figure 3.5 shows the thematic map illustrating the interview responses. These represent the insights into the experiences of the ESL teachers who were in with the robots at the English Language Centre, over the course of the semester.

3.7 Reflection

3.7.1 Functionality of the AI Robot

It is possible to draw inferences about the functionality of the AI robot from the following comments:

> With Temi, you can have a voice-activated personal assistant robot on wheels that follows and recognizes you wherever you go. Temi is also knowledgeable as it has a built in mini-computer. (Johnathan)

> I can see the new generation may not be willing to talk to or seek help from others face-to-face. Instead, they prefer talking to and find help from machines. So Temi is a good choice besides the counter staff help. (Melody)

> Temi is really fun and convenient because it can talk to me just like humans. Surely, sometimes, Temi did not provide appropriate answers. Eventually, it responded me in a stupid way, but that's okay. (Marcel)

> I am worried about the use of Temi as it is a voice-activated artificial intelligence robot on wheels. I heard that severe security flaws were found in Israel before. (Tony)

From these comments, there is little doubt that Temi has been an invaluable resource to a majority of teachers who sought assistance. The combination of conventional face-to-face counter assistance with the use of Temi seems to have created an enjoyable environment. It helped to facilitate self-learning and enabled users to achieve their maximum potential. CILL users were quite satisfied with the level of support they received from Temi, regardless of any security concerns that arose. Despite the occasional error or misinterpretation of user commands, participants reported an appreciation for Temi's responses.

3.7.2 Degree of Interactivity

The following comments describe the degree of interactivity.

> Sometimes, the colleagues in the CILL may not be approachable and helpful, particularly during the COVID-19 pandemic. So I seldom sought help from them. But while using Temi, it did help me a lot as I can talk to Temi freely and openly by raising some questions. (John)

> Temi can recognize human voice. Sometimes, I raised Temi some silly questions but it could still give me prompt responses. (Nathan)

> Even though Temi is a robot, it uses 5G to connect to the network. So, Temi responded me quite well. However, it did not always give me the appropriate answers, so probably it took time for Temi to learn because it has a built-in expanding Natural Language Processing (NLP) system. (Brian)

Teachers described their interactions with Temi as useful and even showed a greater willingness to elicit information from the robot, rather than personnel assigned to the service counter.

Temi not only provided opportunities to gather and exchange information, but also fostered positive interactions between humans and robots. As Bütepage and Kragic (2017) indicates, in order for robots to interact autonomously and successfully with humans, human–robot interaction requires active decision making that takes the human partners into account. The use of a fast-paced robot, such as Temi, facilitates instant human–robot exchanges of information, which increases learner autonomy and can inspire a self-motivation to learn. It has been demonstrated that engagement, success, and enthusiasm are three factors that can play a leading role in facilitating proper learning outcomes when it comes to human–robot relationships (Paluch et al., 2022).

3.7.3 Utility of AI Robots

Temi is the culmination of advanced hardware and innovative software that offers unprecedented remote presence capabilities. As a Robot as a Service (RaaS), Temi allows users to interact with it through voice commands or by touchscreen to access information. In Temi's role at CILL, it delivers innovative solutions to engage users such as offering greetings, guiding them around the building, or providing them with self-learning solutions at the centre.

Temi's autonomous navigation algorithm allows it to flawlessly navigate and understand the surrounding environment, ensuring a smooth and safe navigation experience. Hoyer et al. (2020) highlighted the importance of algorithms in machine learning as it enables an improved experience with the users. Having had a positive and rewarding experience with Temi, their engagement with CILL can be boosted to a certain extent. This can be reflected by the following concerns:

> "If I found that CILL is well decorated and equipped with more technological devices, the whole experience will be different from the past." (Susan)

> "It comes as no surprise that the setting of traditional CILL is just like a mini English corner in a local primary or secondary school. Therefore, I prefer not going there to search information unless there are some substantial changes like the wide use of IT in there." (Heidi)

Temi's built-in analytics allow it to make professional judgments in the areas of human–robot interaction, autonomous navigation, and auto speech recognition in order to determine whether the timely responses are appropriate. According to Chuah and Yu (2021), the key to hosting successful user services lies in the robot being able to create surprising or happy reactions from users in response to the AI's actions or statements. After a period of monitoring Temi's engagements with visitors, the Centre should be able to select which of Temi's responses are most well received by users.

3.7.4 Self-language Learning

The following comments describe how AI can accommodate and promote Self-Language Learning.

> As I am new to the English Language Centre, I can build up my confidence in classroom teaching working with self-access resources. If I really don't know where the resources are located, not just students, as staff members, I can also seek help from Temi. (Daisy)

> I think both undergraduate and postgraduate students benefit from Temi as CILL could offer them some useful tips about academic referencing, how to avoid plagiarism, and also show them how they can prepare for the IELTS exam. (Macy)

> During the semester, students may have many questions about how to cite academic sources properly in the academic paper. You know, as a teacher, we are very busy particularly in the

> middle of the semester. We don't have any spare time to bring or show students what kind of useful materials can be found in Self-Access Centre, but Temi does help us a lot. (Stephanie)

> During the lunch hour, no colleague is on duty at the counter. But everything can still be solved with the help of Temi. (Robert)

Temi has proven to be a valuable asset to CILL and has become immensely popularity amongst the teaching staff. This support for Robot(s) as a Service strengthens the calls for further innovations and automation at CILL.

In this study, participants have consistently accredited Temi with giving immediate assistance, facilitating self-learning moments, as well as providing valuable and useful information. A number of groundbreaking technologies are incorporated into Temi, including Alexa, which is a pioneering initiative in the personal assistant device industry. Temi also helps to propel communications into this new era of high-speed internet and upcoming 5G capabilities. As a whole, CILL users were reasonably satisfied with the level of support they received from Temi. It is also interesting to note that participants found it quite acceptable to receive assistance from an AI robot, in lieu of human staff, during the pandemic.

3.8 Conclusions and Pedagogical Directions

This study was conducted to investigate the feasibility of integrating AI tools into CILL's service provision. The results show that Temi was, in fact, successfully implemented into the facility and that there is a strong consensus among staff of its usefulness. Users saw value in Temi's site-specific information and believed their experience was enriched by its elaborations on displays or facilities. During Temi's service period, it fulfilled a wide range of duties including; leading guided tours, answering specific questions on academic writing, and even offering advice on how to avoid plagiarism. While Temi's functions are impressive, it is important to note that there are many lessons to be learned from this pilot study.

After repeatedly introducing CILL to various student groups, it is clear that Temi's guided tours need to become more multifaceted in order to better meet the needs of these students. For example, information displayed on Temi's interface screen could be enhanced with some background music. This might also enrich the users' appreciation of the robotics interaction and offer a dynamic CILL experience.

Although Temi's assistance was appreciated by teachers, there still remains a great deal of dependence on CILL staff to handle basic English learning issues. One such frequent question is how to improve speaking abilities in a more efficient manner. To resolve this issue and reduce the workload of teachers, more advanced responses could be added to Temi's knowledge bank. By giving Temi greater response functions, users could experience a more pleasurable interaction while being advised on self-directed language learning. More importantly, Temi might inspire students to carry these skills forward into other aspects of their language learning journey.

While considerable attention has been paid to the perceptions and use of Temi by teachers in this study, there are a few limitations that should be considered. It is likely that the sample size for this qualitative case study will be considered relatively small, as only 20 teachers agreed to participate in the study voluntarily. Consequently, there are challenges associated with generalizing this information to ESL teachers in university settings. As a result of interpretive studies (Guba & Lincoln, 1994), the article has outlined the context and interpretation of the research results, and the reader is obligated to determine the relevance and significance of the research in their context (Merriam, 1988). During future research, it will be possible to involve student participants in explaining how the use of AI robots could support language learners as far as the actual process of learning languages is concerned.

Finally, this study also provides a starting point to explore the next generation of education and language learning. It is not surprising that AI tools are becoming more prevalent in education, however the incorporation of AI-augmented learning through the adoption of AI tools could potentially usher in a new era. This fascinating and inspiring vision of the future might provide a key interface for knowledge and education as a whole, as well as greatly improve self-motivation in language learning.

Perhaps the traditions in pedagogy will also be transformed to allow for more interactive and engaging lessons which are personalized for individual students. In the meantime, the English Language Centre will continue exploring the use of AI in the delivery of its services and teaching. It is hoped that this case study of Temi will give educators a glimpse of what AI tools can currently offer and what modes of teaching and learning may look like in the future.

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Chapter 4
The Impacts of Integrating Picture Archiving and Communication System (PACS) in Medical Education on Trainees

Roshan Sabeeha, Jacelyn Yun Qian Wong, Yi Zhen Loh, Christopher Lai, and Hajmath Begum Mohamed Sali

Abstract With advancements in technology, Picture Archiving and Communication System (PACS) in Radiology and Radiography has played an essential role in archiving and retrieving medical images. Other functions of PACS also include visualising and manipulating patient's images for an accurate diagnosis. Without the basic knowledge of PACS, users would face technical challenges leading to a delay in medical care delivery. Starting PACS training with healthcare students would help to acquaint them with the system and serve as a tool to supplement their learning. Hence, the aim of this systematic review is to evaluate the impact of implementing PACS training on trainees. Previous studies were included based on the keywords generated for the search strategy. Our exclusion criteria consisted of articles published before 2000, those not related to PACS, and conference abstracts. Scientific databases such as PubMed, Cinahl, Cochrane, Web of Science, Embase, Medline (Ovid) were used. After reviewing the studies based on these criteria, 21 studies were included in this review and six themes were generated. These themes included 'Self-efficacy', 'Skills of Inquiry', 'Interest and Motivation', 'Application to clinical practice', 'Content and Process knowledge' and 'Utility of PACS'. The results reported an increase in trainees' self-confidence when using PACS. Trainees felt more ready for their future practice and clinicals. Studies showed that trainees were able to develop critical thinking skills and helped to increase their interest and

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motivation in radiology. Trainees learnt new clinical and imaging knowledge from PACS training and found it useful for studying radiology, understanding anatomy, and learning indications for imaging studies. The PACS training also provided trainees the perspective of a practitioner and the image manipulation tools in PACS aided them in visualising anatomy and understanding difficult materials effectively. Hence, the consensus reached based on the results is that implementing PACS training has a positive impact on trainees.

Keywords Technology · Self-efficacy · Skills of inquiry · Interest and motivation · e-learning · Medical imaging · Picture Archiving and Communication System (PACS)

4.1 Introduction

Diagnostic imaging is a key component of information that affects the care that a patient receives (Hood & Scott, 2006). For the longest time, hard films were used for imaging. However, one of the major problems with films was that they were often lost and may not ever be interpreted. Approximately 10–20% of hard copy films are missing or unavailable when needed, possibly resulting in incorrect management as the images were often used to assess disease remission or progression (Kinnunen & Pohjonen, 2001). The loss of images would also result in the patient undergoing repeated examination, causing unnecessary re-exposure to x-rays, delays in the final diagnosis and additional overall health costs (Arenson et al., 2000).

With the advancements in technology and filmless radiography becoming more prevalent, it has allowed for the implementation of picture archiving and communication system (PACS) within hospitals (Bansal, 2006). PACS is a system that allows archiving, transmitting, distributing, and displaying diagnostic images. It consists of various imaging modalities such as CT, MR, ultrasound as well as archiving and display workstations that are connected via various digital networks (Law & Zhou, 2003). PACS has been increasingly incorporated within the hospital framework as it makes images available and accessible on multiple workstations simultaneously, aiding in clinical decision making and providing efficient patient care (Alhajeri et al., 2017) as illustrated in Fig. 4.1. In a study by Hussein et al., (2009) it was demonstrated that PACS makes it easier to get connected with other healthcare centres and therefore increasing the use and expansion of this technology.

It is essential that hospitals place a strong emphasis on conducting indispensable workshops for the healthcare professionals (HCP) to improve themselves with adequate knowledge, optimising quality care and services for the patients, especially with the introduction of new technology. In a study by Dubey et al., (2010) one of the factors found to be essential for a successful implementation of PACS was conducting proper training for PACS users. About 30 years ago, refresher courses on PACS were offered during annual scientific meetings attended by radiologists and physicians. Various manufacturers conducted workshops that were focused on retrieving images

Fig. 4.1 Picture archiving and communication system (PACS) functionality diagram

and displaying them on the workstations as well as using the tools to enhance image interpretation (Protopapas et al., 1996). In the 1990s, instead of didactic refresher courses, hands-on workshops were offered on how to use the viewing workstations, and more recently PACS training have been conducted at the clinical sites.

As important as it is to train HCP, it is also crucial to expose PACS to healthcare students who will be the future HCPs attending to patients. Giving PACS training can help students familiarise with the system before embarking on their clinical attachments. PACS can also be utilised as a learning tool whereby students are able to use the images to supplement their learning. However, the issue with this was that scheduling the training sessions during working hours was not easy as either the radiologists or physicians were busy using the workstations (Protopapas et al., 1996). Therefore, the teaching model initially comprised of didactic lectures via PowerPoint and access to static radiology imaging was mostly found in textbooks. Basic image manipulation such as window width and level as well as reconstruction was only taught by theory. With the advancements in technology, in the year 2000, the Hong Kong Polytechnic University (PolyU) utilised the PACS simulator as a training tool for its undergraduate and postgraduate programmes. The PACS simulator provided a setting for a more basic understanding of PACS and offered a practical experience for the trainees in a more controlled environment (Law & Zhou, 2003). With this, several institutions worldwide started experimenting with the implementation of a more integrated teaching method, allowing trainees to have hands-on practice using PACS. Therefore, the objective of this systematic review is to evaluate the impact of implementing PACS training on trainees.

4.2 Methods

4.2.1 Search Strategy

Scientific literature databases like PubMed, Cinahl, Cochrane, Web of Science, Embase, Medline (Ovid) were searched for relevant published studies using a search protocol that consisted of various forms of the terms "PACS", "Curriculum", "Students" and "Impact". The full search strategy is shown in Table 4.1.

4.2.2 Eligibility Criteria

To be included in this systematic review, studies had to be published after the year 2000. Considering the fact that the teaching syllabus for radiology has evolved significantly, we wanted to assess studies that were more relevant to the current syllabus being used to teach trainees of this generation. Studies were also only included if they were written in English in order for the reviewers to fully understand the contents of the study. While it is possible to translate the articles to English, some of the contents may get lost in translation. We did not include conference abstracts as they did not provide enough information on the methods used and the extent of PACS involvement.

4.2.3 Study Selection and Data Extraction

After removing duplicate studies, reviewers examined the title and abstract and applied the eligibility criteria to select the studies for inclusion. A minimum of two reviewers collectively checked and screened the records for inclusion. If both reviewers were unable to come to a conclusion, the two reviewers stated their opinions and discussed until a consensus was reached. However, when an agreement could not be made, the third reviewer stepped in and made an unbiased judgement after considering the opinions from both sides. Abstracts that mentioned PACS or simulated PACS were included for full-text article assessment. Software such as Zotero and Microsoft Excel spreadsheets were used for recording studies and articles. Rayyan was used as a platform for reviewers to screen the records without bias as the decisions of each reviewer were not visible to others until all the articles had been screened. The data from the selected articles were independently extracted onto a data extraction sheet and counter checked by another reviewer. The data extracted included author, year of publication, study design, methods and measurements, country of origin, total number of students, student demographics and intervention used.

Table 4.1 Search strategy

Database	Search terms
PubMed	(((“Radiology information systems”[mesh] OR “radiology/education”[MAJR] OR “picture archive and communication system” OR “pacs” OR “image teaching” OR “radiology information system”) AND (“Curriculum”[mesh] OR “curriculum/trends”[MAJR] OR education OR module OR learning OR program OR training OR course)) AND (“Education, medical, undergraduate/trends”[MAJR] OR undergraduate* OR student OR medical OR nursing OR “allied health”)) AND (evaluate OR effectiveness OR effect* OR cause OR result*)
CINAHL	(“picture archive and communication system” OR pacs OR “image teaching” OR “radiology information system”) AND (education OR module OR learning OR program OR training OR course) and (undergraduate OR student OR medical OR nursing OR “allied health”) AND (evaluate OR effectiveness OR effect OR cause OR result)
Cochrane	“picture archive and communication system” OR pacs OR “image teaching” OR “radiology information system” AND education OR module OR learning OR program OR training OR course AND undergraduate OR student OR medical OR nursing OR “allied health” AND evaluate OR effectiveness OR effect OR cause OR result
Web of science	(((TS = (“picture archive and communication system” OR pacs OR “image teaching” OR “radiology information system”)) AND TS = (education OR module OR learning OR program OR training OR course)) AND TS = (undergraduate OR student OR medical OR nursing OR “allied health”)) AND TS = (evaluate OR effectiveness OR effect OR cause OR result)
Embase	(‘picture archive and communication system’ OR pacs OR ‘image teaching’ OR ‘radiology information system’) AND (education OR module OR learning OR program OR training OR course) AND (undergraduate OR student OR medical OR nursing OR ‘allied health’) AND (evaluate OR effectiveness OR effect OR cause OR result)

(continued)

Table 4.1 (continued)

Database	Search terms
Medline (Ovid)	(((picture archive and communication system) OR pacs OR image teaching OR radiology information system) AND (education OR module OR learning OR program OR training OR course) AND (undergraduate OR student OR medical OR nursing OR allied health) AND (evaluate OR effectiveness OR effect OR cause OR result))

Note Databases and search terms used to identify literature

4.3 Results

4.3.1 Search Strategy and Article Selection

The details of the search strategy and articles selected are shown in Fig. 4.2. During the initial search strategy, a total of 4069 articles were found. After removing duplicate articles, 3535 articles remained. The titles and abstracts of the articles were reviewed according to the inclusion criteria, and 3488 articles were excluded. The full texts of the remaining 47 articles were studied in detail. Subsequently, 26 articles were excluded from the review resulting in 21 articles to be included in this review.

4.3.2 Study Design

Most of the studies were conducted in the USA (n = 14), followed by two studies from China and Germany each and one study from Canada, Hong Kong, and India each. The study design utilised by majority of the studies were cross-sectional studies (n = 9). The three reviewers independently assessed the included studies and discussed their initial thoughts on broad descriptive coding themes. The codes that were accepted by all were then noted in an excel sheet. These were then used by the reviewers to conduct coding of the remaining included studies. The reviewers met regularly to discuss coding as it developed. After analysis of all the studies, groups of related codes were identified and grouped together to form a theme. The summary of each theme was written, discussed, and refined. This process involved repeated reference to the respective papers to ensure that there is consistency with the study findings. The 6 themes generated after analysis of the 21 included studies are Self-efficacy, Skills of Inquiry, Interest and Motivation, Application to clinical practice, Content and Process knowledge and Utility of PACS (Table 4.2).

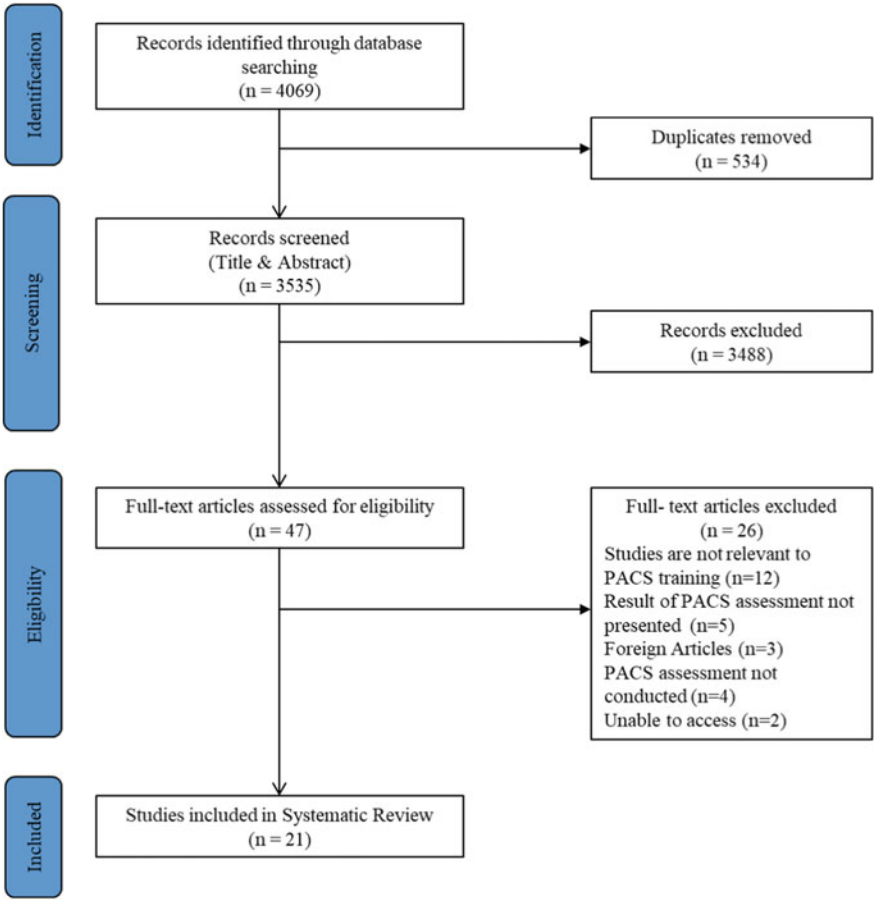

Fig. 4.2 PRISMA flowchart

4.3.2.1 Self-efficacy

In a randomised control study conducted by Chen et al. (2019) the experimental group were exposed to whole cases using PACS, where they were free to utilise the basic reconstruction capability and explore the image characteristics on their own. This allowed the students to have an increased familiarity with Digital Imaging and Communications in Medicine (DICOM) viewer and anatomy, strengthening their self-confidence. Huang et al. (2021) conducted a post-course survey with 34 students using a scale of zero to hundred (0 = strongly disagree, 50 = neutral, 100 = strongly agree). The students responded with an average rating of 89.5 (range 63–100) regarding their confidence in reviewing and interpreting future studies in comparison to review with teaching which was the current standard.

Table 4.2 Summary of thematic analysis

Theme	Description
Self-efficacy	The range of self-confidence the trainee has in his/her ability to use PACS
Skills of inquiry	Trainees are able to attain procedural skills such as critical thinking and problem-solving skills, including asking questions, collecting, diagnosing, analysing, and interpreting clinical data and images
Interest and motivation	PACS serves as a self-directed learning material, garnering a learning interest in radiology. Trainees are motivated to learn using PACS software and recommend it to their peers
Application to clinical practice	Trainees are able to apply knowledge obtained from simulation to clinical practice, better understanding and seamless transition of their role and the use of PACS in the clinical setting
Radiological science and technology	Trainees learn new knowledge on imaging or PACS processes. Improve their understanding and recollection of anatomy, radiology, and clinical content
Utility of PACS	PACS' functions which make it a superior tool in improving trainees' workflow efficiently and providing an effective learning platform in enhancing trainees learning experiences and education

This was also similarly reported by a study conducted by Rengier et al. (2009) where there was an improvement in the students' confidence in their ability to interpret radiological cross sections. In a free-response survey conducted by Novelline et al. (2001) students mentioned that ***"… I feel confident that I can do this for my future presentations."***

Two studies by Restauri et al., (2017, 2018) evaluated the implementation of teaching PACS application into the educational programme of undergraduate medical education. The free response recorded from students stated that they ***"feel more confident about radiology/imaging"*** as well as ***"interpret radiology images so much better"*** and they feel more confident reading and thinking about US and CT. In the second study conducted in 2018, the medical students reported statistically significant improvements in confidence levels with respect to interpretive and noninterpretive skills after using the TPACS. Increased levels of confidence in imaging were also observed as they were able to utilise the PACS workstation. This was also supported by a study conducted by Smith and Boscak (2021), in which confidence in study ordering and image interpretation increased subsequently after the restructured emergency radiology course. Through this course, students were able to review unknown imaging cases via a browser based Pacsbin platform. Towbin et al. (2007) also reported that the study group that used the PACS simulator tended to feel more ready and less nervous. However, this result was not statistically significant, possibly attributed to the small sample size.

4.3.2.2 Skills of Inquiry

Singh et al. (2019) conducted a prospective, quasi-experimental study. This experimental group underwent integrated teaching, which consisted of problem-solving exercises and PACS. Pre- and post- tests that focused on assessing knowledge and interpretive skills were then administered. The difference between the pre- and post-test was calculated and found to be statistically significant ($p = 0.001$), substantiating the gain in interpretive skill. Chen et al. also reported that the teaching method involving the use of PACS allowed for ***"better guidance for students to develop critical thinking and systematic approach to formulate imaging interpretation and differential diagnosis"***. Similarly, Jafri et al. (2008) also reported that 64% of the students surveyed agreed that the PACS sessions prompted them to approach physical diagnosis from different angles.

By combining the use of PACS simulator and case-based learning, Qin et al. (2020) were able to mimic clinical scenarios, motivating ***"students to see, think and behave like genuine doctors"***. This helped to train the students on their diagnostic reasoning. This was proven when 25% and 55% of students who took the Smart-Class agreed and strongly agreed respectively when asked on whether their diagnostic reasoning improved, as compared to 20% and 40% respectively of the control group. One study conducted by Aufferman et al. (2015) conducted a randomised control study and offered search pattern training (SPT) to the experimental group. The SPT group was able to have additional practice with the simulated PACS workstation. This attributed to the improved performance at nodule perception and identification shown by the subjects.

4.3.2.3 Interest and Motivation

In the randomised control study conducted by Chen et al. 85% of the students felt that the interactivity of the learning activity "encouraged better personal interest in radiology, as well as satisfaction with the quality of learning". Similarly, Erinjeri and Bhalla (2006) also reported that a significant proportion of students (78%) stated that they would recommend the course to a classmate and there was an increasing trend towards interest in radiology.

Rengier et al. Conducted a study on both first year as well as fourth- and fifth-year medical students on the use of virtual anatomy. Participants of the module stated that they would urge other students to partake in the course as the assimilation of radiology led to greater keenness for anatomy. They also appreciated the opportunity to correlate the real dissection in the gross anatomy lab with the virtual dissection in the computer lab. In a study by Soman et al. (2010) 232 of the 293 participants were satisfied with using StudentPACS modules as a form of self-directed learning material and that ***"they would use StudentPACS modules for learning different topics in the future"***.

92% of the survey respondents in a study by Smith and Boscak reported that they were very likely to recommend the elective to others. The participants valued the versatility of self-directed learning that Pacsbin provided in combination to the regular interactive faculty sessions, as they were ***"similarly effective when compared to a traditional radiology rotation".***

4.3.2.4 Application to Clinical Practice

In an open-ended survey conducted by Erinjer and Bhalla, participants had the ***"opportunity to have a glimpse of the experience of 'real radiologists' dealing with a case"*** and were able to understand the role of a radiologist in synthesising imaging data with clinical information and radiologic images to form a diagnosis and impact clinical management. This finding was similarly reported by Huang et al., as the students were able to gain access to the practitioners' perspective, become part of the radiology team and gain a sense of purpose within the community. Jafri et al. implemented small group PACS sessions facilitated by a radiologist. This was to simulate the working environment that students would come across during their clinical attachments and to teach a step-by-step method to address frequent clinical problems. They were able to fulfil this aim as students stated in an open-ended survey that ***"it is good to start integrating material that we will need to know on wards and also to help us actually understand pathology rather than just memorise it"***. Similarly, in another study (Novelline et al., 2001), students had to give case presentations based on the images and information obtained from the departmental PACS. This was highly praised by the students as they felt that the skills gained from it would be "extremely useful for their future career".

4.3.3 Comparison with Didactic Lectures

Out of the 21 articles, 6 compared the use of PACS with traditional lessons consisting of lectures and static images shown during the lectures or in textbooks. In the study by Chen et al., students in the experiential group were able to utilise PACS to do basic image manipulation whereas those in the control group were only able to view typical imaging layers via PowerPoint and Word documents. The basic skills of choosing the appropriate window level and width and reconstruction methods were taught only in theory. In the assessment conducted, the experimental group exhibited significantly higher scores than the control group ($p < 0.05$). The study results also supported that reading a contiguous scan enhanced the students' comprehension of anatomy. The "Look Ahead" technique used in the study by Huang et al., allowed students to view the images prior to making their own observations and conclusions, in contrast to the current passive learning where students merely observed a preceptor interpreting imaging study. The "Look Ahead" technique was identified with statistically significant increased student reported interest, engagement with the case, educational value of the experience and memorability of the case in comparison to the current standard. In another study (Singh et al., 2019) the topics in radiology were split into two. The first part was taught using innovative methods and the second part was taught by the conventional lecture method. Irrespective of the teaching methods, the students' knowledge and interpretive skills were enhanced. However, when the innovative teaching method was in use, the increase in scores for interpretive skills was higher and statistically significant. However, the study failed to conduct an assessment on the surveys in regard to the students' satisfaction of the different teaching methods. Soman et al. Compared medical students' impression of learning from StudentPACS modules with their personal experience of learning radiology from textbooks or static images. Out of the 285 students, 257 of them found StudentPACS modules to be either equivalent or better than learning from static images or textbooks. Similarly in the study by Rengier et al., students agreed that the integrated hands-on approach course had additional benefits as opposed to the traditional course. The accordance was higher among the first-year medical students compared to the second-year students. In the study by Qin et al., the Smart-Class group incorporated practice based-learning using PACS display workstations and DICOM viewer. The Smart-Class group achieved a higher mean quiz score ($p < 0.001$) than the Traditional group. 98.2% of the Smart-Class group preferred DICOM image viewer over JPEG images as a learning tool, and 50.9% of the traditional group agreed with the Smart-Class group on the same learning tool.

4.4 Discussion

Studying radiology and anatomy through lectures and static images can be helpful in recalling information and teaching basic imaging skills. However, reading textbooks and listening to lectures are passive forms of learning. Although it still allows for retention of knowledge, simulating an experience or participating in discussions allows for active learning (Bernardo & Malinowski, 2005). This helps in improving learning effectiveness and one example of this would be the implementation of PACS training. Although there have been studies conducted that evaluate the effectiveness of PACS training, there has been no systematic review conducted on it. Hence this review assessed the impact of implementing PACS training on trainees.

The effectiveness of PACS training can be assessed using the Sloan Consortium pillars of quality education which includes access, student and faculty satisfaction, learning effectiveness and cost (Moore, 2005). The hospital and seasonality of cases can influence the types of cases trainees get to see (Bernardo & Malinowski, 2005). With access to patient's cases in PACS, trainees can view and learn from case types that they might not have been exposed to during their clinical rotations. PACS as a form of medical media can also directly guide the learning effectiveness as it accommodates to the various learning styles of students as well as facilitating active learning (Bernardo & Malinowski, 2005). Access and learning effectiveness can contribute to student satisfaction as proven by the results of this review.

PACS training is also able to simulate real life situations and make the trainees feel like healthcare professionals. This allows the trainees to analyse the situation, think critically and form differential diagnosis. Not only does it allow for the trainees to problem solve, but also understand the whole PACS as they utilise the various functions of it. This form of a learning environment helps to trigger and maintain interest, by simulating the trainees to self-generate questions for a better understanding of the situation as well as acquiring and organising their newfound knowledge of the topic (Renninger & Hidi, 2016). With the new knowledge and critical thinking skills gained, trainees can adapt to and tackle challenging situations (Almeida & Franco, 2011).

The emergence of COVID-19 pandemic has also taught us the importance of the need for online teaching tools. With the cancellations of clinicals, schools have had to restructure their curriculum to ensure that students are still able to experience and gain the necessary knowledge. By utilising PACS as an online learning and teaching tool, it prompts the construction of meaningful and engaging remote learning. It is also easily accessible as the students only need to be connected to the internet to be able to review cases on PACS. With the rapid expansion of medical knowledge and introduction of new technology, it is crucial for HCP to keep their medical and clinical knowledge and skills up to date to be able to care for their patients effectively (Tagawa, 2008). This requires life-long learning and institutions should provide opportunities to foster self-directed learning through various avenues such as motivation and problem-solving skills.

When implementing PACS training, one of the concerns that instructors had was that trainees would be distracted due to the computers. As the computers are connected to wireless networks, it's possible for trainees to access the web, distracting them from their work. However, in the study by Koestner et al., most of the instructors (67%) did not observe increased distraction of the students due to the computers, while 33% of the instructors were undecided. Instructors mostly have access to a master computer where they can view the trainees' computer screens and therefore be able to monitor the computer usage.

4.4.1 Strengths and Limitations

This review is the first of its kind to report on the impact of implementing PACS training on trainees. This review includes articles from various countries allowing for more diverse results. The results obtained from the various studies support the conclusion that PACS training has a positive impact on trainees. However, some of the limitations are the small sample sizes and biases stated in the studies. Databases such as ScienceDirect and Google Scholar were not used due to keyword restrictions, and only studies in English were used in this review. This may have resulted in possible relevant studies being missed out. Finally, there were no published systematic reviews on PACS training on trainees that we could compare our results with.

4.4.2 Future Considerations

The studies in this paper mainly consisted of medical students, residents, and nursing students. Future research could be conducted on allied health students in radiography, physiotherapy, and occupational therapy as a varied sample population would provide a more valuable dataset. An initial study can be conducted using two research method designs; quantitative test and an interview. Researchers could consider inviting SIT Year two DR students, who have learnt the foundation of RPACS in their module, to participate in the study after their clinical placement in Trimester 2. Data collected could be helpful in evaluating the extent of student's knowledge on PACS in a clinical setting and achieving a more in-depth understanding of their perspectives on learning PACS respectively. Further studies can be carried out using the various allied health students under SIT. Local studies conducted would also help us to understand the student's satisfaction and views on PACS training, allowing institutions to find ways to improve and provide the best learning environment for the students.

Currently in SIT, only diagnostic radiography students have hands-on experience using PACS within the university during their second year. In the future, exposing radiation therapy students to PACS should also be considered. Radiation therapy is an image-based treatment, and radiation therapists must constantly review images during a patient's treatment delivery as well as when planning the treatment (Law & Huang, 2003). By exposing PACS to the students, they can familiarise themselves with the workspace as well as the images before their clinical attachments, allowing them to feel more confident and prepared as seen by the results of this review.

4.5 Conclusion

This systematic review highlights the following themes which seem to be necessary for the success of PACS training: Self-efficacy, Skills of Inquiry, Interest and Motivation, Application to clinical practice, Radiological Science and Technology and Utility of PACS. Overall, positive feedbacks were received from the shortlisted studies. The trainees demonstrated an increased level of self-confidence and critical thinking skills. They also found imaging content and processes and PACS knowledge useful for their clinical practice, showing high interest in their training. Furthermore, trainees were also satisfied with the features and interface of the PACS, as it aided them in their understanding of difficult materials and improved their work efficiency. These findings suggest that implementing PACS would be effective, and institutions should consider implementing PACS training as part of their medical curriculum.

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Chapter 5
An Applied Research Impact Case: U-Trap Refill Design for Preventing Transmission of COVID-19 and Other Infectious Diseases

Benson K. H. Hung and Kelvin K. T. To

Abstract COVID-19 has sparked a rise in creative inventions to help people adjust to the new normal. To reduce the risk of coronavirus spreading from entering the indoor areas through drainage pipes, a team from the Engineering Discipline of the Hong Kong Institute of Vocational Education has developed the U-trap Refill Automator to assist residents in monitoring the water level in common U-shaped trap drainage pipes while refilling water automatically when the water contained in the U-trap is insufficient. The practice of research-led teaching and research-informed teaching for the benefits of students is substantial in the project. The team practices research-led teaching by sharing the relevant research findings with colleagues and encouraging critique. On the other hand, the research-informed teaching is actualized by the relevant professional development, constructive feedback and guided design. The project is an interplay between research and teaching in that building synergies between research and teaching should be a central element of excellence.

Keywords Applied research · Building drainage · U-traps · Drain outlets · Floor drain · COVID-19

5.1 Introduction

During the 2002–2004 SARS outbreak and 2020 COVID-19 pandemic, there have been virus outbreaks in the same building confirmed or speculated to be spread through droplets through dried up U-shaped drainage pipes (U-Trap) (Yu et al.,

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2004). U-traps or drain outlets serve to stop foul odour and unhygienic substances, including bacteria and viruses, in the drainage system from entering living areas. Defective or dried U-traps could negate this important function. Typically, U-trap is used to connect each sanitary fitment to ensure enough level of water remains in the trap as a "water seal" to block foul air from the stack. Traps filled with water are generally used to act as seals for most sanitary fitments to avoid contaminated aerosol and foul air from the main stack entering the occupied space.

Fears surfaced that the new coronavirus could mimic the 2003 SARS outbreak by spreading through U-traps in building drainage systems, collaboration across multiple perspectives enhances the potential for innovative solutions to the complex issues of our time. Rather than focusing exclusively on an existing engineering subfield such as Biomedical, Civil, Environmental, Electrical, Computer, or Mechanical Engineering, the interdisciplinary approach arose to further knowledge production and problem-solving with broad flexibility and a student-centred focus.

Grounded on a solid foundation of Vocational and Professional Education and Training (VPET) with integrating knowledge and skills across multiple disciplines, this interdisciplinary project team has initiated a project of inventing a U-trap Refill Automator, an automatic watering device installed at the outlets of floor or wall drain that could monitor the water level inside the U-trap while refilling water automatically or according to a pre-defined schedule to make sure the water contained in the U-trap is was sufficient to create a the water seal. The device has been specifically designed with integrated skills and knowledge from relevant academic domains. With an aim to prepare our students for a future of dynamic change, the applied research learning experience engaged all the senses allowing students to create a meaningful, useful, shared outcome.

5.2 Literature Review

Higher education faces the challenge of preparing future professionals to search for solutions that promote multidimensionality through collaboration and an interdisciplinary outlook to respond to society's increasingly complex problems. To a certain extent, real-life engineering projects are in interdisciplinary nature that does not work in silos. As Ledford (2015) argues we must "bring people with different kinds of skills and expertise together. No one has everything that's needed". Without exception, engineers are expected to work with people with different disciplinary knowledge to solve real-world problems that are inherently complex. This is one of the reasons that interdisciplinary learning has become a common pedagogical practice in engineering education (Hsu, 2015). A growing number of scientific papers have been published outlining university teaching projects and experiences based on an interdisciplinary approach (Klaassen, 2018; Power et al., 2019). For a sustainable development in the university context to enhance people lives and advance sustainable development, it is necessary to adopt an interdisciplinary approach in education (UNESCO, 2014).

In a review of the literature on the development of interdisciplinary thinking in higher education, Spelt et al. (2009) put forward the hypothesis that a positive relationship between certain conditions including (a) students' motivation and maturity; (b) the degree of interdisciplinarity; (c) the collaboration among the teaching team; and (d) the conditions of the interdisciplinary learning process. Additionally, the implementation of innovative processes and products is dependent on the development and execution of entrepreneurial strategies (Mars, 2013). Adopting interdisciplinary approach can enrich the general educational experience that involves linking different disciplines together and creating faculty and student teams. Many studies (DeZure, 2010; Domik & Fischer, 2010; Fraser & Greenhalgh, 2001; Klein, 2008; Little & Hoel, 2011) have highlighted the need for learning, teaching, and education to stay close to the problems of the real world when designing interdisciplinary learning activities in higher education. Little and Hoel (2011) have also highlighted how participating in interdisciplinary teaching–learning groups encourages the adoption of a more interdisciplinary outlook, which goes beyond one's own discipline and acknowledges the contribution made by other disciplines to the resolution of the problem at hand. According to Woods (2007), all members of the group should participate actively and tackle real-world problems through experiences based on interdisciplinary collaboration with maximized interdisciplinary communication. Levy et al. (2017) also stress the importance for higher education to include more learning activities that designed to foster interdisciplinary thinking and collaboration. In this research, to enhance the quality of project implementation, the project incorporated suggestions from the literature in order to encourage cooperation and interdisciplinary learning.

5.3 Background

Cases of the COVID-19 pandemic have been developed in some of aged buildings due to suspected reasons of drying out of U-trap. The Centre for Health Protection of Hong Kong SAR Government have had recommended building residents to pour half a litre of water into each drain outlet weekly to block the virus or bacteria spreading from entering the indoor areas in the form of droplets through drainage pipes. Moreover, a full-scale study of positive pressure profiles in drainage stacks was carried out by The Hong Kong Polytechnic University (Wong et al., 2008) after the SARS outbreak of 2003. The study result showed that the pressure of drainage stack fluctuated from negative pressure from higher floors and induced positive pressure to lower floors when water was flushed from higher levels.

According to the HKSAR Government, U-shaped water traps must be filled with water to prevent dried traps and thus make it possible for the disease to spread. For an instance, water must be poured into the U-traps of drain outlets at least once per week in residential flats to reduce the risk of virus spreading through drainage pipes. Different academic departments (i.e. Department of Construction of IVE (Tsing Yi), Department of Engineering of IVE (Sha Tin), and Foundation Engineering programme of IVE (Kwai Chung)) were engaged. Students were asked to combine their creativity with technology in the enhanced design for the users, especially the elderly and the people with disabilities.

5.4 The Current Statutory Requirements

Building Regulation Chapter 123I (Standards of Sanitary Fitments, Plumbing, Drainage Works and Latrines) Section 25(1) (Cap123I, 1997) requires that, "every waste fitment shall be provided immediately under the fitment with a suitable trap". In addition, Section 25(2) states that, "every trap provided for a waste fitment shall havea water seal of not less than 40 mm" and Section 25(3) states that "where the waste pipe from a waste fitment is, under the provisions of regulation 12(3), connected to a soil pipe, the trap provided for the waste fitment shall have a water seal of not less than 80 mm".

5.5 Research Plan and Methodology

To a certain extent, real-life engineering projects are practical challenges with a question dynamic leading from applied issues to fundamental ones. The study explored the different ways that engineering students experience applied research based on a real-life engineering project. There were five proposed phases to actualize the applied research into tangible deliverables.

Phase 1: Preparation and Basic Research

This stage involved carrying out desk studies, reviews of relevant statutory regulations and code of practices, and interviews with users for the input of suitable requirements. Different technologies were examined and was checked with Hong Kong's unique environment. Next the brief introduction of the research was shown, and the findings we got were used in the development respectively.

Phase 2: Formalization of Prototype

Based on the information obtained, we can form a conceptual design of a device with a self-refilling function for U-trap. According to pre-set criteria, the trials in laboratory were done to visualize the final design.

Phase 3: Prototype Development

The Generation I aimed to provide automatic water refilling function and using ultrasonic sensor for water level detection in the U-trap. Generation II prototype that can fit both floor drain and wall drain, enhanced with timer, alert and remote control functions over internet which can be configured via Mobile App and was introduced in real in the prototype. Generation II prototype with extra-large water tank was also produced to significantly reduce the number of times for in refilling water for the water tank.

Phase 4: Perform Testing

Additional testing studies were planned for the prototype to improve configurations and to make the device more useful with users' suggestions. Testing in real tenants' houses was conducted to receive more feedback.

Phase 5: Present and Release Results

This is to present and release results to public and related parties. The prototype may also be further applied to other scopes and locations with minor changes. Fine-tuning of the device has been done in this phase and it is recommended to analyse the results obtained from Phase 4 to conclude any behavioural changes or so.

5.6 Motivation

The drying of the water traps of the floor drains was not uncommon as the water traps may only have been filled by water from floor washing or the overflow from washbasins or sinks. Since the SARS outbreak, the possible cause of the infection via a vertical drainage stack has attracted the attention of the building industry to improve the existing design practice of the building drainage system.

The site installation for tenants/owners from the Urban Renewal Authority (URA) had been started since November 2021. The first batch of production (2000 units) was completed and had been distributed to URA's tenants for free. Tenants of four rehousing buildings were benefited from the donation (660 units), including (a) 12 Soy Street, (b) Shun Sing Mansion, (c) Bedford Tower, and (d) Rich Building. Owners/tenants of two acquisition units were benefited from the donation (700 units), including (a) Wing Kwong Street/Sung On Street, and (b) Kai Tak road / Sa Po Road. The device was equipped with an ultrasonic sensor to detect the water level in U-traps. When the water level falls too low, the device's injection valve will open and release water into pipes. A water seal is then formed to block any viruses from entering the home as shown in Fig. 5.1. Furthermore, the modifications and the future applications of IoT were in line with the preliminary designs and the team built multiple

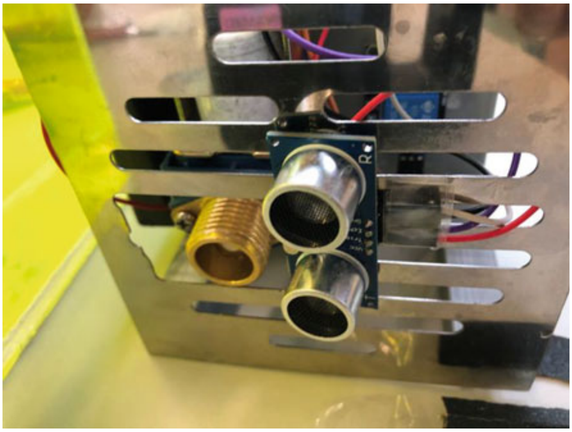

Fig. 5.1 The "U-trap refill automator" can sense when water level within U-trap in the pipes get too low, sending a signal to the device to inject water into the system

prototypes with the added functionalities and attained multiple field tests at site with satisfactory results to explore the possibility to develop the device into next version to incorporate more sensors and Internet-of-Things functionalities.

5.7 Results

Research Implications: Anti-virus Drainage Improvement Designs

Over 20 different drainage configurations were proposed by different professionals in the building industry and were tested in the laboratory including the Hong Kong Institution of Engineers (HKIE, 2003), the Department of Building and Construction at the City University of Hong Kong. The qualitative results of the experiments (Yuen et al., 2003) provided information for the modification of the drainage configuration so that the water trap of the floor trap can be replenished when using the connected waste fitment and the design of the configuration can include the prevention of foam flooding in the case of draining the detergent dosed waste water. However, every change of design parameter (such as the length of the pipe, pipe inclination, and the design of the water trap) requires substantial demolition and installation work of the test setup. This not only increases the cost of the entire investigation but also lengthens the period of the experiment. On the other hand, the U-trap Refill Automator has several advantages as the followings:

- High adaptability: an anti-siphon valve is a standard part and its application is subject to the site environment. The adaptability of the valve depends on the site environment. U-trap Refill Automator has no this shortcoming.
- High reliability: (1) the inflow volume is certain and (2) comparing to other passive designs, this device is an active design with an ensured water-seal.

Fig. 5.2 By adding a new attachment to the original design, the upgraded device can be fitted to both floor and wall drains

- High controllability: (1) a timer is used as a powerful backup to keep the water level sufficient and (2) 24/7 monitoring with its ultrasonic detection.

To ensure that water is regularly filling into the u-traps, the "U-trap Refill Automator" was invented with the following functions as shown in Fig. 5.2:

(a) Water level detection of the U-trap and automatically refill water to the desired level;
(b) Memory function to save the current or any water level as the desired water level with one press of the button;
(c) Timer mode enabling user to set schedule in refilling the U-trap daily, weekly or monthly, capable to fit to drain where water level cannot be detected by the sensor such as vertical drain;
(d) Alert notifications to users when the water level of the reservoir or the U-trap is low through Mobile Applications, Instant Messaging and Email; and
(e) Mobile App for desired water level configuration, sensor readings and remote control of the U-trap Refill Automator operation.

Particularly, the Automator has two generations. The Generation I prototype is equipped with an automatic water refilling function and it uses an ultrasonic sensor for water level detection in the U-trap. The Generation II prototype developed can fit both floor drain and wall drain. Compared with the previous generation, the Generation II Automator is enhanced with timer, alert and remote-control functions which can be configured via a Mobile App. To further reduce the number of times in refilling water for the water tank, there is also a modified version of Generation II with an extra-large water tank to enhance user experience. These three prototypes (i.e. Generation I, Generation II, and Generation II with an extra-large water tank) developed have been tested in a flat unit of the URA located at Kai Tak.

Practical Implications: Technology Transfer and Commercialisation

The research results provide practical guidance for the design of future housing to enhance health and comfort of occupants. The U-trap Refill Automator comprises five major components: a water tank, a water valve, a battery pack, an ultrasonic sensor and a microcontroller (MCU). Water is stored in the integrated water tank and to be dispensed through the water valve to the drain outlet. The battery pack provides power to operate the valve as well as to the electronic circuitry and components in the Automator. The ultrasonic sensor is used to detect the water level in the U-trap and send the information to the microcontroller. The microcontroller is connected to the water valve through a driver circuit board, which can control the valve to be open or closed hence controlling the dispensing of water stored in the water tank into drainage pipes. The Automator can be controlled through a push button installed on it or through a smartphone app with Wi-Fi connection. Three are three ways to control the valve for water dispensing:

- Auto-mode: Ultrasonic detection of the water level in the U-trap enables to automatically refill water to the desired level. When the water level is low, water will be dispensed from the water tank. When the desired level is reached, the microcontroller closes the valve and stop water from dispensing. The desired water level can be set via the push button switch or defined by the user via the smartphone app.
- Timer-mode: Half a litre of water can be dispensed according to a schedule. The smartphone app enables the user to set the schedule in refilling the U-trap daily, weekly or monthly.
- Manual-mode: Half a litre of water can be dispensed manually through the push button switch or through the smartphone app.

Figure 5.3 is a line diagram of the U-Trap Refill Automator and the technical specifications are listed as the followings:

- Water tank volume: from 700 mL to 2.5 L
- Dimensions: 120 mm × 120 mm × 170 mm
- Sensor range: 20 mm to 3 m
- Connectivity: Wi-Fi (for remote control and app connection)
- Batteries: Lithium Ion

Moreover, Fig. 5.4 is the system design diagram of the U-Trap Refill Automator and the corresponding features of different parts of the device are listed as below:

- Water Tank: For water storage
- Water Valve: To allow water dispensing
- Battery Pack: To provide power to the electronics components and valve
- Button A: Multi-purpose push button to allow mode switching, manual water dispensing and desired water level configuration
- LED: Status LED to display status of the device
- MCU: Microcontroller for valve control and device configuration
- Driver board: For power moderation and connections between the MCU, valve and ultrasonic sensor

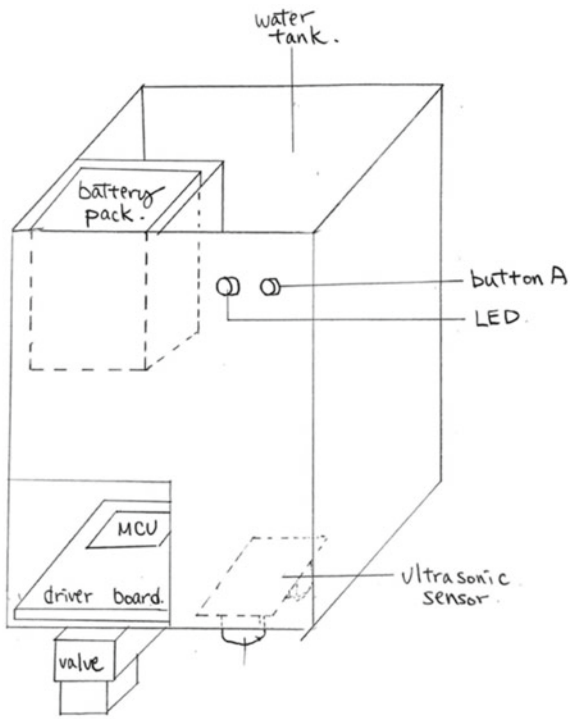

Fig. 5.3 The line diagram of the U-trap refill automator

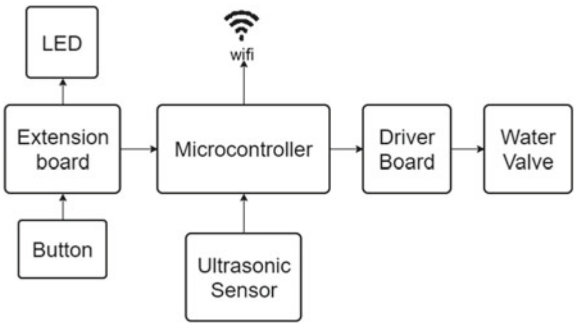

Fig. 5.4 A system design diagram of the U-trap refill automator

Educational Implications: Interdisciplinary Learning and Research-led Teaching

As a collaborator, we strongly believe in facilitating student learning through the creation of an engaging and supportive learning environment. A further core value underpinning our teaching philosophy is interplay between research and teaching in that building synergies between research and teaching should be a central element of excellence. We practice research-led teaching by sharing our relevant research findings with colleagues and encouraging critique. On the other hand, our research-informed teaching is actualized by the relevant professional development, constructive feedback and guided design.

This paper reported the “U-trap Refill Automator” project developed to promote applied research learning experience that combined students from the Civil Engineering, Computer and Electronic Engineering and Foundation Engineering programmes and related to its effects in the development of engineering students’ skills. Specifically, the learning and teaching was carefully curated from different engineering disciplines across the campuses. The three disciplines worked on the basis that their discipline was equal in importance to the project.

The project is consistent with the VTC’s objectives to enrich students with meaningful and deep learning experiences and enhances the student experience of real-world issues. This project can also intensify the council’s capability in applied researches and develop council staff’s expertise in the specific study areas. The benefits of the project are twofold. Firstly, the project provides an opportunity for students to experience meaningful and deep learning while sharpening various twenty-first century skills. By actively tackling real-world issues, students have greater retention of content knowledge and are better able to apply what they know to new situations in future. Secondly, this project enhances VTC’s capability in conducting applied research, develops staff’s expertise in specific technical areas and ultimately ensures that teaching is up-to-date and that students are being exposed to cutting edge technologies.

5.8 Conclusion

The practice of research-led teaching and research-informed teaching for the benefits of students is substantial in the project. The team practices research-led teaching by sharing the relevant research findings with colleagues and encouraging critique. On the other hand, the research-informed teaching is actualized by the relevant professional development, constructive feedback and guided design. The project is an interplay between research and teaching in that building synergies between research and teaching should be a central element of excellence.

Worth mentioning, this project had a robust partnership with the industry in building students’ competencies in technical education. URA adopted and provided the device freely to those occupied units in their acquired properties and rehousing blocks. The authority developed the students’ prototype into a product with a reasonable scale of production for the said purpose. Moreover, the team was able to further modify the design with assistance from the authority which provided professional advice and residential units for conducting trials. The device has been progressed to the second-generation and there were newly installed IoT components that can provide status-check and push notifications on a mobile application. The current solution overcame one of its biggest challenges with a design that could fit floor and wall drains, two common drain outlet designs in Hong Kong buildings, of all shapes and sizes. The engineering team is now preparing to test the device in some older buildings as well as shopping malls. We hope the industry will take notice of the design and take it to the next level and roll it out to the mass market.

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Kelvin K. T. To assisted in developing a driving simulator in order to train MTR drivers for the South Island Line (East), Shatin to Central Link (East-west Line) and Shatin to Central Link (North-south Line) in Hong Kong. He has played a leadership role in supervising five team members in Virtual Reality-based Simulation Training Project Office at the VTC.He has managed to provide planning and scheduling, system design, materials procurement and equipment selection in both projects. He has also developed technical instructions for system set-up and installation activities in order to suit the needs of various stakeholders.

Chapter 6
Co-Presence of Readiness-To-Hand & Presence-At-Hand as the Shape of Things by Revisiting Technology-Aided Learning from the Heideggerian Perspective

Hok-Yin Jeff Lau

Abstract In everyday technology-aided learning, students as Dasein are embedded in equipmentally oriented world with useful and serviceable physical and abstract technology as ready-to-hand for the sake of fulfilling their education needs, while experiencing counterparts as present-at-hand due to (1) technical problems such as system breakdowns, dilapidation or physical damage, and (2) non-technical counterparts such as contents with calculable quantities and relationships in the informationalized world to be theoretically and critically examined. This article analyses the co-presence of the ready-to-hand and present-at-hand modes in learning contexts in sequential and simultaneous ways. Sequentially, the two modes of an technological thing oscillate frequently due to students' strong familiarity with the use and due to contents of calculable quantities and relationships that reinforce calculative thought. Simultaneously, one technology can be primordially used as ready-to-hand with intense familiarity and proficiency to support the theoretical and critical examination of the other technology as present-at-hand (149 words).

Keywords Dasein · Technology-aided learning · Readiness-to-hand · Presence-at-hand · Technological problems · Non-technological problems

6.1 Introduction

In the era of information technology, it is a common scene that learners of today utilize technology to aid their learning. Research of today analyses this phenomenon from social, pedagogical, technological perspectives and so on. However, learners' technology-based learning experience is relatively less analysed from an existential perspective, which is mostly characterized by a German philosopher, Martin Heidegger, whose philosophy, where he explored and questioned the fundamental features and structures of human beings' existence (human being's Being). Humans'

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existential features and structures are fundamental to every human's lived activity in the world, including students' learning by use of technology. Learners' learning experience by utilizing technology can well be explained from the Heideggerian existential experience to expose readers to the most basic and fundamental existential states connected to the world. What this paper would like to discuss is learners' experience of technology-aided learning by leveraging Heideggerian concepts of readiness-to-hand and presence-at-hand, which are related to a person's daily manner of treating daily items and equipment, especially technology, to reflect humans' existential features in their learning activities. Furthermore, through the discussion over readiness-to-hand and presence-at-hand, this paper would also like to justify two ways (sequential and simultaneous) of co-presence of readiness-to-hand and presence-at-hand in dealing with technology in students' learning. The justifications of the co-presence of readiness-to-hand and presence-at-hand in the contexts of technology-aided learning are considered as the shape of things of critically reviewing and revisiting learners' experience of conducting technology-aided learning.

6.2 Existence of Human Beings as Dasein, Being-There, Being-In-The-World

6.2.1 Human Beings' Existence as Dasein (Being There in the World)

Human beings' existence is characterized as Dasein, which is a German term that denotes human beings' "being-there"[1]in the world, which can be questioned by asking oneself "*why am I here, but not inexistent*?". Such an inquiry into the facticity can be conducted by investigating the nature of existence from human beings' "*realm of average everyday experience*"[2] (Anowai & Chukwujekwu, 2019: 1; Lawhead, 2002: 536). It is because by reviewing human beings' average everyday experience with full absorption and subliminal immersion in humans' daily routines and activities[3] Dasein's existential states can be displayed. Dasein's existential states with its absorption and immersion in its own daily world life implies Dasein's constant

[1] Dasein is used as a technical term designed by Heidegger himself to represent human Being, literally translated as "*Being there*" from German to English (Anowai & Chukwujekwu, 2019: 1; Schmidt, 2006: 51); Being-there is to be in the world, which is the most fundamental Dasein's mode of existence.

[2] Average everyday experience: a kind of experience that Heidegger emphasizes most with reference to our usual and subliminal living experience, a primordial experience before viewing any phenomenon of Subject-Object dichotomy where we hold our own Subject position to view in opposition to an Object phenomenon outside of us (Schmidt, 2006: 51).

[3] Daily routines and activities as usual as *walking to school* by students, *greeting superiors* by employees and *cooking food* by cooks, which are conducted practically rather than observed from a scientific and theoretical perspective.

and inextricable connection to and situatedness in its world where Dasein carries out its daily routines subliminally and naturally to have interaction with the world and responses to the world (Schmidt, 2006: 53).

6.2.2 Understanding and Affectedness by the World

Understanding is an essential element to constitute Dasein as Being-in-the-world. Without human beings' daily understanding, their Being-in-the-world and interaction with the world are impossible. Therefore, "*Understanding of being is itself a definite characteristic of Dasein's Being*" (Heidegger, 1962a, 1962b: 34/12). By understanding, Heidegger does not mean the efforted, critical and theoretical understanding of a topic, an issue, or a question to be tackled, which requires mental burden, energy, full attention and consciousness (Schmidt, 2006: 63; Stefani & Cruz, 2019: 118), but the more fundamental subliminal and primordial understanding, which is our everyday understanding, invariably "*a non-stopping flow of understanding*" (Stefani & Cruz, 2019: 118), and which is close to unavoidably constant awareness of *something* all the time whenever a person is alive in the world; This is the most fundamental understanding that "*concerns the whole fundamental constitution of being-in-the-world*"[4] (Heidegger, 1996: 135); this can be experienced in a way that "*I am alive to understand the things in front of me*!" For instance, when a person sees a door handle, s/he immediately and subliminally understands a wide range of meanings from the door handle, including its colours, size, functions and so on. All these subtle meanings flow to the person who understands and perceives the door at the moment.

As Dasein is situated in the world, we are having everyday understanding which leads us to be affected and thus to have a distinctive state of mind at every moment — affectedness by the world. The rationale can be interpreted in the way that the moment Dasein understands, it finds itself existing in the world "*shaped by history and culture*" (Zovko, 2020: 3) where it understands world matters which have happened, are happening or are predicted to be happening in the future. Dasein's understanding and interpretation of wide-ranging messages, positive, neutral or negative, which enter Dasein's perception, affect Dasein's moods and states of mind, and thus human beings as Dasein are *mooded* beings (Elpidorou & Freeman, 2015: 661). The way Dasein carries incessant understanding as an existential structure is the way to cause Dasein to be emotionally affected by the world one way or another and to constitute Dasein's different states of mind at every moment along the flow of time (Elpidorou & Freeman, 2015: 664). By this, we can plausibly see the Dasein-world interconnectedness and affectedness (Elpidorou & Freeman, 2015: 668) and justify Heidegger's

[4] This is the understanding prior to and more fundamental to all other/later thematic/ theoretical understanding tasks to examine an external object entity, which is the present-at-hand understanding — a derivative of the primary primordial understanding (which will be discussed in below sections), as in "A derived from/ based on B" pattern (Heidegger, 1996: 134).

philosophy that "*In hermeneutics, what is developed for Dasein is a possibility of its becoming and being for itself in the manner of an understanding of itself*" (Heidegger, 1999: 11); that is, in the manner of understanding, Dasein is a possibility of becoming itself at every moment with a certain state of mind and mood in response to the world.

6.2.3 Openness and Being-Possible Towards the World

In such an ongoing existential line of being ahead of itself in the face of world matters at every moment, Dasein rides on the constant flow of time such that because Dasein's existence at present constantly precedes its' just-past moment, and Dasein is having understanding of the current and then world matters happening to Dasein itself (Schmidt, 2006: 56, 63). Being affected by the world, Dasein's moods and states of mind vary from time to time slightly or conspicuously so that the changes of emotions and states of mind due to recurring understanding of countless messages of the world motivate Dasein to respond to the world. With understanding active constantly, in response to every worldly situation at every moment, proximally and for the most part, Dasein selects a decision from a set of possibilities of being itself to comport itself to the just next-moment of the world repeatedly and endlessly, and thus Dasein is Being-possible (Schmidt, 2006: 55; Stefani & Cruz, 2019). For instance, at the moment, Dasein is Being-possible to react to the world in different ways, which can be as subtle as a change of a facial expression in response to the just delightful story telling or can be as conspicuous as a behavior in response to an attack from someone else. They are the possibilities for Dasein to comport itself towards the world at every moment, due to Dasein's effective understanding of what has happened and what is happening (Schmidt, 2006: 56, 63). For instance, the current understanding of the danger of a fire in a house allows for openness to a set of possibilities, with one chosen as running away from the dangerous scene.

For this, the introduction of a chosen possibility from a group of possibilities in response to the world is interpreted as *openness* (Stefani & Cruz, 2019: 118). Perhaps we can interpret *openness* in two ways due to practical and primordial understanding[5]; for one, human beings' fundamental understanding renders Dasein's states of mind affected by the world, and this is *openness* to affectedness,[6] and for the other, this is the introduction of a picked possibility to react to the affectedness by the world, and this is *openness* to possibilities.[7] The two types of *openness* must

[5] The relationship between understanding and openness is attested in: "*Thus, understanding becomes, also, openness to possibilities, a constitutive movement that happens within time*" (Stefani & Cruz, 2019: 118).

[6] This is attested in: "*This openness …… is an affective disposition, one of the existential structures of Dasein. This shows that understanding is always an affective understanding – something that …… affects us as soon as this something becomes visible*" (Stefani & Cruz, 2019: 119).

[7] This is attested in: "*The openness to possibilities is the constitutive openness of understanding that …… is the proper condition for Dasein to project itself as possibilities*" (Stefani & Cruz, 2019: 119).

be realized in Dasein's basic existential mode — Being-in-the-world —, because a person by no means selects a possibility alone at a time along the flow of time towards the constant future alone without situating him/herself in the world where s/he is essentially and invariably responding to and dealing with "*the world* …… [of] *our horizon of meaning*" (Stefani & Cruz, 2019: 128).

6.3 Experience of Using Technology as Ready-to-Hand for Learning

6.3.1 Understanding of Readiness-to-Hand in Primordial Context

In Dasein's average everydayness where Dasein is understanding messages from the world without reflections and critical thinking, Dasein is, proximally and for the most part, subliminally, "*tacitly*" and "*bodily*" engaged in the employment of things as ready-to-hand in Dasein's contextual situations of its pragmatic world, which is a project-oriented and "*equipmental world*" (Ihde, 2009: 33: O' Brien, 2014: 537). Readiness-to-hand is the mode of being of a useful thing, in which a thing shows itself to Dasein with meanings as a usable, useful, serviceable and functional tool (Heidegger, 1962a, 1962b: 97). When a thing assumes its useful significance in a particular situational context, a thing is seldom employed alone because a useful thing functions as a connective to other relevant tools as a structure of "*a reference of something to something*" (Schmidt, 2006: 64; Zovko, 2020: 3) in one meaningful world of one "*totality of references*" (Heidegger, 2010: 69). A thing being utilized must be situated "*in a ready-to-hand environment context of equipment……*" (Heidegger, 1962a, 1962b: 154), where a thing being available to be used in a particular effective way is in relation to and in collaboration with other things to serve human beings' needs. Heidegger's well-known example is that in a particular framework of referential totality, a hammer is not merely a hammer, but is used to strike a nail to build up a fence (Heidegger, 1977, 1977, 1962a, 1962b: 99). The functional relation (which Zovko (2020: 3) calls "*relational system*") between the hammer, the nail and the fence is interpreted as "*in-order-to-which*", while the fulfillment, achievements and accomplishments of human beings' purposes through the collaboration of functional things is understood as "*for-the-sake-of-which*", while Dasein primordially and subliminally takes the two processes for granted with absorption in the practical use without suspicion, doubt and reflection on the referencing, functions and locations of things (Schmidt, 2006: 65–66). This is attested in: "*The less we just stare at the thing called hammer and the more actively we use it, the more original our relation to it becomes and the more undisguisedly it is encountered as what it is, as a useful thing*" (Heidegger, 1996: 69).

With Dasein's practical implementation of things, the two processes (Zovko, 2020: 3), "*in-order-to-which*" between things and "*for-the-sake-of-which*" from things to

Dasein, constitute the meaningful and functional world as a "*totality of references*" to us (Heidegger, 1977, 1977, 1962a, 1962b: 99). The abovementioned primordial experience of primordially understanding the use of "*interrelated tools*" as ready-to-hand goes with Dasein's understanding of a useful thing, its functions, its relation to other things, and its capability to serve a user's purpose (Zovko, 2020). Primordially, Dasein is absorbed and immersed in the manner of using things as ready-to-hand under circumstances of referential totality, which mark Dasein existentially—"*we find ourselves*" (Zovko, 2020: 3) and where "*we understand ourselves, and within which we become who we are*" (Polt, 1999: 30).

6.3.2 Using Technology as Ready-to-Hand Among Learners

In this era of information technology, Dasein utilizes electronic gadgets and technological devices to deal with its daily learning issues. As a matter of fact, human beings' Being-in-the-world has already become Being-in-the-technological-world (which Zovko (2020: 7) calls "*the world of technological products*") with technological things "*of reflection and matters to which we devote care and concern*" (Zovko, 2020: 6). This endorses a view (Whitley & Introna, 1998) that the position of technology should be redefined from a merely Objection position to "*its relevance to our living world*" (Zovko, 2020: 2) with a "*socio-technical constitution*" (Harnesk & Thapa, 2016: 2). Nowadays, students integrate technology to their learning activities in their full average everydayness, taking for granted the use of technology as an essential part at their ready-to-hand disposal for their learning and relevance to their learning lives.[8]

Unlike physical items such as a hammer, a nail and a fence, technology is a thing, physical (i.e.: tablets, computers, electronic pens, etc.) or abstract (i.e.: images, Internet, browsers, etc.). The use of technology does not mean that the framework of referential totality of abstract things disappears or suspends. Instead, the framework of referential totality along with the operations of "*in-order-to-which*" and "*for-the-sake-of-which*" from technology to Dasein is effective since as Zovko (2020: 7) suggests, "*if the fundamental characteristic of hermeneutic understanding …… is its projective, future-oriented structure, the activity of understanding by means of …… implementation of the things of our experience can also be applied to the world of technological products, which are also a form of "availability" …… in the contemporary society*".

Regarding the use of physical technological things, a case in point is that students use an Apple Pencil (an electronic pen) to jot notes on the screen of their I-Pad (an electronic tablet), where an Apple Pencil and an I-Pad shares the relationship of "*in-order-to-which*" to be used *for the sake of* jotting notes from teachers during the

[8] This is attested in: "*Our everyday "being-in-the-world" would be unthinkable without the sophisticated products of technology familiar to us today, from cell phones to the worldwide web and cloud computing*" (Zovko, 2020: 8).

lessons. It is important to note that during the process of the connective use of the abovementioned abstract and physical technological things, students do not theoretically reflect on the use and examine the functions of each item and the relations to other items. The process of using the things is completely in students' full average everydayness and daily absorption in their lived world, where students' leveraging technology for their learning is due to the interconnectedness (Being-in-the-world) between themselves and the world, which is an "*equipmentally oriented world*" (O'Brien, 2014: 537) which extends meanings and values regarding the functions and usages of items to Dasein in an framework of totality interconnected.

A case in point regarding the use of abstract technology is that students make use of learning platforms such as Moodle or Blackboard to download materials and to submit their assignments. *For the sake of* submitting assignments, students click on a browser on the desktop, type keywords onto the search engine, click on a search result displayed, enter their student information to access the portal, click on a subject addressed on the portal page and an assignment submission box, and eventually drag a PDF file to the box and upload it to the system. It is plausible to suggest a series of use of abstract technological things from a browser and words typed to web pages, submission boxes and so on, in a connective manner of "*in-order-to-which*" to fulfill students' purpose of submitting assignments to the portal ("*for-the-sake-of-which*"), in the "*the way things show up in the flux of our everyday, pre-reflective activities*" (Guignon, 1993: 4). Abstract technology is applicable since things are not only "*tools, objects of use, cultural products, things of value and significance*" (McDaniel, 2013: 332), but also "*even a sign, or an environment*" (Puthussery, 2019: 33–34), which serves as "*in another sense, an issue very much in there, at any rate, a gathering*" to engage students (Latour, 2004: 233). Technology as ready-to-hand, though not always as tangible as physical tools, can be used directly and indirectly due to the fact that "*a new kind of "readiness-to-hand"* [of technology] …… *is gradually replacing that of our former mode of interaction with physical tools and objects of our mundane environment*" (Zovko, 2020: 10). Therefore, technology, physical or abstract, is utilized as ready-to-hand by students.

6.4 Experience of Treating Technology as Present-At-Hand for Learning

6.4.1 Understanding of Presence-At-Hand in Subject-Object-Dichotomous Context

Presence-at-hand refers to a mode of Being of a Thing which is (for temporary) not useful, serviceable and functional to Dasein, inappropriate (Dreyfus, 2001) and unfamiliar to users (Riemer & Johnston, 2014), and stands apart from the framework of referential totality of interrelation to other useful things in the primordial context (Harnesk & Thapa, 2016: 3). This leads to the suspension of the operations of "*in-order-to-which*" and "*for-the-sake-of-which*". The reason for the derivation of a present-at-hand Thing can be exemplified by the following case in point. For instance, while a person is using his/her toothbrush to brush his/her teeth in his/her primordial full average everydayness without theoretical reflections, critical examination and "*reflective observation*" (Harnesk & Thapa, 2016: 3), the toothbrush suddenly breaks because of different reasons such as excessive strength, being dilapidated and so on. At that time, the situation that the toothbrush stops being useful, serviceable and functional takes the person aback and by surprise – pulls and awakens him/her from the usual absorption and immersion in the full, primordial everydayness of using useful things. In such a context, the "*in-order-to-which*" between the broken toothbrush and a cup, toothpaste, and so on, stops operating, and thus so does the "*for-the-sake-of-which*" (*for the sake of* brushing the person's teeth). Such a situation requires the person to stare at the non-useful toothbrush, treating it as an external object outside of him/herself to scientifically and theoretically examine in a Subject-Object dichotomous way. The examination is conducted since the person may want to figure out the reason for its being broken, whether it can still be used to achieve the purpose of brushing the teeth, or whether it should be replaced with a new one.

With a Thing stopping being useful, serviceable and functional to Dasein, we may describe the Thing as a *problem* in our daily lives. To put it in the context of technology-aided learning, the following section will shed light on the possible types of technology-related problems to trigger off present-at-hand mode of Being of Things in students' learning.

6.4.2 Technical Problems of Technology & Non-technical Problems of Technology to Students

Dasein exposed to technology-aided learning is likely to encounter technology-related problems that stop Dasein from using useful things as ready-to-hand and render Dasein exposed to Things as present-at-hand treated as something external to be examined in a Subject-Object dichotomous way. The problems are generally divided into technical problems of technology and non-technical problems of technology.

6.4.2.1 Technical Problems of Technology to Students

Technological problems of technology include sudden breakdowns of equipment and various kinds of errors happening to equipment. A case in point is that while a student is using an Apple Pen and an I-Pad as ready-to-hand in a connective manner to write down important messages during the lesson, the Pen runs out of battery, the Pen breaks, or a situation that suddenly the internet and the Wi-Fi are suspended and disabled, which leads to a halt to students' use of the gadgets. For the above cases, students' smooth use of the gadget without reflection in the primordial framework of referential totality is suspended, since the gadgets (the Apple Pen and the I-Pad) are not useful, serviceable and functional to students, and the "*in-order-to-which*" relationship between the gadgets does not work. The gadgets are treated as present-at-hand as something external to be examined and reflected on in a Subject-Object dichotomous manner, since students need to solve the technical problems of technology so as to make full use of the tools to continue the study.

Students' encounter with technology as present-at-hand Things with technical problems can be through the three modes of presence-at-hand—"*the modes of conspicuousness, obtrusiveness and obstinacy which have the function of bringing to the fore the character of objective presence in what is at hand*" (Heidegger, 1996: 74). Firstly, obtrusiveness is a mode that characterizes the incomplete totality of technological things because of lack of necessary components in the "*in-order-to-which*" link of the referential totality of things[9] (Campbell, 2019: 1663; ibid.). For instance, the sudden disabling of Wi-Fi service renders Dasein unable to surf the Internet to conduct a series of online activities. Secondly, conspicuousness characterizes the emergence of current presence-at-hand of technological things as previously ready-to-hand[10] due to the higher frequency of experiencing presence-at-hand which announces itself to Dasein's consciousness and draws its attention (Campbell, 2019: 1662–1663). For instance, technical problems such as a sudden suspension of Wi-Fi service or running out of battery, which strip technological things of their usefulness and their equipmentality, draw students' attention and stimulate their consciousness. Thirdly, obstinacy characterizes circumstances that something unwelcome and unexpected "*stands in the way*" of students' use of technological things as ready-to-hand (Campbell, 2019: 1663; Heidegger, 1962a, 1962b: 103). The "*standing in*" hinders the use of things from marching towards "*for-the-sake-of-which*" (purpose fulfillment) as it "*still lies before us and calls for our attending to it*" (Campbell, 2019: 1663; Heidegger, 1962a, 1962b: 104).

The above three modes prevent students from being absorbed and immersed into their own primordial world with things being useful as ready-to-hand in students' everydayness, and students' attention to Things as present-at-hand requires themselves to conduct critical examinations of technical problems which become malfunctioning, unfamiliar and alien to students as Dasein (Dreyfus, 1991: 71). Under such a circumstance, students hold their Subject position to view the externalized technological Objects as scientific and thematic which are not useful for students' learning,

[9] This is attested in "*The more urgently we need what is missing, all the more obtrusive does that which is ready-to-hand become…It reveals itself as something just present-at-hand and no more, which cannot be budged without the thing that is missing…*" (Heidegger, 1962a, 1962b: 103).

[10] Presence-at-hand as a derivative mode of an entity that is objectively present to and observed by Dasein (Schmidt, 2006: 66). The reason for its derivative is that the most basic, primordial mode of a thing showing itself as useful Dasein in the world-hood is readiness-to-hand, and this is the initial stage occupying most part of one's life, upon which presence-at-hand of an entity becomes possible—derivative (which emerges from readiness-to-hand as more original and primordial) as in "A derived from/ based on B" pattern (Riemer & Johnston, 2014: 277). Simply put, *born* from readiness-to-hand, presence-at-hand is a derived examining mode of Subject-Object dichotomy.

as said by Heidegger (1962a, 1962b: 154): "*such 'Things' are encountered from out of a world in which they are ready-to-hand for Others—a world which is always mine too in advance*".

6.4.2.2 Non-Technical Problems of Technology to Students

Non-technical problems of technology should not be considered as the abovementioned recognizable technical breakdowns and errors, but be considered as intrinsic *features* of technology, which unavoidably constantly bring Dasein problems in the informationalized world (Christ, 2015: 63) and in this world of "*information and communication technolog*y" (Heesen et al., 2008: 1). One intrinsic feature is that when a student uses technology, "*both the things of reality and everyday phenomena are reduced to data and mathematical quantities* (*and processes to algorithms*)" (Christ, 2015: 63). Christ (2015: 63) also suggests that while people use technological devices, countless processes of "*calculable quantities and relationships*", figures, numerical units, statistical operations and so on, are involved in students' exposure to technology. This is also described as "*completely abstracted, perfectly calculated and ahistorical, a World without an Earth*" (Conway, 2016: 16). The effect is that "*calculative thought causes human "Dasein" to step out of the world, instrumentalizing it*" (Christ, 2015: 60). In students' technological world, while, admittedly, students finds it usual to be exposed to various technological and digital items on screen which serve as instruments to meet students' ends, students unavoidably undergo the processes of "*calculable quantities*", figures, statistics, analyses, theoretical and scientific examination, and so on. Moreover, in students' learning contexts, assignment tasks, quizzes, questions and tests on technology are equally present-at-hand objects to be observed, examined and analyzed.

6.4.3 Resolving a Paradox Between Readiness-To-Hand and Presence-At-Hand of Technology (Sequential Oscillation and Switch)

Students' putting technology in use in the ready-to-hand mode may seem to conflict with that in the present-at-hand mode. On the one hand, users treat abstract technological things as ready-to-hand such as the Internet, a Portal, a file, a system, a search engine and so on, in contextual practical use and at disposal in full average everydayness; on the other hand, the identical things being used as ready-to-hand can emerge as present-at-hand due to users' undergoing exposure to what Christ (2015: 63) mentions "*calculable quantities and relationships*" and students' tasks, quizzes, questions and so on, which require human consciousness, attention, theorization and examination. The paradox between readiness-to-hand and presence-at-hand of the same technological things can be explained with reference to "*experience variance*"

(Harnesk & Thapa, 2016: 2). Harman (2010: 3) suggests that "*all entities oscillate between these two separate modes: the cryptic withdrawal of readiness-to-hand and the explicit accessibility of present-at-hand*". The same technology being treated by students oscillates between its ready-to-hand mode and its present-at-hand mode. For instance, the process of students' assignment submission from exposure to a browser and a search engine, to, exposure to a portal, a log-in page, a submission box and so on, is highly familiar to students that these entities experienced are in the ready-to-hand mode overall; handling a log-in page is a ready-to-hand daily routine to students, but its present-at-hand mode occurs when students' attention is focused onto their log-in information and passwords (as "*calculable quantities and relationships*" (Christ, 2015: 63)). Another case in point is that while a double-sided toothpick breaks, its presence-at-hand emerges, taking the user by surprise. However, when the user discovers that another side of the toothpick can still be used, the whole toothpick becomes ready-to-hand again. Therefore, it is plausible to suggest that during the whole process, students' exposure to readiness-to-hand and that to presence-at-hand is highly frequently switched, depending on what they experience and on its familiarity. This is attested by Harman (2010) that "*experiences thus emerge in oscillation between these two separate modes of engagement because the actors have developed familiarity with pathways of action*".

6.5 (Simultaneous) Co-presence of Readiness-To-Hand and Presence-At-Hand to Students' Technology-Aided Learning Tasks

The above has discussed the sequential oscillation and switch between readiness-to-hand and presence-at-hand of technology. This section would like to justify the (simultaneous) co-presence between readiness-to-hand and presence-at-hand in technology-aided learning. Take the use of technology to tackle mathematical questions as an illustration. The primordial act of writing down solutions to a math question with the use of an Apple Pen and a tablet in an "*in-order-to-which*" connective fashion is in contrast to students' dealing with a math question displayed on the screen of the tablet as present-at-hand. The math question (*data and mathematical quantities* (*and processes to algorithms*) (Christ, 2015: 63)) displayed on the screen as present-at-hand is something to be treated with theoretical and scientific thinking and examination, which require much of the burden, energy and attention from students. However, to help students deal with the question as present-at-hand more smoothly and easily, making full use of technology as ready-to-hand as possible is suggested so that students can actualize the functions of technology by making full use of an electronic pen (physical technological things) to touch visuals such as "*eraser*", "*pen*", "*draw*", "*ruler*", "*comment*", "*calculation*", and so on (which are abstract technological things as ready-to-hand) on a touch-sensitive display screen to help tackle the math question. This is to emphasize that while using the above-mentioned things as ready-to-hand, students do not need to stare at them or figure out where to find the "*eraser*" function on the toolbar, but to accurately reach the approximate area where the function is. Most importantly, the relationship between readiness-to-hand and presence-at-hand is that the former can serve as a supporter to the latter. However, in case of experiencing technical problems of technology such as system breakdowns, broken physical structures and so on, the co-presence may not be effective. For instance, when an electronic tablet is running out of battery, not only are there no questions as present-at-hand to be tackled on the screen, the "*in-order-to-which*" with the electronic pen stops working. We can plausibly say that technical problems of technology can cause an abrupt halt to the use of technological gadgets involved and to the presentation of information.

6.6 Conclusion

For their learning, students as Dasein are situated and embedded in their "*equipmentally oriented world*" (O'Brien, 2014: 537), making use of both useful, serviceable and functional physical and abstract technology as ready-to-hand in the connective "*in-order-to-which*" fashion *for the sake of* fulfilling students' education needs, in their full average everydayness without theoretical reflection and critical examination. However, in the technological world, students as Dasein frequently experience technological items, physical and abstract, as present-at-hand out of their proximally and the most part of their average everydayness, due to technical problems and non-technical problems. The former includes system breakdowns, dilapidation, physical damage, disabling of Wi-Fi, and so on, as present-at-hand Things, which students have to consciously examine and theoretically solve. The latter in the informationalized world (Christ, 2015: 63) includes information and contents displayed from technology such as "*calculable quantities and relationships*", figures, and so on, are themselves the Things (non-technical problems) as present-at-hand, but which students do not as consciously address and examine as they do to technical problems of technology, but which they are unavoidably constantly exposed to by using their calculative thoughts. What this article emphasizes is the sequential and simultaneous co-presence of readiness-to-hand and presence-at-hand in a learning context. For the sequential one, the ready-to-hand mode and the present-at-hand mode of the identical technology oscillates and switches depending on the degree of students' familiarity with contents and information displayed at a time. For the simultaneous one, ready-to-hand mode of one technological thing is used with high familiarity, proficiency and mastery to tackle the present-at-hand mode of another technological Thing such as questions and exercises to be theoretically examined and critically solved. Both primordial experience and derived experience are available at the same time. Such findings can strongly be suggested as the shape of things of critically reviewing and revisiting learners' underlying experience of possessing technology-aided learning in the technological world. Such a critical review of the shape of things proposes that we view learners' learning experience not from a single perspective, but from the multiple perspective of the interaction between readiness-to-hand and presence-at-hand.

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Part II
Human Touch: Knowledge, Skills, Competencies and the Future of Education

Chapter 7
Modeling of Domain-Specific Competence Among Technicians (EQF 6) at Vocational Schools in Germany

Eberhard Huester and Michael Schaefer

Abstract The present study focuses on the structure of domain-specific competence among technicians at vocational schools. An article on the pretest of the study was published in 2022 (cf. Walker & Huester (2022). The structure of domain-specific competence in the occupation of technicians at vocational schools in Germany. In C. Hong (Ed.), Applied Degree Education and the Future of Work. Education 4. 0 (Lecture Notes in Educational Technology Ser). Singapore: Springer Singapore Pte. Limited.). In the pretest, multidimensional constructs already emerged for content knowledge and problem solving. Content knowledge and fluid intelligence showed significant standardized regressions on the dimensions of problem solving. The regressions of content knowledge on problem solving were the strongest. Is domain-specific competence also a multidimensional construct in the posttest? Sample: The posttest was equal to the pretest conducted by six colleges (EQR 6) both in a longitudinal control-experimental-group-design (n = 243) and as regular classes via the digital learning platform Moodle. The data analysis will be made by SEM with Mplus. Results: Content knowledge and problem-solving competence are multidimensional. The highest regressions related to problem-solving competence are obtained in the multidimensional content knowledge as outlined in the PPIK theory.

Keywords Domain specific competence · Higher education · Learning design

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7.1 Introduction and Presentation of the Research Issues

Technical drawings according to DIN EN ISO represent components and assemblies cognitively as mental representations. In addition, technical drawings are used for uniform communication so that components and assemblies can be manufactured appropriately at different production sites. If uniform communication fails, the corresponding components or assemblies cannot be manufactured as required (Fritz, 2016, p. 9).

Under certain circumstances, this may involve considerable corrective work, which results in additional costs.

For these reasons, prospective technicians in mechanical engineering (EQF 6) learn the domain-specific competencies of being able to adequately read, interpret and check a component drawing for possible errors (Ministerium für Bildung, Frauen und Jugend [Hrsg.], 2003, p. 22).

However, in order to adequately promote the reading and interpretation of technical drawings, it is important to model the corresponding learning-psychological structure and the associated learning-psychological contextual factors (Abele, 2014, p. 18).

In the pretest, multidimensional content-knowledge had already been shown to be more influential on analytical problem-solving competence than fluid intelligence (Walker & Huester, 2022).

This paper focuses on the associated posttest. Between the pre- and the posttest, there are learning arrangements which will be analyzed with a larger sample at a later time.

The present work is concerned with the modeling of suitable measurement models for assessing content knowledge and analytical problem-solving competence. The basis for this is the corresponding pretest. The following issues arise from this study:

- Can the model of vocational competence in the posttest be represented in a multidimensional, reliable and valid way like in the pretest?
- 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?

The reference for this analysis is the corresponding pretest (Walker & Huester, 2022).

Accordingly, the following chapter deals with the operationalization of a model with the help of appropriate constructs. In the further course, this model will then be estimated through structural equation modeling.

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

7.2.1 Latest State of Research in the Field of Further Training as a “**Staatl. Gepr. Techniker**” *(European Qualifications Framework 6)*

The pretest already identified a two-dimensional structure for content knowledge. Likewise, a five-dimensional structure could be modeled for analytical problem-solving competence. These dimensions were generated from originally six theoretically derived dimensions via systematic testing using confirmatory factor analysis (CFA) (Walker & Huester, 2022).

Furthermore, the pretest revealed that both fluid intelligence and content knowledge showed significant standardized regressions on the dimensions of analytical problem-solving competence. In comparison, learnable content knowledge produced significantly higher standardized regressions on analytical problem-solving competence than fluid intelligence (Walker & Huester, 2022).

The test subjects were 243 students (9 female and 234 male) from the technical college (*Fachschule Technik*), specializing in mechanical engineering and having an average age of 26.3 years. In the posttest, the same sample is used to test the structure of competence and the relationships between latent variables.

7.2.2 The Structure of Vocational Competence and the PPIK Theory

According to Ackerman, competencies develop through the interplay of general cognitive ability, knowledge and interest. He emphasizes the importance of previously acquired knowledge as a connecting point for new knowledge as a result of a learning process. Hence, interest is decisively involved in the knowledge domains in which cognitive resources are invested. Process, personality, interests and intelligence as knowledge (PPIK) aim at intellectual intelligence development in adulthood. In this context, intelligence as knowledge plays an increasingly important role in young adults, while the influence of 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).

Vocational competence can be categorized into two learnable domain-specific dimensions. One dimension consists of domain-specific knowledge and the other dimension consists of being able to apply and transfer this knowledge in challenging situations (Nickolaus, 2011, p. 333; Nickolaus & Seeber, 2013, pp. 177–182).

In contrast to holistically-oriented approaches, the basic structure of domain-specific competence aims at performing reliable and valid competence measurements with the help of corresponding subdimensions, (Nickolaus, 2011, p. 333; Nickolaus & Seeber, 2013, p. 170).

Furthermore, this structure is confirmed by empirical findings. In line with this, towards the end of the vocational training, a multidimensional content knowledge structure was found in almost all the occupational fields studied (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).

In this context, the same basic structure of domain-specific competence as in the pretest is used to model the dimensions of content knowledge and analytical problem-solving competence (Fig. 7.1).

In theory, for the area specifically examined in this study—i. e. sectioning in technical drawings—the following six subject areas can be defined: sectional designations, hatching of sectioning, lines in sectioning, intersection in technical drawing, sectional types and spatial imagination. Each of these dimensions is theory-based with regard to content knowledge and analytical problem-solving competence (Walker & Huester, 2022).

In the present paper, these six previously established subject areas are to be estimated regarding the respective subdimensions. For this purpose, suitable structural equation models are used. 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 the same as in the pretest (Walker & Huester, 2022).

7.2.2.1 Domain-Specific Competence ("*Berufsfachliche Kompetenz*")

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).

In this work, domain-specific competence is understood as a learnable and domain-specific multidimensional construct. The following two basic dimensions are considered to be differentiable: knowledge and the application as well as transformation of knowledge in challenging situations (Nickolaus & Seeber, 2013, p. 177).

The application and transformation of knowledge in these types of situations as domain-specific knowledge can be analytical or creative. The focus of this research is on analytical problem-solving competence (Walker & Huester, 2022).

Knowledge can also be categorized into different areas. In the following, declarative knowledge about facts is examined in more detail.

On the one hand, a dualistic basic structure of domain-specific competence can be assumed. According to Süß, this structure consists of content knowledge ("*deklaratives Sachwissen*"/declarative knowledge about facts) as specifically operationalized expertise (see Chap. 2.2.3) and of analytical problem-solving competence (see Chap. 2.2.2).

On the other hand, another aim is to identify the subdimensions of domain-specific competence ("*berufsfachliche Kompetenz*") in the same way as in the pretest (Walker & Huester, 2022).

7.2.2.2 The Concept of "Analytical Problem-Solving Competence"

Problems can be distinguished from tasks by their barrier between initial and final state. If this barrier is not present, the term "tasks" is used instead. In this context, it is significant to note that whether or not there is a barrier between the initial and final state also depends to a considerable extent on the individual's previous experiences (Dörner, 1976, pp. 10–12).

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

Experts thus possess adequate domain-specific knowledge that enables them to solve problems adequately through learned chunk networks. Novices lack this domain-specific knowledge, which leads them to use more inefficient problem-solving strategies, such as selective attention (Chi et al., 1982, p. 17).

Domain-specific problems play a major role in vocational training. Thus, content knowledge is of particular importance for overcoming barriers (Walker, et al., 2016, p. 163; Rausch, 2017, p. 178).

The term "analytical problem-solving competence" used here refers, on the one hand, to the general and the domain-specific cognitive resources required for error detecting in technical drawings and, on the other hand, to the according necessary ability to overcome barriers (Walker & Huester, 2022).

7.2.2.3 The Concept of Content Knowledge ("*Deklaratives Sachwissen*"/Declarative Knowledge About Facts)

Geary makes a significant categorization of knowledge. Thus, a differentiation can be made between knowledge that can be learned automatically for evolutionary reasons (biologically primary first) and knowledge that must be learned with great effort (biologically primary secondary) and thus cannot be learned automatically (Geary, 2000, pp. 11–15).

The domain-specific knowledge needed to interpret a technical drawing can thus be classified as biologically primary secondary.

Even if the knowledge categorization according to Heinz Martin Süß does not appear to be that distinct at this point, content knowledge (declarative knowledge about facts) plays a particularly decisive role in the profession of the technician.

Table 7.1 The Concept of Knowledge (Süß, 1996, p.66; cf. Walker & Huester, 2022)

	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)

Accordingly, the technician must be able to communicate deviations from DIN EN ISO verbally to the product designer (Table 7.1).

7.2.2.4 The Concept of "Fluid Intelligence"

Fluid intelligence refers to an individual's general cognitive ability. It is largely genetically determined or acquired at an early age (Horn & Cattell, 1967, pp. 108–129).

A close correlation can be observed between the working memory (specifically focusing on the central executive) and the processing capacity (Oberauer et al., 2005, pp. 61–65).

In order to measure the general cognitive ability, the proven CFT test, which has become established in schools, was already used in the pretest (Funke & Vaterrodt, 2004, p. 47).

7.3 Hypotheses

H_1: With the help of the structural equation models, a confirmatory factor analysis (CFA)—which was already applied in the pretest—can be used to design a suitable instrument for measuring the domain-specific competence of technicians in the posttest on the subject of sectional views in technical drawings (cf. Walker & Huester, 2022).

(a) In the posttest, there is a multidimensional structure for content knowledge (verbalizable knowledge about facts) as in the pretest (Walker & Huester, 2022).
(b) As in the pretest, a multidimensional model can also be determined for analytical problem-solving competence in this posttest as well (Walker & Huester, 2022).

H_2: As shown in the pretest, similar results can be observed between the subdimensions of domain-specific competence and fluid intelligence (Walker & Huester, 2022).

Here as well, content knowledge (verbalizable knowledge about facts) is expected to have the strongest influence on analytical problem-solving competence.

(a) Fluid intelligence affects the multidimensional structure of content knowledge (verbalizable knowledge about facts) with a directed regression (Walker & Huester, 2022).
(b) Fluid intelligence affects the multidimensional structure of analytical problem-solving competence with a directed regression (Walker & Huester, 2022).
(c) The dimensions of content knowledge have the greatest effect with a directed regression on the corresponding dimensions of analytical problem-solving competence (Walker & Huester, 2022).

7.4 Method

7.4.1 Sample

The test subjects are the same 243 students as in the pretest (9 females and 234 males) from the technical college ("*Fachschule Technik*"), specializing in mechanical engineering and having an average age of 26.3 years (Walker & Huester, 2022).

As in the pretest, the data set is collected via the digital learning platform Moodle with the help of the previously designed tests on content knowledge and analytical problem-solving competence at six different vocational schools in Rhineland-Palatinate (Germany) (Walker & Huester, 2022).

The sample is also a random cluster sample as in the pretest. In this approach, specific groups of a population are measured entirely as samples. This is acceptable if the so-called "clumps" as used random sample largely correspond with the population (Fahrmeir et al., 2007, p. 26; Walker & Huester, 2022).

The specific job-related homogeneity was already pointed out in the pretest. This remains equally valid for the posttest (Walker & Huester, 2022).

The analysis takes place during regular classes and, as in the posttest, is carried out experimentally in the form of conventional classes (Walker & Huester, 2022).

7.4.2 Instruments Developed for and Applied in This Study

The structural equation model of multivariate statistics (SEM) is a multivariate framework rather than a single technique. In this multivariate framework, measured (manifest) and non-measured (latent) variables can be developed. There is a statistical relationship between manifest and latent variables which is estimated with adequate estimators such as the WLSMV estimator with reference to qualitative data (Brown, 2006, pp. 1–10; Byrne, 2012, pp. 4–5; Reinecke, 2014, pp. 1–2).

It should be emphasized that the SEM requires theoretical justification. Altogether, the size of a parameter in a SEM is only an indication of causality (Arzheimer, 2016, pp. 41–45; Little, 2013, p. 154; Reinecke, 2014, pp. 11–12).

Content knowledge and analytical problem-solving competence are measured by a power test with dichotomous data. The students are given sufficient processing time to complete the test in the same manner as in the pretest (40 min in this case) (Bühner, 2011, p. 21).

As in the pretest, the test subjects 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 sufficient test time.

With regard to fluid intelligence, the result of the CFT20-R is, in contrast, relatively dependent on the test time. For this reason, it is also referred to as a "speed test" (Bühner, 2011, p. 21).

7.4.2.1 Development of the Content Knowledge Test

According to the pretest, the content knowledge test focuses on the subject of sectioning in technical drawings based on DIN EN ISO. For a better understanding, a small example is illustrated below for each of the six content areas:

- **Intersection in technical drawing:** These include, for example, the correct entry of the section of a complex sectional view according to DIN ISO 128–44 (Fritz, 2016, p.66).
- **Hatching of sectioning:** 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 examples (Fritz, 2016, p. 64).
- **Lines in sectioning:** These may include, for example, hatching lines drawn as narrow solid lines in accordance with DIN EN ISO 128–20 and having a line width of 0.25 mm in the preferred line group of 0.5 mm (Fritz, 2016, pp. 23–25).
- **Sectional designations:** According to DIN ISO 128–44, for example, half and full sections are not designated in contrast to complex sections (Fritz, 2016, p. 66).
- **Sectional types:** The content knowledge of types of cuts includes, among other things, the 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 used (Fritz, 2016, p. 61).

The content knowledge items have been developed as multiple choice tasks on the digital learning platform Moodle. There are five given possible answers, only one of which is correct. In addition, the students are asked to refrain from guessing the correct answer by using the "don't know" answer option. Thus, the number of guessed answers is minimized. This way, the 30 items are structured uniformly. Furthermore, care is taken to ensure that the selectable answers make as much sense as possible to the novice. However, it is important to note that questions asked cannot be answered without the corresponding content knowledge. To answer the question: "In a complex intersection in technical drawing, are parallel cutting planes represented in the sectioning as if they were in one plane?" ccontent knowledge of sectioning is essential. If the necessary content knowledge of the latter is missing, no judgement about a correct answer can be made (Walker & Huester, 2022).

7.4.2.2 Developing the Test of Analytical Problem-Solving Competence

The measurement of analytical problem-solving competence is also designed to test specific content knowledge of the subject of sectional views in technical drawings based on DIN EN ISO. As with the test for declarative knowledge (see Chap. 4.2.1), a small example is illustrated for each of the six content areas for a better understanding (Walker & Huester, 2022).

- **Intersection in technical drawing:** These include, for example, the incorrect cutting line of the front view according to DIN ISO 128–44 (Fritz, 2016, p. 66).
- **Hatching of sectioning:** As an example, the incorrect hatching angles of the front view according to DIN ISO 128–40 and DIN ISO-50 can be cited (Fritz, 2016, p. 64).
- **Lines in sections:** These include, for example, the three boundary lines for the DIN EN ISO 128 sections (Fritz, 2016, p. 61).
- **Sectional designations:** For example, according to DIN ISO 128–44, half and full sections are not provided with a designation (Fritz, 2016, p. 66).
- **Sectional types:** For example, the error that whole components are displayed in three different section 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).

Analytical problem-solving competence is measured with 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 properly diagnosed. In any case, the students will also read real technical drawings in their future careers. Moreover, a large number of errors can only be detected 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. In addition, the corresponding numbers of the error designations have to be assigned digitally to the exact error location using the crosshairs of the drawing view (Walker & Huester, 2022).

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

In the pretest, the CFT 20-R was used to measure general basic intelligence. The first part of the CFT 20-R consists of 56 items which are divided into four subtests (Weiß & Weiß, 2006, pp. 14–15).

The results from the pretest are used to model the analysis in the posttest.

7.4.3 Analysis and Evaluation

The data, collected in the same way as in the pretest via the Moodle digital learning platform, are first saved in Excel spreadsheets and then transferred to a shared Excel spreadsheet. This Excel spreadsheet is in turn transferred to the statistics program SPSS. Finally, a KFT-Dat file is generated from SPSS, which is subsequently imported into the syntax-based statistics program Mplus. In Mplus the SEM can be created as shown in Fig. 7.2 for example.

First, the six-dimensional hypothetical CFA model from the pretest is tested both for content knowledge and for analytical problem-solving competence (Walker & Huester, 2022).

For the next step, however, the data obtained in the posttest are used. Again, correlations greater than one appear comparable to the pretest for both constructs of domain-specific competence. Combining, for example, two latent variables of content knowledge results in a more restrictive model with five latent variables. For the five-dimensional model there are now fewer parameters to estimate than for the six-dimensional model, since a correlation does not have to be estimated. In this way, a degree of freedom is gained in the five-dimensional model compared to the six-dimensional one.

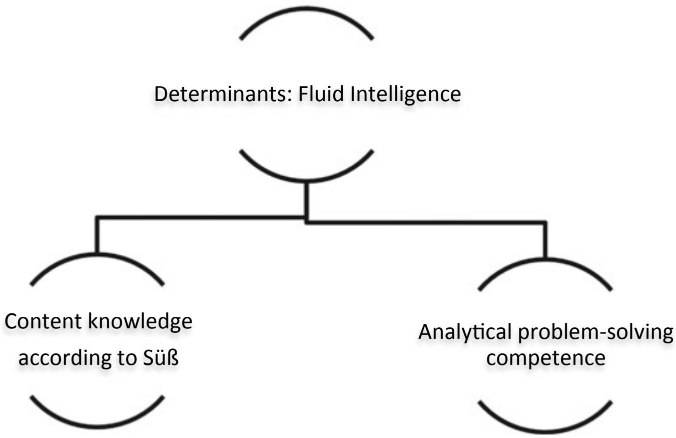

Fig. 7.1 Structure of this study (cf. Walker & Huester, 2022)

Both models have the same indicators. They differ only in a lack of correlation, which occurs by combining two latent variables representing the same construct. Hence, the five-dimensional model can be regarded as a nested model of the six-dimensional one. This provides the basis for a comparison of the two models by means of the chi-square difference test (Brown, 2006, p. 162).

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

This procedure is repeated analogously to the pretest until the chi-square difference test becomes significant and until there are no more high correlations (*e.g.* $r < 0.90$). If the chi-square difference test becomes significant, the less restrictive model applies (Walker & Huester, 2022).

7.5 Results

7.5.1 *H_1: Using the Structural Equation Models, a Confirmatory Factor Analysis (CFA) Can be Used to Design a Suitable Instrument for Measuring Domain-Specific Competence of Technicians on the Subject of Sectional Views in Technical Drawings*

7.5.1.1 (a) There is a Multidimensional Structure for Content Knowledge (Verbalizable Knowledge About Facts). This Basic Assumption is Confirmed in the Pretest (Walker & Huester, 2022)

For the empirical testing of H_{1a}, two approaches are carried out in order to maintain the assumption of a multidimensional structure of content knowledge.

In the first approach, the latent variables with the highest correlation are always combined, e. g. ($r \geq 0.90$). Subsequently, the resulting model, which is reduced by one dimension, is compared with the previous model via chi-square difference test. This procedure is continued until the chi-square difference test becomes significant and there is no longer a higher correlation between two latent variables (Byrne, 2012, pp. 265–272; cf. Chap. 4.3).

The pretest already revealed an excessive imbalance with regard to the item distribution on the two remaining dimensions of content knowledge (cf. Walker & Huester, 2022).

Similar results are also found in the posttest: With a value of ($r = 0.832$), the correlation between the latent variables still present at the end is even slightly higher than in the pretest. However, five summarized dimensions are opposed to a single one this time as well.

Overall, no multidimensional structure can be found in either the pretest or posttest of content knowledge (Walker & Hüster, 2022).

The second approach is different. Here, the latent variables are summarized that have the highest correlations and that can also be theoretically justified (cf. Chap. 4.3).

In the six-dimensional model, a total of five correlations are above the value 1, which is why a summary based solely on the correlation level cannot necessarily be regarded as expedient. Thus, by the second approach, the two latent variables "intersection in technical drawing" (NSW1) and "sectional designations" (NSW4), which do not have the absolutely highest correlation, but which nevertheless show a value above 1 and can additionally be theoretically justified, are summarized.

The pretest revealed a two-dimensional structure (Walker & Huester, 2022).

In the posttest, the chi-square difference test already strikes when comparing models between the three- and two-dimensional structural models. Here, too, the maximum correlation of ($r = 0.889$) can be considered acceptable. Consequently, a three-dimensional structure of content knowledge emerges in the posttest. This is illustrated below in Fig. 7.2.

The latent variable NSW2 contains the two content areas "hatching of sectioning" and "lines in sections". The latent variable NSW1 consists of the two content areas "intersection in technical drawing" and "sectional designations", while the latent variable NSW5 results as a consequence of combining the content areas "Sectional types" and "spatial imagination".

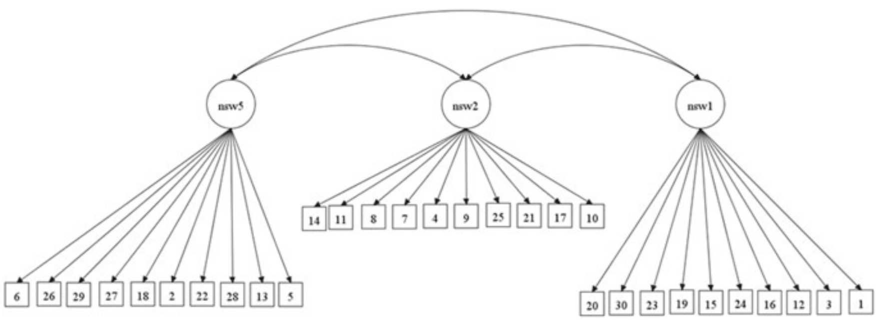

Fig. 7.2 Three-dimensional structure of content knowledge (*$n = 243$/ RMSEA = 0.020/ CFI = 0.952/ TLI = 0.948 WRMR = 0.903*)

In addition, an acceptable model fit is obtained in the posttest *($n = 243$, RMSEA $= 0.020$, CFI $= 0.952$, TLI $= 0.948$ und WRMR $= 0.903$).*

Overall, the first approach does not provide any evidence of a multidimensional structure of content knowledge. This approach seems to be unsuitable for this purpose due to the relatively large imbalance between the latent variables.

However, if the latent variables that show the highest correlation—and that can also be theoretically justified—are summarized in the second approach, a three-dimensional structure of content knowledge emerges. Thus, hypothesis H_{1a} can be confirmed.

7.5.1.2 (B) A Multidimensional Model Can also be Determined for Analytical Problem-Solving Competence. This Assumption also Refers to the Pretest (Walker & Huester, 2022)

Based on the preliminary theoretical considerations, the model of analytical problem-solving competence is assumed to have a multidimensional structure (Walker & Huester, 2022).

For the empirical testing of H_{1b}, the latent variables with the highest correlation, e. g. ($r \geq 0.90$), are always combined. Subsequently, the resulting model is reduced by one dimension and compared with the previous model by means of a chi-square difference test (cf. Chap. 4.3).

Comparable to the pretest, the highest correlation in the posttest is found in the six-dimensional model between the content areas 2 (hatching of intersecting surfaces) and 6 (spatial imagination). The correlation was 1.211 in the pretest and 1.524 in the posttest.

Therefore, as in the pretest, these two latent variables are also combined into one in the posttest (cf. Table 7.2).

Table 7.2 Summary of the five dimensions

6 dimensions (hypothetical)	5 dimensions (empirical result)
Intersection in technical drawing (npl1)	Intersection in technical drawing (npl1)
Hatching of sectioning (npl2)	Hatching of sectioning (npl2) & Spatial imagination (npl6)
Lines in sectioning (npl3)	Lines in sectioning (npl3)
Sectional designations (npl4)	Sectional designations (npl4)
Sectional types (npl5)	Sectional types (npl5)
Spatial imagination (npl6)	

After that, the six-dimensional model is compared with the five-dimensional model using the chi-square difference test.

If the chi-square difference test yields significant results, the model with the larger number of parameters to be estimated is retained. If the chi-square difference test appears to be non-significant, it is the other way round (Urban & Mayerl, 2014, pp. 218–219).

Since the chi-square difference test, compared with the pretest, also does not become significant in the posttest, it appears necessary to test the five-dimensional model with a four-dimensional one. For the four-dimensional model, the dimensions that produce the highest correlation in the five-dimensional model are combined according to the known procedure. However, testing the five-dimensional model with the four-dimensional one does not result in comparably high correlations and the chi-square difference test becomes significant.

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 model. This applies equally to the pretest and the posttest. Consequently, the five-dimensional structure is retained (Fig. 7.3).

The model shows acceptable fit values. Thus, a five-dimensional structure of analytical problem-solving competence emerges in the posttest, confirming hypothesis H_{1b}.

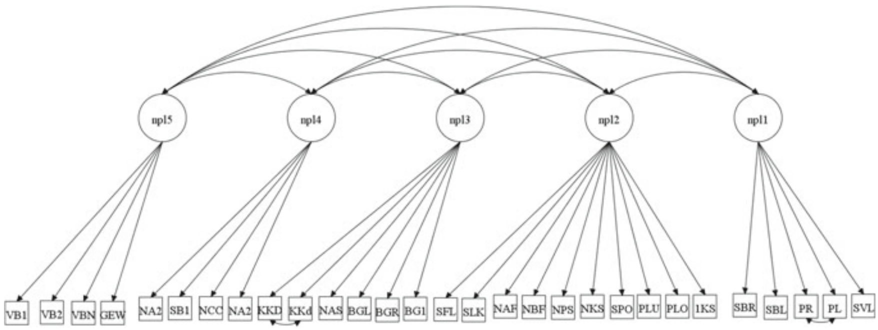

Fig. 7.3 Five-dimensional analytical problem-solving competence (n = *243/ RMSEA = 0.045/ CFI* = 0.*973/ TLI = 0.970/ WRMR = 1.109*)

7.5.2 *H_2: Similar Results can be Observed Between the Subdimensions of Domain-specific Competence and Fluid Intelligence, as Already Shown in the Pretest (Walker & Huester, 2022). Here as Well, Domain-Specific Knowledge in the Form of Content Knowledge (Verbalizable Knowledge About Facts) Should Show the Strongest Influence on Analytical Problem-Solving Competence. Fluid Intelligence Affects the Multidimensional Structure of Content Knowledge and Analytical Problem-solving Competence with a Directed Regression*

7.5.2.1 (A) Fluid Intelligence Affects the Multidimensional Structure of Content Knowledge with Standardized Regression

Fluid intelligence loads directly on the three dimensions of content knowledge. The standardized regressions (β = *0.218**–0.272***) all become highly significant. Thus, H_{2a} can be confirmed by inferential statistical evidence.

The structural model follows below for illustration purposes. Some standardized regressions (β) do not yet become significant. Comparable to the pretest, this can possibly be attributed to the relatively small sample ($n = 243$). In a larger sample, these regressions would probably also become significant (Table 7.3 and Fig. 7.4).

Table 7.3 Regressions and correlations structural model (*n = 243/ RMSEA = 0.025/ WRMR = 1.055/ CFI = 0.949/ TLI = 0.946*)

Dimension	NPL1	NPL2	NPL3	NPL4	NPL5	IQ	NSW1	NSW2	NSW5
NPL1									
NPL2	0.044								
NPL3	0.354**	0.700**							
NPL4	0.666**	0.229	0.229						
NPL5	0.193**	0.267**	0.267**	0.375**					
IQ	0.104	0.287**	0.145	0.198**	0.035				
NSW1	−0.143	−038	0.578	0.618**	−0.039	0.218**			
NSW2	−0.175	0.229	0.103	−0.533	0.818**	0.272**	0.854**		
NSW5	0.426**	0.444	−0.228	0.419	−0.318	0.241**	0.830**	0.831**	

** Highly significant ($p < 0.01$)

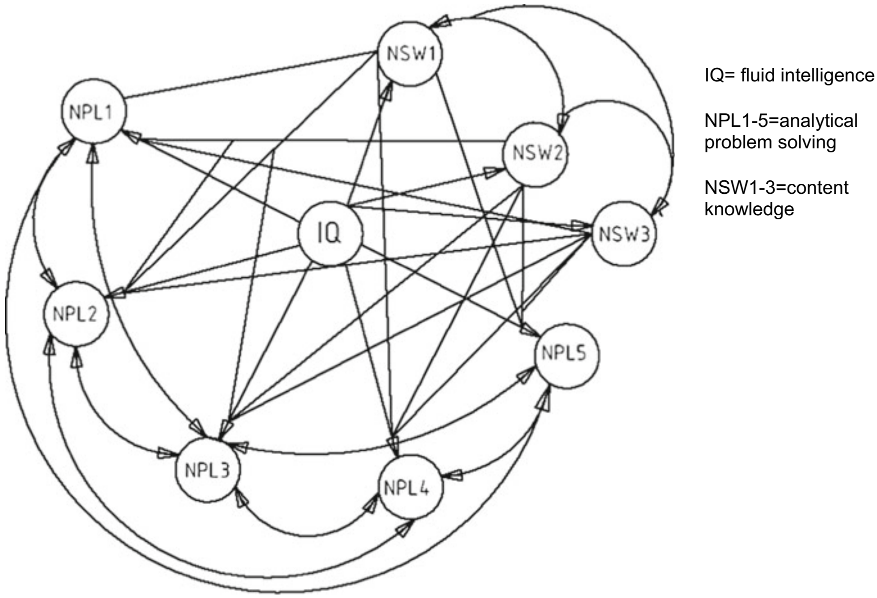

Fig. 7.4 Regressions and correlations structural model (*n = 243/ RMSEA = 0.025/ WRMR = 1.055/ CFI = 0.949/ TLI = 0.946*)

7.5.2.2 (B) Fluid Intelligence Affects the Multidimensional Structure of Analytical Problem-Solving Competence with Standardized Regression

Two of five regressions of fluid intelligence on analytical problem-solving competence yield significant results (*NPL2-NPL4/* $\beta = 0.198{-}0.287$).

Unfortunately, the other regressions do not become significant. One reason for this could be the relatively small sample size. Another one could be the increase in equations to be solved due to the added third dimension of content knowledge. Overall, the regressions of fluid intelligence on the dimensions of analytical problem-solving competence can be confirmed. Thus, H_{2b} is to be considered valid.

7.5.2.3 (C) The Dimensions of Content Knowledge Each Have the Strongest Effect on the Corresponding Dimensions of Analytical Problem-Solving Competence with Standardized Regression

In comparison, as in the pretest, the respective dimensions of content knowledge have the greatest influence on the dimensions of analytical problem-solving competence ($\beta = 0.303{-}0.804$). However, two regressions do not yet become significant, which is likely to change with a larger sample.

In fact, content knowledge provides the strongest regressions on analytical problem-solving competence, thus confirming H_{2C}.

7.6 Conclusion

In summary, evidence of a multidimensional structure was found for both content knowledge and analytical problem-solving competence by applying structural equation modeling (Mplus software) via confirmatory factor analysis (CFA). For this purpose, an experimental and explanatory field study was conducted with the aforementioned ($n = 243$) students.

Hence, the results are in line with the multidimensional model of domain-specific competence (cf. Chap. 2.2), in which knowledge and problem-solving competence basically represent two separate competence dimensions.

Similar to the pretest, analytical problem-solving competence also covers five dimensions in the posttest. However, the two-dimensional content knowledge from the pretest extends into three dimensions in the posttest (cf. Walker & Huester, 2022).

The exogenous variable fluid intelligence and the three latent dimensions of content knowledge influence the five latent dimensions of analytical problem-solving competence in a directed manner. Here, the standardized regressions of the three latent dimensions of content knowledge on the five latent dimensions of analytical problem-solving competence ($\beta = 0.303-0.804$) are the highest. With a value of ($\beta = 0.198-0.287$), fluid intelligence shows significantly lower regressions on the five latent dimensions of analytical problem-solving competence than the three dimensions of content knowledge. In addition, regressions of fluid intelligence on the three dimensions of content knowledge can be established ($\beta = 0.218^{**}-0.272^{**}$).

These regressions result from an acceptable model fit *($n = 243$/ $RMSEA = 0.025$/ $WRMR = 1.055$/ $CFI = 0.949$/ $TLI = 0.946$).*

Thus, the results are consistent with the pretest. Compared with the exogenous variable fluid intelligence, in this test prior knowledge has already emerged as a more significant factor with regard to analytical problem-solving competence (Walker & Huester, 2022).

The visibly higher standardized regressions of the three dimensions of content knowledge in the structural equation model thus provide evidence for Phillip Ackerman's PPIK theory. Finally, the students' learnable content knowledge required for the interpretation and error specification of technical drawings according to DIN EN ISO appears to be more significant than the comparatively non-learnable basic cognitive ability of fluid intelligence.

This result assigns a special significance to learnable content knowledge both as prior knowledge and as knowledge resulting from the learning process. Prior knowledge thereby establishes connecting points for further knowledge and competence development, which can create appropriate chunk networks.

These findings confirm the intellectual development of the students examined in this study analogous to the PPIK theory with reference to age. The importance of prior knowledge and knowledge as a result of the learning arrangement is consistent with the age of the students and their associated intellectual development (*mean = 26.3 years*).

The findings of this work will be followed up as part of a larger research project with a larger sample additionally taking into account the criterion of vocational interests.

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Chapter 8
Supporting and Enhancing the Future of Degree Education in Graphic Design: A University of Gloucestershire Case Study

Claudia Brewster and Grant Pooke

Abstract This collaborative paper authored by Claudia Brewster and Grant Pooke derives from the experience of teaching and managing the delivery of a practice-based Graphic Design (GD) BA Honours degree pathway at the University of Gloucestershire, UK. Supported by two curriculum-based case studies, it explores and discusses examples of new and emerging Design practices in Industry 5.0. The experiential timeframe extends from the start of the academic year in September 2022 through to the student assessment period in June 2023. How might some of the brand-based contexts of emerging technology and the social platforms they utilise be incorporated into a framework which supports modular learning and skills acquisition for First Year (Level 4) Graphic Design students? What additional skill sets and aptitudes might Virtual Design applications require from a student cohort and how might student learning gain be effectively assessed and developed?

Keywords AR · VR · Next generation vocational/professional practices · Employability skills and aptitudes · C21st world of work · Innovative pedagogies · Instructional design

8.1 Introduction

Digital and immersive technologies have driven the evolution of the creative design industry. The paradigm of Industry 4.0, our present technological age, has been outlined as the legacy of connected communities, national, international and global. Elangovan defines Industry 5.0 as the future industrial age which is predicted to expand connections between humankind and digital platforms (Elangovan, 2021).

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Innovative technologies and futuristic, immersive environments provide opportunities for re-imagining the creative industries. These new conjunctions underpin creative design practice as a highly specialised form of late modern cultural production. These profound shifts and the opportunities they herald will be negotiated by a new generation of creative design practitioners on the cusp of graduation.

In response to Industry 5.0, this paper will consider some inclusive approaches to incorporating emerging technologies into modular learning schemes to support the skills acquisition and learning gain of First Year Graphic Design (GD) students at the University of Gloucestershire, UK (henceforth UoG). Education 5.0 refers to the progression of educational delivery in order to match the pace of industrial change, thereby preparing our students for Industry 5.0. In devising the next generation curriculum, we propose that introducing emerging technologies right at the start of year one of the tertiary journey, rather than cumulatively at penultimate or final year stages, better supports students in becoming agile and adaptive creative practitioners. Two proposed industry briefs have been designed to introduce industry principles in Virtual Reality (VR) and Augmented Reality (AR) using creative problem-solving and interactive methods of pedagogic delivery. More broadly, both assessed project briefs have also been conceived to support a more holistic engagement by students, recognising both underlying socio-economic contexts and the ethical imperatives of sustainable and progressive design practice. As Halpern et al. state: 'Each of us can bring the practice of wisdom into our careers, our lessons, and the life choices we make, deepening and empowering our work for a more just, sustainable, and reflective world' (Halpern, 2008).

8.2 Augmented Reality and Social Media in Education 5.0

Typically, the majority of incoming Generation Z students within GD have an underpinning in digital literacy arising from previous online social interactions and digital creative development. As Rienties et al. suggest, students are increasingly accustomed to communication through social learning tools, such as Facebook or Twitter, with new expectations on lecturers to use this knowledge in the seminar room, (Rienties et al., 2013). Experientially, these online exposures provide a basis through which to transition our students' technical development and confidence with virtual media by ensuring that initial and subsequent assessment briefs recognise these formative and interactive engagements. The design world has recognised and embraced the value of these tools for future expansion. For instance, Galer has recently noted that augmented reality can increase online engagement by up to 200% (Galer, 2021).

AR brand experiences are an expanding focus for the design sector. Successful AR brand activations include those by Adidas, Black Lives Matter (BLM) and Kinder. In 2019, Adidas became the first retailer to sell directly from an AR snapchat game. Snapchat's popular imagesharing functionality creates interactive and engaging experiential opportunities. Adidas's baseball-themed activation generated broader interaction and association with their brand and products, evidenced by outcomes which surpassed their key performance indicators (KPIs) by 115% in less than 12 months (Toth, 2021). Kinder created an AR game to explore virtual environments using social media. This integrated brand environment engendered a playful and interactive reflection of the Kinder brand which resonated with their target audience. Kinder reported that parents discovered an 87% enhancement in child 'playfulness', with a 43% increase in family 'togetherness,'–both outcomes accompanied by an 8.2% increase in Kinder revenues (The Drum, 2021). Toni Adeyemi developed an AR filter for BLM which seeks to raise awareness for related organisations and donations. The AR filter aims to direct people towards associations, charities and movements committed to fighting racial inequality and supporting justice reform.

These examples of brand activations demonstrate the societal advantages of AR filters, using social media as a platform for collective debate and collaborative change. As evidenced here, Graphic Design as a creative and inherently social practice, is a fundamental component in realising immersive and interactive AR experiences. It is therefore taken as axiomatic that responsive pedagogic practice should reflect the AR expectations and requirements of brands in Industry 5.0. The 2017 Quality Assurance Agency for Higher Education (henceforth QAA) UK subject Benchmark Statements for Art & Design recommended teaching approaches 'with integrated digital technologies, which mirror the context of professional practice'. Consonant with these examples the aspiration at UoG is to align an inclusive approach to assessment practice and technical skills acquisition to real world commercial needs.

Attitudes towards social media platforms continually evolve as different societies and the consumer demographics they comprise debate the benefits and challenges of freedom of content through social channels. Stasi reflects that the vast scale of our expanding social platforms and their impact on our lives has led to inevitable concerns. (Stasi, 2019). Although social media can be a positive tool within education, there are inevitable caveats. For example, Flavin argues that students may wish to keep the technologies used in their social lives separate from their studies (Flavin, 2017).

However, it seems reasonable to suggest that the social channels where students share personal successes and accomplishments can also be used to expand skills development and to establish professional attributes. As Kelly notes, during Industry 4.0 people have been sharing streams of creativity and their successes online. This process has increased recognition within education that that we learn more effectively when we share (Kelly, 2017). Therefore, incorporating social media into a First Year GD assessment brief enables our students to expand their understanding of content sharing with the additional benefits arising from the curation and critique of such practice with peers across and within the wider creative design community.

There are various factors which influence and help shape social media channels such as social judgements, time consumption and global commentary. As Stasi notes, social media companies have revolutionized the way people communicate, access and circulate information and participate in public debate (Stasi, 2019). These considerations have led to extensive discussion regarding the efficacy of social media in education, such as reports by *The Guardian* newspaper and by Poore reviewed below. The 2016 *Guardian Education Report*, while initially celebrating the use of social media in universities, also recognised that many academics still view Twitter, Facebook and Instagram as distractions rather than educative tools (Ross, 2016). Instead of viewing social media as a diversion best left out of the seminar room and lecture theatre, such platforms can be responsively employed to support meaningful teaching collaboration between users and technologies. The recognisable and approachable social qualities of these channels may affirm student confidence in using both new and otherwise potentially intimidating technologies. As Poore reflects, social media tools have 'how-to' guides and recognisable features which educators can now harness by integrating them into their own pedagogic approach.

The challenges of social arbitration and global commentary might be suggested as considered and potentially moderating strengths within a pedagogic setting. The critically contextualised use of social media platforms in tertiary teaching contexts also enables students to connect with Industry 5.0 and a global network of knowledge. Poore suggests that students are more motivated when they know that their work will be published online. They are recognising the impact that this worldwide review can have, which provides a high incentive (Poore, 2016). These online social media exposures may correspondingly benefit students' professional and vocational development in both key and transverse skills acquisition. Similarly, from personal observation at UoG, there has also been a noticeable trend in GD students securing positions in industry by using platforms like Instagram as expanded portfolios to showcase their developing professional practice.

Our contention is that encouraging first year students to recognise the value of social networking in the creative industries is highly likely to have a beneficial impact on their own employment recruitment. As educators there is a shared onus in developing responsive approaches to harness the benefits of these tools to expand our students' skills development. As Echenique et al. observe, universities should make use of social networks, and take advantage of the positive attitude students have towards them. The academic potential of these social tools could revolutionise our methodologies and education systems. (Echenique et al., 2015).

If one of the principal challenges regarding the ambivalent perception of Education 5.0 is apprehension of the unknown, then educators may also benefit from students' security in accessing and realising some of the more professionally relevant, if transactional benefits of social media platforms. For example, the discursive (and diverse) exchanges which characterise forum use may support self-reflection in developing more advanced digital design skills and competencies (Strampel, 2007). Therefore, social media may offer an approachable and inclusive pathway into teaching AR skills for Industry 5.0. In the context of Education 5.0, as Johnson notes, we should no longer question the use of social media in our classrooms, but rather integrating and supporting its educational inclusion (Johnson et al., 2016). This critical perspective has influenced our AR brief planning for First Year GD students at UoG. The first proposed brief would aim therefore to extend learning engagement in developing AR outcomes by circulating achieved resolutions through social media platforms. This very much reflects the perceived ethos of Industry 5.0 which enables shared creative content to build both digital competencies and connectivity.

In summary, the first proposed academic brief for UoG GD students will focus on Augmented Reality (AR). The outcome for this summative assessment would be defined as a creative AR response to a particular societal issue, which could be shared via existing social platforms. For example, an interactive AR filter for social media which raises awareness for a particular cause or campaign.

8.3 Emerging Virtual Environments in Industry 5.0

Industry 5.0 has also been defined as the connection between human and technological environments. The term used to express this is the 'embodied internet' which aims to consolidate and recreate methods of communication from our physical world into the digital realm (Bertrand et al., 2018). These online spaces are predicted to be valuable methods of integrating humankind's future use of technology and its generative possibilities. To develop this next step into virtual environments, designers are required to challenge and interrogate existing technological constraints in relation to their own developing creative practice. This process begins in Education 5.0, as this paper will outline below.

Industry 5.0 has been characterised as the broader expansion and universal use of digital spaces (Tiwari, 2022). Brands have been exploring and experimenting with creating digital communities for decades. Many of these developments have been inspired by the successful expansion of online communities in social media. Facebook's recent innovations are a ground-breaking example of this. Facebook's rebrand into 'Meta' and their 'Metaverse' proposal was launched in 2021 in order to design virtual environments for social interactions (Meta, 2021). This announcement has already led to new and intriguing opportunities for Graphic Designers and has been heralded as a call to action for designers of the future (Galer, 2021). The Metaverse incorporates some of the established attributes of Facebook to connect societies by building bespoke environments which reflect and mediate the interests of its users. It is predicted that their Metaverse and other succeeding proposals could be the successors of the internet and build the foundations of Industry 5.0 (Meta, 2021).

The predecessors of Meta such as AltSpace, Rec Room and VR Chat have generated innovative new modes of connection and communication. In these exciting and disruptive platforms, users are directly building their own worlds and connecting with technologies to ground-breaking new levels (Hackl, 2020). From these emerging immersive environments, digital communities have begun to expand. Meta have used their existing digital credentials to make significant steps towards acclimatising user communities to wider audiences. Meta have also made aspirational predictions for the socio-economic benefits which these immersive communities may deliver. For example, $50 million has been pledged to establishing socially responsible practices in the design of the Metaverse (Meta, 2021). Meta have correspondingly focused research into wellness, digital safety, inclusive practices and in creating social-economic benefits. The Meta immersive expansion *Horizons* is described as a social experience with new and extraordinary ways to explore, experiment and create. Therefore, encouraging supportive interaction and experimental collaboration between users, much like a creative classroom. (Meta, 2021). This clearly defines the sense of community, inclusion and creation that its makers envisage as intrinsic to the future of Industry 5.0.

Global brands are already exploring opportunities within these emerging digital environments and immersive technologies. This has inevitably led to industry brand activations in virtual venues such as those by Adidas, Gucci and the National Society for the Prevention of Cruelty to Children (NSPCC). The Gucci Garden, is a unique virtual exhibit where users create avatars by exploring their fashion range in virtual form. The Gucci Garden also reflects another valuable characteristic of virtual environments: neutral and inclusive avatars in which models are without apparent race, age or gender characteristics (Archetypes, 2021). Adidas launched *Delicatessen*, a VR experience of exploration and adventure, in order to both promote their products and to offer escapism during the 2020 Covid-19 lockdown. Their goal was to appeal to their 'adrenaline junkie' consumers, with the added benefit of inviting everyone else. As Stuart Wells, global Director of Brand Marketing for Adidas noted: '…immersive technologies like VR, enable us to replicate experiences that customers might not consider or be able to do otherwise' (Takle, 2017).

The NSPCC have also employed VR in order to establish new tools for assisting children in sharing their experiences of abuse and neglect. These immersive scenarios were designed as a new way to train adults and carers in methods of support in these difficult scenarios (NSPCC, 2020). Their summative report of testing the use of VR in navigating these complex societal issues established that 98% of their test group would recommend the NSPCC VR tools for supporting children (NSPCC, 2020). This innovative solution to complex societal issues provides a promising prediction for the future of VR capabilities. As each of these case studies demonstrate, Graphic Designers have a significant professional role and responsibility in developing socially meaningful and consequential VR experiences. As industry brands are increasingly drawn to VR, it is vital that Graphic Designers are able to deliver the technical skills required by these nuanced and socially accountable interventions.

The second GD brief will be formulated to support students in proposing and fashioning a VR environment which establishes ideas of a creative community for their users. Through researching and analysing a chosen community and problem to resolve, students should develop an informed visualisation of an inclusive and metacognitive VR environment for their target audience. This outcome might be realised as renders of a VR space which establishes an inclusive and supportive environment for a particular target audience. Students will be able to reflect on the impacts of immersive environments in order to develop proposals for impactful and well-informed virtual communities.

As Industry 5.0 is being constructed around increased VR interactivity in the commercial world, our students will be expected to acclimatise to these new virtual spaces. Therefore, introducing fundamental VR practices early on in our students' tertiary education should enhance vocational capability and future adaption. Within the contemporary world of work and emerging Industry 5.0, students will be required to expand their professional practices and to demonstrate wider technical skills and lateral, problem-solving ability.

8.4 Emerging Technologies in Education 5.0

The university sector has continued to develop teaching practice within the Digital Age of Industry 4.0. Industry 5.0 should replicate this but with a more integrated response across pedagogic practice. As a component of this, students may require guidance in current practices, alongside informed judgements and predictions regarding future industry standards. As Molias reflects, current university students have progressive methods of learning from multiple sources, increased digital literacy and further reaching methods of interaction with each other (Molias, 2015). Educators should be routinely prepared to deliver content on emerging technologies which inform and support platforms such as AR and VR. As Anyanwu notes, educators should strive to become more comfortable with, and fluent in, new technologies in order to apply such appropriately, and be conversant with new technological tools, resources, and approaches. By reaching these goals, educators would also empower and advance their own professional skills (Anyanwu, 2017). In recognition of these imperatives, the GD degree pathway at UoG has developed strong links with local Digital Design agencies. By building upon these industry connections through networking events and agency presentations, our teaching team are consistently developing and refining their existing and emerging technological practice.

The 5.0 expansion of technology also necessitates developing approaches to creative thinking. Present concerns around creativity in Industry 5.0 are based on the premise that technology should not challenge creativity. Hegarty recognises this conviction, reflecting that, '…technology may expand our capacity to express ourselves, but it can also mask creativity' (Hegarty, 2014). Concerns such as these should be addressed early on within the tertiary education journey. As educators we can work collectively to dispel these apprehensions by developing creative projects each of which should recognise a nuanced and holistic approach to the design process. For example, to generate digital designs, students would continue to follow a reflective design process through enquiry, analogue conceptualisation and reflection. In summary, the value of a rigorous and integrated approach to Graphic Design making will remain central to generating more effective digital outcomes.

The value of emerging technologies is continuously expanding within the Graphic Design sector. Significant adaptions have been made to establish Graphic Designers within the digital revolution of Industry 4.0. As Hegarty explains, our world is expanding with new and exciting technological developments. The next digital revolution of Industry 5.0 is transforming the way that we create and do things (Hegarty, 2014). During Industry 4.0, designers largely retained the autonomy of the creative process, however their project curation was often restricted by a lack of digital literacy in the face of these fast-paced developments. Hegarty goes on to warn that '…sometimes we forget technology should be the handmaiden of our creativity' (Hegarty, 2014). If Industry 5.0 is to be characterised by further collaboration between technology and humankind, establishing deeper digital literacy within tertiary education will be imperative. Expanding digital skills in applied design education will support creative collaboration between practitioners and their technologies, rather than either being a secondary consideration. If Graphic Designers can adapt and fashion their technological tools to these aims, creativity and technology should be able to operate synchronously.

Introducing emerging technologies should also be responsive to contemporary definitions of Graphic Design. For example, anecdotally, many students of the discipline are not necessarily already active or experienced in programming or digital applications. With this in mind, a balance should ideally be met between preparation for the broader use of technology in Industry 5.0, and complementary analogue creativity within Graphic Design. Therefore, a pilot review of first year GD students' preliminary digital literacy is proving useful and informative. These informal audits are being explored and proposed as an initial, approachable digital task.

For example, generating a Flourish Data Visualisation is one possibility which is being explored in curriculum. Flourish Data Visualisations are digital responses to research data which are simple to construct and engage with, while also teaching the fundamental principles of UI and UX Design. In previous pedagogic practice within UoG's GD degree pathway, Flourish has proved a constructive tool for measuring and assessing the digital literacy of our students. By reviewing levels of digital literacy and defining learning outcomes responsive to this, we seek to remain sensitive and alert to the range of our students' previous educational and experiential backgrounds. This reflective practice should continue to support an inclusive learning environment with assessment criteria placing equal value on the various component stages of the design process whilst avoiding overly prescriptive definitions of a final outcome.

Within our design pathway, we seek to provide bespoke technical educational support as part of the module assessment process. These technical delivery sessions help to enable our students to experiment, explore and to challenge skills, without any perceived goal-orientated pressures. In order to incorporate and replicate vocational and professional practices for our students, workshops are redesigned to incorporate a wider range of technical delivery processes and programmes. These adaptive learning technologies aim to be responsive towards next generation vocational and professional practices. In order to meet the challenges of the future of design and the redefinition of our industry, students are encouraged to expand their risk-taking capabilities without fear of erroneous outcomes. Sharpe et al. reflect that twenty first century students increasingly have confidence in technology, and the support that this provides can often increase their willingness to take creative risks. (Sharpe et al., 2010). This affirmative response to technology is conceived to facilitate safe and supportive experimentation within technical workshop sessions from the first year of the tertiary learning experience.

Consonant with the 2017 QAA Benchmark Statement, our GD degree pathway at UoG provides '…spaces with integrated digital technologies, which… enables students to work in an iterative manner to generate solutions more effectively'. In order to create integrated digital learning, the technical sessions are closely interconnected to module delivery. Our lecturers incorporate digital literacy into workshops, lectures, seminars and formative assessments. Keengwe reflects the shared ethos that teachers must be continually renewing their technological knowledge and be able to apply new technological tools and approaches confidently (Keengwe & Anyanwu, 2017). Every member of our delivery team has digital industry experience enabling relevant and supportive teaching which is reflective of industry standards. As technologies change at pace, so must the knowledge of our delivery team; establishing and maintaining strong and informed industry connections will therefore continue to contribute to retaining the currency of industry relevant knowledge. The digital skills explored in these proposed briefs for first year students are therefore envisaged to enable and to support next generation vocational and professional practice. In preparing our students for the world of work, they recognise the interconnection between technical skills and next generation industry practice.

8.5 Community and Ethics in Industry 5.0

Another attribute of Industry 5.0 is that anything created should have purpose and beneficial impact. Immersive technologies are valuable tools for empathetic engagement, mitigating barriers of physical distance and with the potential to strengthen communities. As Saniuk suggests, the new processes and structures of Industry 5.0 will be influenced by three ethical attributes of development: human-centricity, sustainability and resilience (Saniuk, 2022). When developing pedagogic practice for Industry 5.0, we should also consider the ethical goals for the future of the creative industries more broadly. A commitment to inclusion would seem to be an essential component of human-centricity. To reflect a clear commitment to sustainability, informed and relevant design practice should ideally introduce and support deeper, critical enquiry and reflections on practitioner agency as an integral part of the process. In recognising the importance of resilience and future-proofing content delivery, curricula should aim to support students in adapting to new environments through problem-solving and creative innovation.

Industry 5.0 provides for significant opportunities for developing connected, inclusive and progressive communities. Immersive technologies are often referred to as effective and transparent empathy machines (Milk, 2015), which adds a valuable perspective on establishing inclusive environments. Industry 4.0 has resulted in escalating interconnection across and throughout global societies. Through digital forums, global societal issues are more visible, enabling important platforms for discussion, ideas dissemination and education. Users are able to access information and perspectives from diverse backgrounds and situations. Immersive digital environments may also enable members of society who may have been previously disconnected. As Dick states, multi-user AR/VR experiences enable isolated members of our society to build virtual communities without the constraints of physical distance

(Dick, 2021). This adds further value and dimensions of social responsibility to the role of the design creators of these environments.

Informed by the successes of existing online forums, Graphic Designers can now create interactive spaces connecting wider and larger user demographics. Similarly, AR and VR tools have the potential to create a more inclusive society. Dick explains that AR/VR devices and applications can assist people with disabilities, by making physical environments more accessible by adding virtual interactions (Dick, 2021). These opportunities for establishing broader and more supportive environments are vital for the social and economic future of the design industry. As educators we are obliged to prepare our students for these design futures. Therefore, the proposed VR brief for our first year students is conceived to encourage reflection upon their wider role and vocation as designers. For example, using the successful NSPCC VR campaign as a case study, students are enabled to research problems faced by a particular community and to design solutions in response. The outcome of our students' concepts and design prototypes could be visuals of an interactive immersive VR environment which supports their target audience's requirements or which raise awareness of a societal issue. The VR communities so created are assessed in response to their ethical and potential societal impacts, as well as in relation to the level of technical proficiency achieved.

Industry 5.0 also enables further inclusion within work environments. The collaboration between humankind and machine is predicted to lead to increasingly decentralised professional power. As Tiwari notes, Industry 5.0 will sponsor increased productivity, efficiency and wider connections within the work environment by merging human intelligence with digital capability. This should inevitably lead to further collaborative productivity and decentralised power (Tiwari, 2022). The premise is that the inevitable skills-share through collaboration with technology will further democratise and expand inclusive opportunities across the workforce. Future professional opportunities may increasingly be reflective of seniority involving digital skill sets and knowledge, with tenure and rank being less fundamental to success. As Judkins reflects, technology has a significant impact on all aspects of society, thereby encouraging informed alignment with its progression. (Judkins, 2015). Correspondingly, educators have a responsibility to support our students with enhanced digital skills in order to prepare them for the future of work and a rupture with the industry status quo. More speculatively perhaps, encouraging technological skill development, effective problem-solving and resourcefulness may lead to a design industry predicated on skills and less reflective of societal bias.

As the United Nations (UN) reflected in a 2015 resolution, '…the spread of information and communications technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies' (UN, 2015). Solving, among other imperatives, the digital divide created by global inequalities is a significant driver for the UN and has seen some promising improvement over the last decade. As Huang reflects, recent technological advances in art and design have developed as a bridge between people, products, the environment delete comma and society (Huang, 2022). However, graphic designers should also perhaps be mindful of the limitations of digital resources as the world continues to increase connectivity. As Georgiadou notes, companies have already begun to implement Virtual Reality training in order to promote inclusion within their workplaces (Georgiadou, 2020). The onus is on and with Education 5.0 to respond in kind, expanding immersive technological skills to improve employability as the basis for wider social and economic equity. Developing the take-up of these skills by and for future designers could also achieve significant steps towards a more inclusive society.

However, VR is still challenged by cost efficiencies and differentiated access to technological equipment and supporting infrastructure. In part response, industry agencies have begun to develop more cost-efficient opportunities for engaging in VR, such as the Google cardboard headset. VR can also be adapted to gaming engines which expands user accessibility. However, many of these VR systems rely on extensive digital literacy or server systems which are often restricted and expensive. As industry advances, there are also inevitable concerns raised within creative communities. As Hegarty puts it, '…technology allows us to do more things and to do them faster than ever before. But that doesn't mean that what we're producing is any better' (Hegarty, 2014). Therefore, educators should retain the core value of creative problem-solving as integral to their pedagogic practice, enabling the expansion of innovative thinking alongside the pace of technological advancement.

The predictions for Industry 5.0 envisage new ways that design practitioners might influence societal change through creative problem-solving. As noted by the organisers of the 2019 Cheltenham Design Festival, this is a very exciting time for designers, but it requires curiosity, creative risk-taking and innovative problem-solving to make positive societal impact (CDF, 2019). This is echoed by the 2017 QAA benchmark statement for Art & Design which states that: 'Experiential, active and enquiry-based learning are features of art and design in honours degrees. Students not only develop the ability to solve set problems in a creative way, but they also develop the ability to identify and redefine problems, and to raise and address appropriate issues'. By incorporating these lateral and problem-solving skills into tertiary education, our students are better prepared for the fast-paced challenges of Industry 5.0 and the evolving futures of work.

Developing a project using AR and social media necessitates both an understanding of community (however defined) and a central ethical purpose or drive. Social media can have many benefits in the educational setting when applied to the correct tasks (Poore, 2016). To support this project proposal for first year design students at UoG, a new topical project focus would be introduced for each academic year. These ethical purposes would reflect current and relevant societal concerns. For example, students could be tasked with developing an AR engagement in response to the loneliness experienced within many isolated communities during the Covid-19 pandemic lockdowns. By independently identifying a wide range of relevant research sources in relation to the creative challenge, students should be able to generate ethical and responsive solutions to the problems outlined in the brief. These in-depth student investigations would also provide new information and experiential insights, encouraging valuable self-reflection regarding the broader role and accountability of the designer. As Jarvis suggests, as educators and reflective practitioners, development comes through reflection, learning new skills and adjusting our attitudes where necessary (Jarvis, 1999).

The next consideration regards incorporating ethical design practices within the proposed VR brief. The 2021 Design Research Society conference (DRS, 2022), noted that designers have significant moral and social responsibilities, shaping the future products and services which inform the way we live. Therefore, designers must challenge themselves and respond to ethical issues conscientiously. Industry 5.0 offers valuable potential for creating virtual communities which reflect the anticipated inclusive principles of the future. GD students should be encouraged to research and evaluate their designs in response to ethical and socio-economic issues. For example, virtual environments and avatars allow society to challenge the constraints that many individuals with protected characteristics routinely face (Bertrand et al., 2018). VR also establishes opportunities for building further connections across international boundaries. These developments are likely to create profound societal impacts. As the architects of these environments, the ethical responsibilities of designers will expand substantially.

8.6 Sustainable Practice in Industry 5.0

In the past, the Graphic Design sector has come under scrutiny for sustainable practice. As a 2016 report from the Australian Government reflected, the sector relies on a variety of resources of extensive quantity (BV, 2016). Therefore, designers should make considered decisions around the sustainable life cycle of their designs. This intervention highlights the opportunities for more sustainable, or at least more considered usages of resources and the design community's responsibility for such. Sustainability has been universally highlighted as a significant challenge for our industry. Industry 5.0 allows design practitioners to conceive of new solutions to this global societal challenge. In 2016, the World Economic Forum noted that, Industry 5.0, and digital development could actually assist the world's sustainability. This is a powerful reflection of the role of digital processes across the economies of the future. As Industry 5.0 emerges, so does the potential of digital platforms for helping to address some of the key ecological imperatives of our time. This establishes fundamental accountabilities for the ecologically and climate-aware graphic designers of the future.

Immersive technologies have the potential to create connections across global societies and to re-imagine, if not to break, more physically tangible boundaries. For example, the often discretionary 'need' for international travel has profound environmental and climactic effects. By part analogy, the Metaverse is establishing translation capabilities so that language and travel would no longer be such insurmountable barriers to building international communities. These global connections would help establish essential skill-shares as we work to collaboratively critique and resolve significant societal issues. The United Nations Sustainable Development

Goals Report (UN, 2021), heralded the acceleration of Industry 5.0 and digital platforms through worldwide collaboration which emerged in response to the Covid-19 pandemic. Through this, the report predicts a brighter future, where societies worldwide are further connected through technological advancements. This characterisation supports an understanding of Industry 5.0 which encompasses strengthening interconnections within and between societies as well as those bridging technology and humankind.

However, digital solutions are not yet universally heralded as entirely sustainable resolutions for the creative industries. Researchers from the Centre for Energy-Efficient Telecommunications (CEET) note that the information communications and technology (ICT) industry produces more than 830 million tons of carbon dioxide annually (CEET, 2013). More recently this figure has been revised upward to 10% of the European electricity expenditure and 4% of its carbon emissions (EU Footprint, 2021). This poses a significant contribution to the sustainable issues that global incentives are determined to resolve. However, by recognising constraints regarding the sustainability of digital resources, solutions have quickly emerged and will rapidly continue to make an impact. The World Economic Forum reflected that improved management of energy storage could potentially save 8.8 billion metric tons of CO_2 emissions by 2025 (WEF, 2016). Within the UK's university sector, UoG was among the recognised pioneers of institutional sustainability, having previously been awarded the number one position in the 2019 *People and Planet* sustainability league table for all UK universities (People & Planet League, 2019). The institution's graphic design lecturers use these informed insights and practices in their delivery to encourage a broader and more reflexive approach to the deployment of green technologies.

As educators we should be transparent regarding the constraints and consequences of each design solution that we pose. Companies that have harnessed digital solutions as a means of establishing ethical perceptions without exploring the full extent of environmental impacts have been accused of 'Green Washing'. These and similar practices risk both devaluing and causing reputational harm (through negative user perceptions) in respect of the many truly ethical green practices within the design sector. However, there has been an increased recognition that sustainable design can only be fully achieved through research, ongoing critical review and the setting of, and adherence to, ethical goals. The recent UN Sustainable Development Goals Report advised the collective responsibility of developing digital processes which support climate-sensitive outcomes, respect biodiversity whilst remaining resilient (UN, 2021).

Design practitioners in Industry 5.0 should be accountable for ensuring that these responsibilities and affiliations are respected and upheld. Resilience, fundamental to the future of sustainable practice in design, can only be achieved by informing, supporting and encouraging future generations of designers through responsive and adaptive education. The proposed UoG briefs for developing AR and VR Graphic Design BA solutions incorporate a commitment to the values of sustainable practices. First year students are encouraged to research, to strategise and to promote the sustainable benefits of the virtual environments which they create. An informed awareness of sustainable practice in emerging technologies is an invaluable learning outcome not just for this assignment brief but equally for our students' onward professional development and sense of vocation.

8.7 Proposed Design Assessment Practice and Rationale

The proposed UoG AR and VR Briefs will be assessed through portfolio submissions. These documents shall be evaluated on the basis of the acuity and clarity of investigation, the innovation of design process and its corresponding ideation with each submission measured with reference to five assessment criteria. These are provisionally formulated as follows: Research, Analysis, Concept, Development and Outcome. Each of these criteria will be assessed equally in order to reflect the parity of each stage of the design process, replicating best industry practice. The underpinning pedagogic rationale being that thorough, well-defined individual research and cogent analysis should inform principled design solutions. A clear and ethical purpose is expected to inform the student's pedagogic development, while also instilling ethical considerations when participating in social platforms. Each student will also be encouraged to use their cognitive and practical skills to formulate appropriate and workable responses in order to resolve the challenges of their brief and the context(s) of its proposed use or application.

By articulating a variety of relevant concepts, students should be able to explore and understand the broader value and application of research and analysis within the design process. This should support more refined design solutions and further opportunities for exploration and professional progress. Holistically, students' skills development should be reflected in and through experimentation with innovative technologies achieved through technical workshops, module delivery and independent study. The final outcomes for each brief will be carefully formulated to enable freedom of exploration and creative expression. It is our shared contention that more openly defined outcomes also uphold a commitment to an inclusive educative environment which is especially relevant for supporting the confidence of first year students. This brief has been designed to allow our students to develop technical proficiencies from different skill foundations, while also exploring a social cause in which they have personal conviction.

Both of these set assessment briefs would be used developmentally as case studies for implementing further Industry 5.0 relevant content into GD delivery at UoG. The success and learning gain of these assessed briefs will be measured both quantitively and qualitatively via formative course reviews, student feedback, industry insights from visiting (external) professionals and summative assessment results from the participating cohorts. The input of External Examiners will also be requested in relation to broader comparators of practice elsewhere within the university sector. Once these outcomes have been subject to further reflection, peer discussion and review, we anticipate using these case studies as a basis for further course and module development, reflecting the ethos of Education 5.0.

8.8 Concluding Observations

Industry 5.0 has far-reaching ramifications for Graphic Designers as it has for all practitioners within and across the creative industries, whether in the UK, transnationally or globally. Alongside these expansive opportunities and the challenges they pose, the professional role and expectations of the contemporary design practitioner have changed to accent further social and ethical accountability. As outlined, the proposed and exploratory academic briefs for our first year GD students aim to incorporate the expansion of technical proficiency, an awareness of ethical design considerations and the broader context of their operation.

Student feedback and outcomes from the introduction of these proposed briefs will inform the development of our next generation curriculum for the future of work. As suggested in this paper, the potential for incorporating ethical and sustainable practices into each brief will also support our students' development and their understanding of the future challenges faced by the design industry. The complementary delivery of technical skills acquisition and an awareness of ethical contexts will not only enhance the vocational opportunities for our student cohorts, but will crucially reflect the stringent standards of the contemporary design sector and the imperatives of Education 5.0.

These interventions are conceived as part of an exploratory stage in re-fashioning and further enhancing the design curriculum at UoG and, as centrally, the student learning experience. Naturally, curriculum assessment tasks are of, and in themselves, just one experiential component of a broader design education. Our aspiration here is to deploy such to further help and support a dynamic, creative design environment which fosters critical challenge and supported progression, enabling self-reflection, student confidence and agency in their tertiary learning journeys.

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Chapter 9
Students' Perceptions of Employability Towards Interdisciplinary Education in the Construction Engineering Programme in New Zealand

Kam Yuen Cheng and Yin Fang Zheng

Abstract Technical skills alone can no longer fulfil and adapt to industry and market demands as an economy grows. Enterprises now need a broader skillset than a single professional or technical expertise. This signifies that the company's needs for personnel are technical and soft skills. Soft skills comprise teamwork, critical thinking, and general thinking capabilities (Becerik-Gerber et al. in Handle Proxy, 2006). Methodology: A questionnaire survey was developed and distributed to all the thirty two year-two and three-degree Bachelor of Construction—quantity surveying and construction management programmes in one higher education polytechnic in New Zealand. Findings: This paper shows that students undertaking those interdisciplinary electives reported a significantly stronger development of work-ready skills in the industry. Specifically, interaction with industry, bi-cultural awareness and problem-solving skills were more developed. Originality/value—This study advances our knowledge of the relationship between interdisciplinary education and students' perceptions of their employability. The goal of this study is to increase understanding of interdisciplinary course design and pedagogy and strengthen the connection between learning and work in New Zealand by examining the effectiveness of interdisciplinary learning with a focus on social-cultural aspects in programmes related to construction engineering in New Zealand.

Keywords Construction management · Employability · Interdisciplinary course · Work readiness · Biculturalism

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9.1 Introduction

With the development of science and the progress of society, the integration of the global economy and the enhancement of cooperation, companies have more diverse needs for employees, and technical capability alone can no longer meet and adapt to the needs of companies in the market. They expect employees to be good at the technical level and apply soft skills. Soft skills are teamwork, collaboration, the ability to evaluate the impact between technological, social, economic, and human elements, critical thinking, and comprehensive thinking skills (Becerik-Gerber et al., 2006). Luxhj and Hansen (1996) identified The inability to collaborate and converse with others; the failure to come up with original solutions, and the inability to handle complex problems requiring the integration of social, economic, legal, and technical factors are just a few of the flaws in traditional education. To inspire students to tackle multidimensional challenges, multidisciplinary learning aims to lower student attrition, promote self-confidence, communication skills, and inventiveness, emphasise integrated problem-solving, and strengthen teacher leadership skills.

Most construction programmes do not allow for continuing evaluation or interdisciplinary connections across courses. In conventional learning, primarily a terminal process, the ability to pass final examinations is the key learned skill. Continuous assessment of a contextualised, autonomous, transdisciplinary, and student-centred approach may improve its effectiveness. As the key player in preparing students for working in the industry, higher education institutes should adjust the corresponding teaching mode to adapt to the rapid development of industry changes. Such changes are embodied in the rational setting of interdisciplinary courses in the curriculum, designed to cultivate interdisciplinary technical talents suitable for the changing society. Interdisciplinary workability is essential in the future community (Kang, 2008). This paper used construction management and quantity surveying programmes in New Zealand higher education as a case study to explore the student's perception of interdisciplinary electives in construction engineering-related programmes.

9.2 Characteristics of the Interdisciplinary Curriculum in General

The traditional engineering curriculum education system in the United Kingdom continues with the handicraft master-apprentice teaching model. This teaching model is dedicated to a deep understanding of the scientific principles of the subject and applying them to the greatest extent in daily production (Robinson, 1990). However, suppose advanced technologies such as BIM, VR, and drones are being extensively used, and more diversification in the workforce is seen in the construction industry. In that case, this traditional model can no longer catch up with the needs of the industry. The development and reform of new educational models are imperative (Barnard et al., 2013). This curriculum reform model adapted to the development of industry and society is manifested in the introduction and set of interdisciplinary courses. The concept of interdisciplinary courses is comprehensive. It not only refers to the simultaneous study of two or more different types of subjects but also focuses on embedding different knowledge from multiple subjects and integrating them into professional practice (Repko, 2008). The interdisciplinary curriculum will include studying other professional liberal courses, such as philosophy, economics, and business (Klaassen, 2018). The benefits of setting up interdisciplinary courses are twofold.

On the one hand, it can improve students' transferable skills such as communication, teamwork, critical thinking, and comprehensive thinking skills (Newell, 1998). Moreover, people with professional skills can bring more diversified value to the company because of their soft skills (Spinks et al., 2007). With the dual guarantee of professional knowledge and soft skills, they can have a better forward-looking judgment on the company's strategic development rather than confining the training of talents to the technical level (Richter & Paretti, 2009).

From students' perspective, a sound selection system and curriculum arrangement play a positive and irreplaceable role in their learning (Barnard et al., 2013). Under the interdisciplinary elective course model, the school provides a variety of interdisciplinary courses for students to choose from. Students will choose courses under the teacher's guidance to minimise the problems of learning motivation without explicit knowledge of what they are looking for or whether the courses match their learning objectives and personal growth plan. (Lattuca et al., 2013; Richter & Paretti, 2009). Among the interdisciplinary electives, humanities-related interdisciplinary elective courses play a crucial role in improving students' interpersonal and communication skills required by the industry before entering society. It can also help students build critical thinking and cultivate holistic thinking skills and team awareness (Barnard et al., 2012). In addition, the people-oriented and encouragement of self-discovery nature of humanities courses support students in better understanding themselves in terms of their strengths and weaknesses through the learning journey (Harrison et al., 2007).

9.3 Characteristics of Interdisciplinary Courses Under the Unique Cultural Background of New Zealand

With New Zealand's unique historical background, Te Tiriti o Waitangi (Treaty of Waitangi) play an essential role in the curriculum design. Interdisciplinary course development in New Zealand has its unique bicultural characteristics. As a unique traditional culture of New Zealand, Māori culture has long embodied the humanistic spirit (Belich, 2002). "The curriculum acknowledges the principles of the Treaty of Waitangi and the bicultural foundations of Aotearoa New Zealand. All students could acquire knowledge of Te Reo Māori me ōna Tikanga". the Treaty of Waitangi puts forward three "P" principles. These three "p" refer to Partnership, Protection and Participation. The partnership encourages everyone to integrate into each other's establishment. The close contact and cooperation between communities are teamwork in the modern sense (Bennett & Liu, 2018). Protection refers to protecting and learning Māori culture to enhance mutual respect. Participation means that Māori culture should be more diversified to participate in all aspects of social life, including integration into school education, related to overall comprehensive thinking in the modern sense. The interdisciplinary electives incorporate Māori culture into their learning. For regional education, such curriculum settings and arrangements make it easier for students to integrate into the culture and society while positioning their long-term development goals to align with New Zealand. In addition, the bicultural background encourages students' divergent thinking and being more innovative and creative.

9.4 The Influence of STEAM Education on the Construction Engineering-Related Curriculum in New Zealand

As a new educational framework concept introduced at the beginning of the twenty-first century, STEM has played a significant role and far-reaching influence in reforming and promoting academic curricula in the past 20 years (Herro et al., 2017). STEM refers to the interdisciplinary curriculum centred on science, technology, engineering, and mathematics, which aims to encourage students to adapt to the development of science and technology better and comprehensively in modern society and cultivate students to establish a comprehensive engineering thinking mode and scientific thinking attitude (Becerik-Gerber et al., 2006).

However, the pure STEM model can no longer meet the expectations of organisations and enterprises looking for talents with not only technical but also soft skills. The STEAM education model is expanded to STEAM on this basis. The A refers to "Art" literally, but this is a humanistic care discipline represented by Art (Herro et al., 2017). Focusing on humanities and caring subjects, adding related interdisciplinary courses will help improve students' overall creativity and develop divergent thinking (Hunter-Doniger, 2018). From a scientific point of view, adding more "A" can help students develop logical thinking and thinking in images in a balanced manner. This is a basis for enhancing students' overall development ability (Miller, 2014a, 2014b).

The reform of the STEAM model specific to the QS and CM education model in New Zealand is reflected in the interdisciplinary humanistic care courses based on the background of Māori culture to cultivate students' overall ability. On this basis, optional courses that supplement professional skills are committed to developing comprehensive talents (Cook, 2016). For example, students can choose introductory project management courses as interdisciplinary elective courses to improve their project management and coordination skills. Learning from different perspectives can also encourage students to further understand and improve their technical skills by interacting with others. Similarly, it has also integrated business and other humanities subjects into the curriculum. Considering the many contributions and reciprocal advantages of all parties concerned, STEAM complements and challenges preconceived perceptions of this emerging educational movement, which is usually focused on calls for competitive economic development and technical improvement (Sochacka et al., 2016). With a deeper understanding of their abilities, students can choose more suitable professional elective courses under the guidance of the humanistic subject.

9.5 The Current Programme Structure of Construction Management (CM) and Quantity Surveying (QS)

The degree is designed to comply with approval and accreditation rules. It is consistent with higher education in New Zealand's objectives, values, desired graduate outcomes, and core academic policies and procedures. The importance of Kia Hihiri (Inspire), Kia Tuhono (Connect), and Kia Pono (Trust) inform and contribute to the culture of the degree and are integrated throughout the programme.

9.6 Vocational Applied Learning

Critical thinking and management capability are developed through participation in activities that provide learning opportunities within industry contexts. Students will use work-integrated learning to understand effective industry practices and develop the industry's skills to be future leaders.

The teaching and learning approaches deployed are founded on Ara's deep and successful history in providing vocational and applied learning with outstanding results for students. This degree is designed to cater for the unmet need for graduates to be able to move into management and leadership roles in the construction industry.

Setting up and arranging applied vocational courses improves students' comprehensibility, including critical thinking and overall thinking ability, transforming these abilities into skills, and preparing for future application at work.

9.7 Cultural Understanding of New Zealand

New Zealand's unique socio-political development has created an atmosphere in which indigenous (Māori) ideas and values are increasingly infused into our country's distinct identity and the resulting worldwide competitive advantage. Simultaneously, the Māori economy is rapidly growing in New Zealand, incorporating Māori viewpoints and goals into decision-making.

Students with the information, abilities, and attitudes necessary to capitalise on New Zealand's worldwide competitive advantage will be more prepared to function well in both a multicultural, long-term New Zealand and a bicultural, global market. Graduates of this degree will have a sound working knowledge of core Māori values and processes through assessed experiential learning within unique Māori settings (e.g., whakawatea Whenua) and relevant curriculum. Collectively, these two lines of knowledge acquisition will produce students able to engage effectively in the growing Māori economy and on the world stage.

The cultivation of cultural awareness of New Zealand enables students to better integrate into the local culture and learn to solve and distinguish problems in a multicultural context. Ability. Comprehensive analysis and critical thinking about the application of knowledge under the background of local culture and how to better integrate professional knowledge into local culture so that this part will become an advantage for future employment.

9.8 Socio-Cultural Learning

Ara values the social context of good learning experiences. Students are more successful in a positive, supportive learning environment, and their fellow learners contribute to their learning. The degree programme design acknowledges that understanding is influenced by cultural background and is a social experience. The Department of Engineering and Architectural Studies has built a culture where students develop a sense of belonging to a broad community of learners.

This sense of belonging is achieved by integrating cultural experiences, team-based learning activities, peer mentoring, and assessment approaches. This focus on assisting students in developing a sense of being part of the New Zealand construction industry prepares them for working in multidisciplinary teams with diverse cultural and socio-economic profiles.

Cultivating Socio-cultural learning curriculum setting and arrangement develop students' ability to adapt to a society based on their professional background. Under the influence of social culture, curriculum education helps students use holistic thinking and critical thinking skills to better adapt to society and have a deeper understanding and understanding of the social role of the construction industry in the future. So that students can solve problems in different environments, better apply their professional knowledge and express their professional opinions reasonably and appropriately.

9.9 Economic, Social and Environmental Sustainability

Ara commits to the sustainable organisation and providing students with learning opportunities to be sustainable practitioners. The degree programme is designed to give these opportunities; sustainability is considered in economic, social, and environmental terms with attention to the impacts on present and future generations needed to live and thrive.

From another perspective, the concept of sustainable development has always been part of New Zealand's traditional culture—Māori culture, which has a profound historical impact on New Zealand's society. The concept of "Kaitiatanga" emphasises that humans are the children of Ranginui and Papatunuka. Nature has nurtured human beings, and human beings should also be the Kaitiaki of nature. Such a relationship is as natural as the family members in the extended family guarding the family. Whether how history develops and the social form changes, the spiritual support of human beings is always rooted in nature; from this perspective, the concept of Māori Kaitiatanga and sustainable development in modern society are inherited. Now in New Zealand, this concept exists in the traditional Māori culture and is widely accepted by modern companies and integrated into the company culture as part of the company's sustainable development philosophy.

Sustainability and the wise use of global resources are integrated throughout the programme with specific learning outcomes in relevant courses. An example would be the Estimation courses, where the minimisation and cost of materials, labour and plant waste are calculated.

The courses–Site Management and Site Safety- cover procedures for managing waste on sites, while energy efficiency is studied in Building Services and Construction. Quantity surveying students research life-cycle costs and sustainable alternatives in Cost Planning and Building Information Modelling (BIM). Students model energy consumption using appropriate software such as BRANZ ALF (Annual Loss Factor) and Design Navigator in the first-year Environment course. They were extended in the BIM Project elective course in the first year, where students use more sophisticated software to measure energy efficiency.

Economic, Social and Environmental Sustainability train students in their professional background to cultivate students' compatibility with society. With the concept of sustainable development, we constantly improve our comprehensive thinking ability and quality from a professional point of view to think about how to maximise economic energy conservation and sustainability. Using the curriculum advantages of interdisciplinary education enables students to integrate such concepts into their professional studies before entering society, helping them adapt to social development needs.

9.10 Employability of Learners

From helping employment, reforming the interdisciplinary elective course system based on humanistic care courses can help students improve their competitiveness and are a guarantee for enhancing Employability (Richter & Paretti, 2009). Taking QS and CM majors in New Zealand as an example, learning about Māori cultural background courses can help students integrate into the local culture, integrate into local enterprises, and play an active role in employment. Their data shows that more companies pay more attention to the soft power of employees than professional skills when recruiting employees, and employees' soft skills and professional qualities are placed in an equally prominent position. Furthermore, students do not have the opportunity to systematically understand their soft skill training and promotion during school. In that case, it is difficult for them to realise their shortcomings and professional ability in the enterprise. Soft power and professional ability complement each other, and improving the delicate portraits can help students understand themselves more clearly and better understand themselves. Critical thinking will help students better understand the gap between themselves and the company's employment requirements and can and of their subjective initiative to make up for the opening.

Through the knowledge and understanding of Māori culture during university, students can deepen their belief in and knowledge of local culture and better integrate into local culture, bring local culture to the enterprise, and combine local culture with the humanistic care culture of modern society. It can better base itself on the local area, provide enterprises with cohesion, and increase their core competitiveness (Davis et al., 2014). More companies respond that the lack of professional competence and the lack of humanities culture become more serious when graduates enter the company because most engineering students do not have the consciousness of choosing humanities subjects during their school years. This also reflects from one aspect, such as construction management (CM) and quantity surveying (QS) majors in the third year, to provide students with the importance of humanities interdisciplinary courses. If the school does not offer such a choice, most students choose elective courses based on professional courses, which leads to a complete lack of education for humanistic care courses. If the school takes humanities courses as its characteristic, it will compensate for the student's shortcomings in education. The 21st-century innovation concept's STEM teaching idea alludes to an interdisciplinary education that includes science, technology, engineering, and math. In addition to learning in a single course and from peers in various fields, students also have the chance to develop their original and diverse ways of thinking outside of professional classes. Additionally, this teaching approach might help pupils become more conscious of collaboration.

9.11 Research Gap

Although we know that one of the academic goals of an interdisciplinary course is to assist graduates in transitioning into the workforce (Holdsworth & Sandri, 2021), we do not know how students view the increase in employability due to interdisciplinary courses. Academics value the study because it allows them to examine how students perceive their employability and how multidisciplinary elective activities impact that perspective, which can then be used to drive future curriculum development. The study also allows for examining more particular graduate behaviours throughout the transition to work, such as self-esteem. The application of skills in a context, the development of bicultural awareness, and the transfer to the profession have all been highlighted as broad transdisciplinary course-specific aims in New Zealand higher education construction engineering courses but have not been examined. This research, which examines the success of an interdisciplinary course from the student's viewpoint, attempts to fill this gap.

9.12 Methodology

The role and significance of interdisciplinary elective courses in QS and CM majors are investigated using a questionnaire survey. In the form of questionnaire surveys sent to third-year undergraduates, open-ended and chosen questions are utilised as the starting point for gathering the opinions of third-year undergraduate students on interdisciplinary elective courses. This research aims to investigate students' perceptions of employability following interdisciplinary elective courses on students' elective courses. A comprehensive examination of six criteria, including in-depth integration of cultural, social, and economic sustainability of interdisciplinary elective courses, was performed.

The study population (N = 32) consisted of every student in years 2 and 3. It is important to note that the students in their last year of undergraduate construction engineering studies had much experience working in the field, including internships or teaching in high schools (specifically, engineering or science). Before this programme, they had little exposure to interdisciplinary teaching and learning.

According to the constructive-qualitative method, a phenomenon under research should be handled holistically in its natural environment (Patton, 1990). The study described how students' attitudes and thought patterns changed during the course (Stake, 1995). The previous session began with students completing open, anonymous questionnaires.

9.13 Analysis and Findings

9.13.1 Profile of Respondents

The total number of year two and year three Degree students is thirty-two, all of them were sent the questionnaire, and eighteen valid responses were received. The effective response rate was 56.25%. Two-thirds of respondents are full-time students, and another one-third are students working in the industry in different capacities, such as consultancy firms, main contractors, and suppliers. All respondents are students, and more than 30% are from industry, showing the survey results' representativeness, currency, and appropriateness.

9.13.2 Reliability of the Data

As shown in Table 9.1, most learners are full-time students accounting for 66.7% of respondents, and 33.3% are working in construction engineering-related industry. All the full-time students received the internship opportunity in year two, and all respondents have industry experience. The survey result validates students' attitudes towards interdisciplinary electives regarding the competencies expected in the industry showing the relevance and value of the research results.

Data reliability is referred to as consistency. Cronbach's alpha values greater than 0.70, according to Nunnally and Bernstein (1994), suggest strong internal consistency. The data's 0.94 Cronbach's alpha indicates that it is of very high quality.

Table 9.1 The background of the respondents

Category	Attribute	Percentage (N = 100%)
Occupation respondent	Student only	66.7
	Consultant	5.5
	Main Contractor	11.0
	Supplier	11.0
	Other	5.5

9.14 Findings

9.14.1 Attitudes Towards the Influence of Interdisciplinary Electives Over the Application of Knowledge

As part of the questionnaire that the students completed at the start of the first session, they were asked: "When you think about your research methods, industry project outcomes, or working/internship experience as part of your degree programme, how do your interdisciplinary electives influence your application of construction knowledge and skills in solving the technical problem(s)?" Half of those interviewed agreed that it impacted the application of essential facts, implying a cognitive effect. At the same time, 44% were indifferent, and 6% disagreed, according to the data.

The students were questioned about their views on vocational applied learning via interdisciplinary learning in the most recent questionnaire, which they completed at the beginning of the most recent session. For the second time, one-third of those who answered the survey thought that multidisciplinary electives did not influence the application of construction engineering knowledge, with the remaining one-third remaining undecided.

In my current position as a project manager for a design-build business, I need transdisciplinary abilities daily. This is something I have done and continue to do regularly. It is referred to as "learning by doing". Students' perceptions of change toward interdisciplinary learning are summarised in Table 9.2.

9.14.2 Attitudes Towards the Role of Interdisciplinary Electives in Cultural Understanding of the New Zealand Workplace

In the preliminary questionnaire, students were asked, 'How do you estimate the importance of those interdisciplinary electives such as business, culture, say, Te Reo, ICT, management (approaches, methods, strategies, and tools) in grasping the problem(s) you encountered in your workplace?' In the final questionnaire, students were asked, 'How do you estimate the importance of those interdisciplinary electives such as business, culture, say, Te Reo, ICT, management (approaches, methods, strategies. According to the study's findings, most students (67%) had no opinion: they were 'neutral.' However, just 22% of the remaining students felt that it might benefit them in terms of cultural awareness. In comparison, 11% answered that they did not perceive a connection between this behavioural component and their knowledge of workplace challenges.

After examining their responses, it was shown that half (53%) of respondents considered that interdisciplinary electives were beneficial.

Table 9.2 Students' perception of change toward Interdisciplinary learning

		Before			After		
	Questions	Agree (%)	Neutral (%)	Disagree (%)	Agree (%)	Neutral (%)	Disagree (%)
Q.1	Thinking about your research methods, industry project outcomes or your working/internship experience undertaken as part of your degree programme, how do the interdisciplinary electives influence your application of construction knowledge and skills in solving the technical problem(s)?	50	44	6	33	33	33
Q.2	How do you rate the role of those interdisciplinary electives such as business, culture, say, Te Reo, ICT, and management (approaches, methods, strategies, tools) in understanding the problem(s) you encountered in your workplace?	22	67	11	53	27	20
Q.3	Upon completion of this course, I can function in multi-disciplinary teams	56	44	0	53	7	40
Q.4	Upon completion of this course, I can and professional and ethical responsibility	44	44	11	53	33	13

(continued)

Table 9.2 (continued)

		Before			After		
	Questions	Agree (%)	Neutral (%)	Disagree (%)	Agree (%)	Neutral (%)	Disagree (%)
Q.5	Reflecting upon your programme of study (degree course), the integration of the different disciplines in your electives (business, culture, ICT, management) enriched your learning experience?	28	61	11	53	13	33
Q.6	How important do you think interdisciplinary electives (Culture, Business, ICT, Management) prepare you for industry, particularly the soft skills required in critical thinking, problem-solving, and teamwork?	28	50	22	40	27	33

One student said in response to an open question. "It has helped me understand the structure and importance of different roles in my workplace, why they approach/view projects differently and can sometimes have different outcomes or priorities, but they all contribute to the big picture and the project's success," another student said in response (Student A).

Also included are excerpts from student interviews that demonstrate how they believe interdisciplinary learning has improved their understanding: "I'll incorporate them into my work", "For example, when I go to work, I will use talents that I have learned via interdisciplinary knowledge, such as communication abilities." (Student C).

According to the questionnaire results, the observations' behavioural component—practicality–fosters the students' considerable enthusiasm for interdisciplinary learning and learning.

9.14.3 Attitudes Toward Social and Cultural Learning

In your electives (business, cultural, ICT, management), explain how combining multiple disciplines has benefited your learning experience. 'Positive' is an adjective that refers to a positive attitude (or reaction), whereas 'non-positive' refers to a negative attitude (or response) or a lack of a perspective (or response). The percentage of students in each cell in the table corresponds to the cell in question. According to the graph, most students (61%) expressed apprehension regarding interdisciplinary learning and teaching before the start of the semester. When asked how they felt about interdisciplinary education, 28% said they felt optimistic about it, while just 11% said they felt adverse.

According to the findings, a favourable attitude toward interdisciplinary and cross-disciplinary learning was shown by most students (53%) after the course. A third of the students expressed dissatisfaction with interdisciplinary knowledge in their surveys (33%).

When the tables are compared, it becomes clear that the student's points of view shifted drastically over the course. At the beginning of the semester, most students had a neutral idea regarding interdisciplinary electives on job application and learning experience. Still, towards the conclusion of the semester, they had a positive attitude toward both, from 28% up to 53%.

9.14.4 Attitudes Toward Interdisciplinary Electives on the Soft Skills Improvement

"What role do you believe multidisciplinary electives (culture, business, information technology, and management) have in preparing you for the workplace, especially in developing soft skills such as critical thinking, problem-solving, and teamwork?"

Specifically, it indicates that students' attitudes toward interdisciplinary learning and teaching were neutral at the beginning of the course (50%), with just 22% having negative attitudes against either or both. A few students expressed an interest in multidisciplinary electives focused on soft-skills development, which were offered as part of the curriculum (28%).

The results demonstrate that, after the semester, 40% of students had a positive assessment of interdisciplinary electives on soft skills growth. However, the number of people opposed to it increased from 22 to 33%.

According to the open question in the survey, "it has the potential to teach me certain important skills, such as communication and collaboration". In addition, information and communications technology (ICT) may aid me in better use of the computer and keeping up with society."

"Lessons in interdisciplinary topics have assisted me in comprehending issues from various viewpoints, and they have improved my comprehension and problem-solving abilities." (Student C is an example of this.)

9.14.5 Attitudes Towards Functionality in Multidisciplinary Teams

The preliminary questionnaire, which the students answered before the first session's commencement, asked whether they felt they were "qualified to function in multidisciplinary teams" after completing the course. According to research, a favourable attitude toward the topic is expressed by most students (56%), while 44% say no opinion on the matter.

Students answered at the beginning of the final session and were asked their opinions on the Interdisciplinary team working again. There was a behavioural component of agreement with 40% of the students this time around and the corresponding favourable attitude of 53% last time.

"Interdisciplinary studies will aid me in better integrating into society while also boosting my talents," says the student.

The question was posed: "How have you reconciled and synthesised interdisciplinary knowledge and understanding with your technical background, considering your professional experiences or studies?".

"Coming up with solutions as a group."

9.14.6 Attitude Towards Ethical and Professional Aspects

After completing the course, the students were invited to complete a preliminary questionnaire at the start of the first session. They were asked whether they understood their professional and ethical responsibilities. Statistics show that over half of the students (44%) had no opinion on the matter, indicating that they were neutral. Most students (44%) were more positive in their assessment.

The students were questioned about their views toward interdisciplinary learning in the most recent questionnaire, which they completed at the start of the most recent session. More than half of the students expressed support this time, while 33% voiced neutrality and 13% voiced opposition.

9.15 Discussion

According to students, interdisciplinary learning in construction engineering courses helped them integrate well into the workplace. Still, it also helped them understand the subject matter better because of the cultural aspect. They further stated that this approach was natural and appropriate for today's generation, where the line between cultural and technical skills is blurred.

We understand that no such results for undergraduate New Zealand students in science and engineering education have been recorded. Students experienced a sense of accomplishment after the course, which is typical of multidisciplinary learning and stems from the need to integrate into society and a bi-cultural workplace. Some students had significant prior work experience in their respective fields before enrolling.

This sentiment was echoed in the behavioural component. Students spent much more time learning about the new subject than the technical abilities they had previously learned in years one and two of their education. Furthermore, because of education, the cognitive component of students' perceptions is altered. Before taking the course, students believed that interdisciplinary electives would be challenging to prepare them for the collaboration skills expected in the industry because most students believe that hard skills are more important; however, by the end of the course, students identified challenges had been alleviated, and the interdisciplinary electives were assisting them in learning and applying technical skills that are expressed in finding a balanced mix of disciplinary know-how and experience. They also discovered that working across fields benefits all of these abilities. According to Marcketti and Karpova (2014), students enjoyed engaging with business to enhance problem-solving skills in a real-world context with their classmates; effective collaborative learning in higher education is dependent on reliance, accountability, and participation (De Hei et al., 2015). Stember (1991) proposed similar requirements for good interdisciplinary cooperation, focusing on belonging. Successful interdisciplinary teams must be able to balance differentiation and integration. Although this is the first time we have observed their behavioural expression of the value of technical and interdisciplinary skills, these attitudes are consistent with the literature's discussion of the difficulties associated with interdisciplinary teaching (Grünzweig, 2004; McComas & Wang, 1998), and this is the first time we have observed their attitudes regarding the value of technical and soft skills. Despite the significant difficulties associated with interdisciplinary learning—such as biculturalism and management, which students encountered during the course—there was a substantial increase in the proportion of students who agreed that interdisciplinary electives effectively support their understanding of workplace problems. Similarly, kaitiakitanga cannot exist without mana, tapu, and mauri. Because they are all interrelated, we must also pose the whakapapa necessary to be a kaitiaki. Although most students claimed that they were unsure or could not decide whether interdisciplinary electives could help them better understand ethics and professionalism in their roles as construction engineering specialists or enrich their learning experience beyond the existing technical core curriculum before taking the course, more than half had expressed support for studying interdisciplinarity at the end. This tendency might be related to students' increased social participation with students from other departments and their recognition of the significant academic benefits of interdisciplinary study.

The study's theoretical contribution is the description of attitudes held by students in scientific and engineering education regarding interdisciplinary learning and teaching of science and engineering disciplines. To the best of our knowledge, this is the first time this kind has been characterised. For example, the findings' implications for teacher education programmes may be used as a case study to illustrate the practical impact. Moreover, engineers and scientists are in short supply (National Science

Board 2010). Significant efforts are being made to persuade high school graduates to pursue jobs in these sectors to enhance their contributions (Rockland et al. 2010). The Follow-up study will include interviewing course graduates after they have completed their teacher training to see if and how they incorporate interdisciplinary teachings into their work at high schools in the future.

9.16 Conclusions

After taking the elective, interdisciplinary courses, the research examined how students' perceptions of interdisciplinary science and engineering learning and teaching evolved. Participants' data showed that student perceptions changed during the study. At the beginning of the research, most students had unfavourable views about interdisciplinary learning and teaching, but towards the end, most students had positive attitudes toward both. Most students who participated in the survey agreed that their soft skills had improved after participating in interdisciplinary courses. These improvements are mainly reflected in the advancement of teamwork, critical thinking and comprehensive thinking ability. The progress of these abilities is different from professional skills, which can be quantified, but more of a process of subtle improvement and progress in daily learning and life. The third-year students who participated in the questionnaire had positive and significant feedback on the impact of the interdisciplinary curriculum from those who had work experience and were currently working. These experiences are the insights brought by the synergistic effect of practical work experience and interdisciplinary curriculum learning. On the one hand, the teaching of interdisciplinary courses promotes the improvement of students' soft skills by broadening students' horizons and enhancing students' understanding and perception ability. From this perspective, interdisciplinary courses indirectly improve students' learning ability, and the value of ability improvement to students and the industry is immeasurable. Students have a more intuitive understanding and experience of soft skills and how to improve soft skills through personal participation in the learning of interdisciplinary courses. Students can smoothly understand the interdisciplinary cognitive curriculum in the emotional part, develop an interest in it through learning, and establish a virtuous learning cycle under the guidance of interest. According to the study's findings, following the training, a cognitive component (interdisciplinary learning is natural and enhances knowledge) was added to the pre-existing emotional part (interdisciplinary learning is natural and improves understanding) to produce a complete picture (finding interest in education). This is a response to the discovery of additional learning problems. It happens with difficulties uncovered in previously unknown new regions of knowledge. Despite the significant challenges that interdisciplinary teaching entails- challenges that the students were exposed to as part of the lessons they taught-the proportion of students who expressed interest in taking interdisciplinary classes in the future increased significantly over the course of the semester.

Successful interdisciplinary needs a more profound commitment to be allies or create partnership approaches centred on kaitiakitanga. When organisations who have not done the work take those concepts, they become flat, one-dimensional marketing terms rather than deep values that are solutions to our student's learning.

Limitations of study

The study's modest sample size is one of its flaws; It would be ideal if it included recent graduates from more tertiary institutes. Further research is recommended to ascertain the differences in perceptions between full-time students and those in employment.

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Chapter 10
The Missing Link of Secondary STEM Education in Hong Kong: Transdisciplinary Integration of Revitalizing Vocational and Professional Education and Training

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Abstract In Society 5.0, Education 5.0 enables economic development with the resolution of social problems through advanced technologies and manages technological power appropriately in terms of a humanistic perspective. Education 5.0 is a future education model aiming to encourage student ownership to form a contemporary student-participatory curriculum with teacher mentoring. While STEM education as an Education 5.0 enabler is the key to realizing Industry 5.0 to personalize and rehumanize the manufacturing process, this paper will look at the need to better align secondary STEM education with Vocational and Professional Education and Training (VPET) initiative by transdisciplinary integration to facilitate Hong Kong better transiting to Industry 5.0. The objective is to examine the secondary STEM education development and its potential role and benefits of creating a foundation of transdisciplinary STEM secondary education in overcoming the current shortcomings of the vertical division of academic disciplines. It seeks to restore the VPET nature in the STEM scholarship and emanate from the secondary STEM curriculum renovations and transformations to tackle social and economic challenges, so the processes of STEM pedagogy will be changed significantly to adapt humanization empowerment

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by adjusting the methods and approaches to achieve new industrialization and help align with the call of Education 5.0 in Hong Kong.

Keywords STEM education · Hong Kong · Transdisciplinary Integration · Vocational and Professional Education and Training (VPET) · Social Sciences, Humanities, and the Arts for People and the Economy (SHAPE)

10.1 Introduction

Science, technology, engineering, and mathematics (STEM) knowledge and skills are critical to every global citizen in the twenty-first century as well as the STEM workforce. The desired skills for the STEM workforce include the use of an interdisciplinary approach to problem-solving, technology, innovation, and communication with multiple media tools (Young et al., 2011). Given there are continuous needs for workers to equip STEM skills and acquire content knowledge, policymakers and other stakeholders put more emphasis on STEM education to increase the number of students pursuing STEM degrees and careers (National Academy of Sciences, 2007; Presidents' Council of Advisors on Science and Technology, 2010), some researches further figured out the importance of artistic skills in the STEM workforce (Madden et al., 2013; Keefe & Laidlaw, 2013; Kim et al., 2012).

Vocational education and training (VET), by its essence, is an ideal platform for the integration of STEM. The advanced technology programmes not only becomes a delivery system of STEM skills and literacy to every student, but also the integrated STEM can further drive to facilitate VET by nurturing youth's problem solving and innovation, especially in the workplace. This combination of initiatives may attempt to breakthrough in the workforce development for subsequent industrialization (Industry 5.0) needs and adapt to Education 5.0, in which a holistic educational transformation is urged to prevent dehumanized education emerging from previous educational paradigm on over-focusing technology-based innovation (Education 4.0) (European Commission, 2020a). Instead, future-proof education is called to consider looking far beyond technology and bringing humans back within the educational process (Dervojeda, 2021a).

In Hong Kong, STEM education was first proposed in 2015 as one of the vital education agendas and remained stated in the ongoing curriculum renewal. According to Education Bureau (EDB) (2016), the aim was to equip students' critical thinking ability across different disciplines to apply and integrate their specific STEM knowledge in tackling actual problems in their daily life. This type of learning process enables lifelong learning and helps develop well-rounded individuals, which is the ultimate goal in education and lays the foundation of a broader spectrum, highlighting that future generations should be more rehumaized (Dervojeda, 2021b). Because of this context, this paper aims to examine the secondary STEM education development and its potential role and benefits of creating a foundation of transdisciplinary STEM secondary education in overcoming the current shortcomings of the vertical division of academic disciplines. It seeks to restore the VPET nature in the STEM scholarship and emanate from the secondary STEM curriculum renovations and transformations to tackle social and economic challenges, so the processes of STEM pedagogy will be changed significantly to adapt humanization empowerment by adjusting the methods and approaches to achieve new industrialization and help align with the call of Education 5.0 in Hong Kong.

10.2 Literature Review

10.2.1 STEM and Transdisciplinary Integration

STEM education constitutes an integrated teaching and learning approach to Science, Technology, Engineering, and Mathematics which is widely recognized as important to societal development in the ever-growing economic, scientific and technological globalization. Viewing from individual discipline, Science is "the study of the natural world, a body of knowledge accumulated by humanity and a process that generates new knowledge (through the scientific method or enquiry)" (Reeve, 2013, p. 16). Technology "involves modifying the natural world and the generation of knowledge and processes to develop systems and devices"(Estapa & Tank, 2017). Engineering is "the application of mathematics and science to create technology, and involves the design and development of systems, models, structures, devices, and products." Engineering touches all aspects of our lives, it has shown its ability and potential to dramatically change our quality of life, for better and worse (Lachapelle & Cunningham, 2014, p. 38). Mathematics provides computational tools for predictive analysis in the sciences, engineering, and technology" (Churchill, 2018, p. 49). Breiner et al., (2012, p. 5) pointed out that the acronym "STEM" is the "purposeful integration of the various disciplines as used in solving real-world problems". Shanahan et al. (2016) also noted that integrated STEM education from the notion of boundary objects brings collaborators together. The metaphor of a boundary object indicates neither fixed nor monolithic but partially shared and situationally established among various stakeholders.

Kolodner et al. (2003), Estapa and Tank (2017) pointed out that the scientific method and engineering design process are essential for STEM education, which involves the application of knowledge and creating technology that typically involves different steps, such as problem definition, needs analysis, conceptual solution design, artifact design, and scientific experiment. STEM education is also characterized by its interconnectedness among specified disciplines. Vasquez et al. (2013) describe STEM as an interdisciplinary approach to learning that removes the barriers separating the four STEM disciplines. Students integrate and apply them into real life to enjoy learning experiences. Regarding curriculum integration, there are four levels: disciplinary, multidisciplinary, interdisciplinary, and transdisciplinary. Transdisciplinary integration is considered as desirable and effective (English, 2016). By using disciplinary integration, disciplinary knowledge and concepts are taught separately with few connections. For multidisciplinary integration, a theme-based approach is adopted, concepts and skills are taught separately in each discipline. The adoption of an interdisciplinary approach enables a higher level of knowledge and skills connection and linkage among disciplines, students could have a deeper understanding of the knowledge and skills. In transdisciplinary integration, knowledge and skills from two or more disciplines are applied to real-world problems and projects to shape the total learning experience (Vasquez et al., 2013). Churchill (2018) echoes the ideas of English (2016) that transdisciplinary integration is the most desirable form of disciplinary integration in education, where traditionally separated disciplines are integrated into an educational process of solving ill-defined and significant problems humanity faces. Transdisciplinarity is moving beyond STEM to the level of STEM+, which allows other disciplines, practices, and human potential to be integrated, and the other cores to be put aside.

10.2.2 VET and STEM in Education 5.0 Era

VET is usually interchangeably understood as TVET (Technical and vocational education and training), with its focus originally being to prepare youth for the workforce, making it a primary part of the educational agenda. Therefore, VET has been further defined as the study of technologies and sciences, practical skills acquisition, and knowledge relevant to occupants in different economic sectors and social life. (UNESCO & ILO, 2002, p. 7). With the progression to the twenty-first century, VET is regarded as a constitutive response to the technological transformation, requiring a greater demand for multiliteracies in numerous aspects and higher qualifications (Fawcett et al., 2014). The foundation of the VET system is to respond to many dynamics of the labour market and economic needs, such as social and occupational mobility, and to facilitate the school-to-work transition from the whole education system (Siekmann & Korbel, 2016). VET may involve intermediate-level knowledge and skills in the technical workforce sector in different ways so that VET qualification, workplace learning, and apprenticeship can be carried out smoothly (Knight & Mlotkowski, 2009).

STEM in VET is important for securing skills for the digital economy and Industry 4.0, which means more technologies and elements will drive the move from industrial automation to industrial digital transformation. The constant global economic agenda has pushed for the delivery of STEM skills to speed up economic growth and stay resilient amidst various crises. According to International Labour Organization (2021), STEM competencies become a solid backbone to a workforce that can withstand economic pressures because critical thinking, problem-solving, and innovation skills will become deeply ingrained. When STEM competencies are operationalized by employability, proactive citizenship, and human flourishing to achieve STEM's goals, four domains have been classified to support the success of STEM: STEM knowledge, thinking skills, multiliteracies, and socio-emotional intelligence (International Labour Organization, 2021). In order to STEMifying VET and ensure the success of incorporating VET in STEM outcomes, it is essential to enhance the ability to wield technology purposely for more significant results so sustainable economic growth can be safeguarded. It can develop a workforce defined by individual employability and flourish to digitize VET to a higher level of human capital development despite challenging circumstances (International Labour Organization, 2021).

Given the driving from Industry 4.0, Education 4.0 is aimed to transform into a technology-based innovative educational model and based on the belief that self-regulated and interest-based learning with problem-solving, innovation, and creativity are highly valued (Watson, 2017). As a demand-led education model, it emphasizes the need to prepare students to take on challenges and flexibilities to customize the learning content for students. It can give the workforce of tomorrow the tools to become active lifelong learners and serve as a self-sustaining model for education. However, when COVID-19 brings about an unprecedented long suspension of schooling and places more emphasis on remote learning, the intensification of technological domination has aroused a great worry of dehumanizing education. Hence, Education 5.0 has become a new model which is emerging with Education 4.0 in parallel to tackle the impacts on students' learning from pandemics (World Economic Forum, 2022). Education 5.0 attempts to re-shift the origin of education to humanity, it is about preparing intellectually, socially, and emotionally strong individuals, mindful of their health and personal development (Oliver, 2022). While Education 5.0 will enable a smart curriculum that is integrated with the potential use of Artificial intelligence (AI) and Information and communications technology (ICT) for educational development, Education 5.0 has also caused some concept changes, such as Study-Smart, Work-Smart, and Life Ready Education, etc. (Rahim, 2021).

Under such an Education 5.0 context, the traditional or revitalized delivery of the VET system seems ideal to facilitate STEM development. While VET will engage students in the application of technology to an advanced level in preparation for the workforce, they may have more authentic experiences in problem-solving decision-making and hands-on process that are customarily encountered in the real world context or the occupational-specific context through problem-based and project-based approaches (Dixon & Hutton, 2016). VET programmes may require stronger business/education partnerships that influence and enrich the students' experience through internships, apprenticeships, scholarships, and competitions. Such partnership can help our future generation better understand the relevance of their learning to future careers and support a seamless pathway and continuity to help students facilitate their school-to-work transition and complete their post-school qualifications (Social Compass, 2019). As a result, VET in Education 5.0 is signified as putting human qualities at the center to cultivate individual employability skills in terms of societal and individual needs. VET students and graduates could be more mindful of their interaction with technology, specifically safety and ergonomics at home, school, and work (Andres et al., 2022). VET and STEM integration is expected to expose students' horizons to experience the learning of different concepts in a contextual manner—rather than just bits and pieces and then assimilating them at a later time (Tsupros, Kohler & Hallinen, 2009). Against this backdrop, rigorous VET programmes can integrate with STEM education to provide a strong foundation for and serve as a delivery system of STEM-related competencies and literacies for a broader range of students (National Association of State Directors of Career Technical Education Consortium, 2013; Techakosit & Nilsook, 2018).

10.2.3 Overview of Secondary STEM Curriculum in Hong Kong

Over the past decade, STEM has gained increasing attention in the globe (Sanders, 2009). In response to the ever-changing economic, scientific and technological development, STEM education development in Hong Kong acts as a critical emphasis in the ongoing renewal of the school curriculum that is essential for students' life-long learning and whole-person development. Apart from cultivating students' interest and developing a solid STEM knowledge base, it aims to foster their innovation and entrepreneurial spirit as required in the twenty-first century (Education Bureau, 2016). A holistic and integrated approach is adopted, including "(1) Renewing the curricula of the Science, Technology and Mathematics Education Key Learning Area (KLA); (2) Enriching learning activities for students; (3) providing learning and teaching resources; (4) Enhancing the professional development of schools and teachers; (5) Strengthening partnerships with community key stakeholders, and (6) Conducting review and disseminating good practices (Education Bureau, 2016).

Under the curriculum reform since 2000, KLAs[1] were introduced by Curriculum Development Council (CDC) to the school curriculum to provide a context for developing and applying generic and subject-specific skills" (CDC, 2002, p. 3). Learning across the KLAs is intended to extend the learning experience laterally, enhance students' motivation to learn, equip them with the ability to examine an issue from different angles, and connect different learning experiences, thereby strengthening their understanding of the KLAs. The promotion of STEM education aligns with the global educational trend of equipping students to meet the rapid changes and challenges of economic, scientific, and technological development (CDC, 2015). A holistic approach was encouraged through various strategies focusing on strengthening students' ability to integrate and apply knowledge and skills of different disciplines in school education to develop their potential in innovation, which renewing the curricula of Science, Technology and Mathematics Education KLAs is one of the strategies (CDC, 2015). The update of the curriculum contents maintains the pace with the latest developments in various fields of science and technology and facilitates teaching and learning activities. Major updates of the curricula are as follows.

[1] The eight KLAs are "Chinese Language Education," "English Language Education," "Mathematics Education," "Personal, Social and Humanities Education," "Science Education," "Technology Education," "Arts Education," and "Physical Education".

10.2.4 Major Updates of Science KLA (Secondary 1–3) Curriculum

The contents are updated to keep abreast of the rapid development in science and technology, especially in life sciences (e.g., DNA as the book of life, Biotechnology, and health) (CDC, 2017d):

- Some contents are fine-tuned to strengthen the bridging between junior and senior secondary science curricula (e.g., Elements and atoms, Periodic table).
- Unifying concepts are introduced to enhance students' understanding of the connections and overarching coherence across different science disciplines.
- Science process skills are strengthened, particularly in the basic quantitative treatment in scientific investigations, including interpretation of data and graphs and the use of symbols, equations, and graphs to represent and communicate ideas.
- Learning and teaching activities are enriched for students to integrate and apply knowledge and problem-solving skills to create solutions and make inventions with hands-on and mind-on activities (e.g., projects and design-and-make activities).

10.2.5 Major Updates of the Technology Education (TE) KLA (Secondary 1–3) Curriculum

The Technology Education KLA Curriculum (S1–S3) comprises six knowledge contexts: Information and Communication Technology, Materials and Structures, Operations and Manufacturing, Strategies and Management, Systems and Control, and Technology and Living (CDC, 2017a; EDB, 2022a). Many schools are adopting a subject-based learning approach through subjects such as Computer Literacy, Design and Technology, and Home Economics / Technology and Living to implement the learning element modules of the Technology Education curriculum (CDC, 2017a). At least 30% of curriculum time under Information & Communication Technology (ICT) is allocated to learning and teaching programming concepts (including coding) in below:

- The six knowledge contexts under the TE KLA curriculum, namely ICT, Materials & Structures, Operations & Manufacturing, Strategies & Management, Systems & Control, and Technology & Living, are grouped into 16 core and 10 extension modules to ensure students acquire common and concrete knowledge base.
- All schools are recommended to offer the core modules with 8% of the curriculum time. Some schools may offer extension modules to meet the different needs of their students (up to 15% of the curriculum time).

- Theme-based and design-and-make learning activities are promoted to enhance students' integration and application of knowledge and skills through project learning.
- Students' interests and curiosity are cultivated through hands-on and minds-on STEM-related activities, which allow them to solve problems and create solutions for the well-being of humankind.

10.2.6 Major Updates of Mathematics KLA Curriculum

A holistic and multi-stage review of the Mathematics curriculum (P1-S6) is planned to address issues like enhancing vertical continuity/progression in Mathematics and lateral alignment with other KLAs, STEM education, and incorporation of other elements for ongoing curriculum renewal (CDC, 2014; CDC, 2017b). Learning and teaching activities for students to integrate and apply knowledge and skills, as well as to work out creative solutions, new ideas, or calculated judgment, will be strengthened (e.g., project learning, mathematical modeling, problem-based learning). Therefore, the newly suggested learning and teaching sequence and the curriculum framework are intended to (i) enhance the effectiveness of learning and teaching; (ii) enhance the support of Mathematics in STEM education; (iii) strengthen the learning and teaching of Data Handling and Probability so as to develop students' ability to make an informed decision based on calculated risk.

From the development review of the KLA described above concerning the secondary STEM curriculum, it can manifest that lots of efforts have been made to help promote secondary STEM education. The following section will examine existing secondary STEM education practices to provide an improved direction for future development to help Hong Kong echo with the global trend of Education 5.0.

10.3 The Missing Links of Secondary STEM Implementation in Hong Kong

10.3.1 Lack of Effective Curriculum Integration and Overall Implementation Planning in Present Secondary STEM Education

One of the major problems in Hong Kong secondary STEM education is examination-oriented culture. While the Hong Kong Diploma of Secondary Education Examination (HKDSE) becomes a high-stakes assessment, it makes the secondary school curriculum extremely packed and marginalizes STEM education's importance. Under the existing context in which the secondary school curriculum is HKDSE-oriented, the integration of STEM subjects may not be desirable (Ali, 2021).

According to the Education Bureau (2020), a key reason for slow progress in STEM education is the lack of efforts to define STEM education for the integration of the KLAs. The requirements of integration have not provided detailed information regarding 'selection criteria for the KLAs,' 'kinds of STEM integration', and 'scaffolding process'. These may cause a monodisciplinary approach or limited integration of secondary STEM education in one or more KLAs, where students cannot draw and understand necessary connections between the STEM disciplines and the real-world problem under consideration (Honey et al., 2014). Different surveys also revealed that major school respondents agreed there is insufficient lesson time for secondary STEM education (75.7%) and a challenge in developing cross-subject STEM education in secondary schools (71.8%) (Hong Kong Federation of Youth Groups, 2018). Secondary schools give lower priority to STEM subjects even though the policy is advocated (Amgen Asia and Global STEM Alliance, 2017) and those teachers are unprepared to teach STEM education (Geng et al., 2019). When scaffolding or scaffolding processes, such as scientific enquiry or enquiry-based learning, are not adequate, it may bring about a bottleneck in secondary STEM education development. Schools may preferably arrange only small parts of separate STEM elements (related to subject content) to implement in each STEM subject, but collaboration among these subjects may need further inputs to build a concrete STEM curriculum.

Another major problem is the lack of long-term planning for STEM education development, especially at the secondary level. Starting from the 2021/22 school year, Combined Science and Integrated Science will be phased out at Secondary four. According to The Government of HKSARG (2021), it mentioned that some students have difficulties in studying the two science disciplines of Combined Science in parallel, while simultaneously some schools have difficulties arranging for teachers to teach Integrated Science. It hopes such change can facilitate STEM education development in secondary schools and help students effectively articulate a diversified range of study choices and career pathways. This decision has taken into account all factors, including the curriculum design, social demands, resource deployment, students' needs, lateral coherence of various subjects, and international benchmarking, so as to respond to changes in society and students' needs, the number of students on related subjects enrollment is only one of the considerations. Under the new arrangement, secondary schools can switch to offering additional Biology, Chemistry, or Physics to strengthen students' science knowledge foundation or to offer an elective subject (e.g., Technology and Living) or Applied Learning (ApL) course (e.g., Applied Science, Engineering and Production) in the STEM-related areas, encouraging students to participate in more STEM-related life-wide learning activities, to cater for students' interests and development needs, and broaden their learning experiences in STEM education (Education Bureau, 2021). Nevertheless, it contradicts their stance earlier ago about considering students' needs and school contexts from a professional angle to offer different senior secondary elective subjects, including those with low student enrollments, so catering for learner diversity and supporting students in multiple studies and career pathways (The Government of HKSARG, 2019).

Combined Science and Integrated Science subject contents and curriculum were created to provide opportunities for students to gain a comprehensive and balanced science learning experience under a science subject, thus giving them space to take elective subjects under other KLAs. The design of Integrated Science adopts an interdisciplinary approach, while Combined Science comprises three parts with selected contents from the subjects of Biology, Chemistry, and Physics. Students may take any two parts to complement other elective subjects. Under the senior secondary curriculum, Integrated Science and Combined Science are regarded as one subject, and students may only opt for one of the two modes (The Government of HKSARG, 2019). As mentioned, it highlights the nature of the interdisciplinary approach, which is the cornerstone of STEM education. These two integrated science subjects, in addition to the traditional science subjects (including Physics, Chemistry, and Biology), not only can cater to the student's individual needs for taking science subjects to master essential scientific knowledge, but also give students space to consider acquiring the domains of knowledge in connection with subjects under other KLAs (The Government of HKSARG, 2019). Students can even further select these science-centered or STEM-related pathways as local tertiary institutions offer bachelor's degree and diploma progammes of a cross-disciplinary/integrated nature that go beyond traditional subject learning (The Government of HKSARG, 2019). From the decision to phase out these two subjects, the planning of secondary STEM education seems inconsiderate.

The implementation of STEM education is rather school-based nowadays. Regarding the content of activities, there are two approaches to promoting STEM education in Hong Kong. The first approach is scientific enquiry-based STEM activities, and students conduct experiments to induce scientific conclusions or rules and use technology to help their enquiry. They refine the experiment and use prior knowledge of other subjects to induce the results, combining elements from Science, Technology, Engineering, and Mathematics becomes an interdisciplinary enquiry (Liang & Fung, 2022). The second approach to STEM activities is hands-on experience-based STEM activities (Chan, 2018). This arrangement of activities is mainly based on engineerings, such as making a home device or telescope. Students make use of Science, Mathematics, and technology knowledge to generate a product. Hands-on experience-based STEM activities are rather problem-based, they involve a wide range of Science, Technology, and Mathematics knowledge and even involve coding that requires computational thinking or specific knowledge of technology. For the Problem-based STEM activities, students identify the problem and make knowledge applications to solve the problem. Such activities often involve an engineering design cycle (maker education) that uses knowledge of Science, Technology, and Mathematics to study, analyze and solve the problem (Tsang & Lee, 2017). Students have to apply knowledge and skills of different subjects and actively solve the problem in the learning process, which fosters their self-directed learning skills and competencies.

In terms of secondary schools, there is great flexibility in the development of STEM education because each school can have different strategies for implementation. If schools want to promote STEM education more formally, the "allocation of time to subjects” arrangement will be relocated, and a new subject with a school-based curriculum will be built. The reasoning is to implement the essential STEM teaching components to allocate in the school timetable, and normally junior forms students will learn from this new STEM subject to enhance the STEM competence of all students in the early stage (Lee & Foster, 2019). To balance the needs of senior forms students, schools will provide a STEM-related pull-out programme. Under this approach, a group of selected students will be trained as a STEM team in school, and some other students will participate in school-based STEM activities and public STEM-related activities and competitions. Nevertheless, this “too-loose” strategy from EDB aroused some criticisms. When each school is directed to build upon its strength to provide students with STEM-related learning activities, diversified learning, teaching, and assessment strategies in the way of the continuous development process to cater for students’ needs and interests, schools’ learning activities and teaching strategies must be varied because they need to balance the purposes, views, and interests of the students and teachers (Chen et al., 2021). They will also consider providing learning opportunities beyond the classroom to the students to form a part of the essential student learning experiences. Such room for flexibility will further allow each school to put less emphasis on STEM education because of insufficient and uncommitted resources, packed teaching schedule and curriculum, and inadequate expertise of individual teaching staff.

The latest ongoing curriculum renewal specified an improved and more aligned integration of secondary STEM education across different KLAs, with emphases on enquiry-based learning, integration and the application of knowledge and skills to solve authentic problems, and hands-on and minds-on activities. However, the STEM curriculum design and content remain driven by schools, so it may again depend on school resources, teachers’ interest and expertise, and the attention of school planning development. For example, some schools will focus more on equipping students with basic skills and techniques required in STEM projects, and some may focus more on ICT because it can provide opportunities for students to learn about the latest development and trends in technology (Leung, 2020; Mak, 2018). Under such circumstances, some schools may inevitably encounter problems and obstacles when implementing STEM education. Owing to STEM is not a separate subject, and the teaching schedule in some schools is so tight that squeezing time for STEM education will mean the sacrifice of time for teaching other subjects. Eventually, it may limit STEM activities to those students who are talented in the area rather than a programme targeted at every student.

10.3.2 Worrying STEM Proficiency and Unfavourable STEM Pathway

STEM proficiency achieved by Hong Kong students can be measured by the results they obtain in the science test of the Programme for International School Assessment ("PISA"). In the latest PISA 2018, Hong Kong remained ninth in scientific literacy after experiencing a marked decline in its ranking in science from second in PISA 2012 to ninth in PISA 2015. More importantly, the drop in mean science scores for Hong Kong students in PISA 2018 exceeded the average decrease in mean science scores across all OECD economies by 19 points over the same period (Research Office, Legislative Council Secretariat, 2020). The percentage share of "high achievers" in the PISA science test also decreased by 8.1 percentage points between 2006 and 2018. The result was the second largest decrease in "high achievers" in the science of any PISA participating country or economy during 2006–2018 (Research Office, Legislative Council Secretariat, 2020). Another latest result of the international test Trends in International Mathematics and Science Study (TIMSS) 2019 also come up with a consistent phenomenon of STEM proficiency drop, considering that secondary two students in Hong Kong had dropped 11 places respectively in the global rankings for scientific achievements, while they were sixth in 2015. The average science score of participating students in 2019 was 504, breaking the lowest recorded by any cohort in the seven editions of the quadrennial study since 1995 (The University of Hong Kong, 2020). The significant decline in secondary two students' performance in science provoked EDB to consider conducting an in-depth study to look into the results, drawing on the experiences of high-achieving countries and regions to enhance Hong Kong students' international competitiveness. Besides, this in-depth review aims to review the general curriculum policies and teaching and learning measures to figure out the reasons behind and work out necessary improvement measures to boost our student's performance in science (The Government of HKSARG, 2020). However, Lee and Fok (2022) concluded that Hong Kong students outperform mathematics their worldwide counterparts, indicating the ineffectiveness of existing curriculum planning and implementation to develop students' positive attitudes toward mathematics.

Hong Kong has been criticized for a small share of manufacturing, and a weak manufacturing base restricts career prospects of engineers as well as scientific researchers when the manufacturing industry is the most technology-intensive industry among developed economies and has become a significant driver behind innovations and business Research and Development (OECD, 2010). The small domestic market hinders the growth of knowledge-intensive industries such as computer and software engineering, which often require a large and sophisticated home market to scale up. According to Chan (2021) The target of "doubling the ratio of local Research and Development (R&D) expenditure to GDP from the current 0.73% to 1.5% within five years since 2017 is failed, implying Hong Kong's R&D activities depend more on government investment in terms of funding sources and willingness. Consequently, the scenario is not what we had hoped for. Students may be attracted by various STEM interest classes in secondary schools, yet STEM-related UGC programmes graduates[2] are only proportionate around 22% in 2019/20 (University Grants Committee, 2020), the number of graduates maintain stable until a slight increase in 2020/21,the predicament of the shortage of STEM talents in Hong Kong seems aggravated (The Government of HKSARG, 2022). The employment prospects from graduate school do not deem desirable, and the enrollment in graduate schools from local students decreased by more than 40% from 2003 to 2019 (Chun et al, 2022). If the situation persists, the shortage of local STEM talents will worsen because STEM careers' prospects are hardly attractive to graduates. Undoubtedly, it is necessary to connect the linkage between secondary STEM education and the VPET pathway in the existing education system to narrow the misalignment.

At present, the career prospects for STEM graduates are not particularly attractive. Hong Kong relies more on the financial and service industries as a service-oriented economy and an international financial center than the technology sector. Reflecting this, the traditional Four Key Industries in Hong Kong, including financial services, tourism, trading and logistics, and professional and producer services, have long dominated Hong Kong's economic growth and the job market (Research Office, Legislative Council Secretariat, 2020). At the same time, they keep contributing the highest gross domestic product (GDP) as well as total employment. In contrast, the innovation and technology industry only accounted for nominal GDP and total employment. The weak research and development expenditures might further weaken students' enthusiasm for pursuing undergraduate STEM studies in Hong Kong. Hong Kong's gross expenditure on R&D ("GERD") as a percentage of GDP has been at a low of less than 1% since 2000, lagging behind many developed economies compared to other developed countries between 1 and 5% (Research Office, Legislative Council Secretariat, 2020). It results in many high-preforming students choosing to study university degrees in medicine, business, and law instead of STEM disciplines, which offer more attractive career prospects (The Academy of Sciences of Hong Kong, 2016). Students admitted to those three disciplines had higher median entrance scores than those admitted to the science and engineering disciplines. When some students regard the engineering programme as a safety net in their university choice and may not be genuinely interested in engineering or science, STEM-related programmes such as engineering become unfavorable (Varsity, 2017).

For example, technology education has experienced its "golden age" between the 1970s and 2000s in Hong Kong (Volk, 2003), it has changed from skill-based teaching to a more balanced development of technological capability, understanding, and awareness over the past three decades which enables students to cultivate their initiative, creativity, problem-solving skills and practical design competence (Ng, 2016). Moreover, senior-level curricula were further updated in 2015 because the elective subjects, such as Business, Accounting, and Financial Studies, Design and Applied Technology (DAT), Health Management and Social Care, Information and

[2] The STEM-related programmes include elements of academic programme categories: Biological Sciences, Physical Sciences, Mathematical Sciences, Computer Science and Information Technology, Engineering and Technology, and Architecture and Town Planning.

Communication Technology, and Technology and Living, are designed to facilitate students in pursuit of multiple pathways for further studies or future career development (CDC, 2017a). However, the changing economy in Hong Kong to finance and banking since the 1990s has posed challenges to Technology Education. While it is not officially offered as an independent curriculum at the secondary level in Hong Kong, both Design and Technology at the junior level or DAT/other technical subjects at the senior level are not compulsory subjects in the education system. Though the overarching aim of the DAT Technology curriculum is "to provide students with fundamental knowledge and skills in technology and design and to cultivate them the attributes of innovation and entrepreneurship necessary to face the rapid social, economic and technological changes in a knowledge-based economy" (CDC and HKEAA, 2014, p. 3), some schools have even cut back or suspended technology education subjects which result in a decline in the number of students studying in the technical and technology-related subjects (Table 10.1) (Feng, 2013). In this connection, the government should not only invest more resources in secondary schools to promote STEM education to build up students' interests in STEM subjects and relevant content knowledge to attract them to pursue STEM programmes in universities through Career and Life Planning Education (CLPE), but also design a better articulation with ApL subjects to facilitate VPET in secondary schools.

10.3.3 Unpopularity and Questionable Positioning of STEM Elective Subjects in the Senior Secondary Education Structure

Mathematics is a core compulsory subject throughout the six-year secondary education in Hong Kong. Yet, Science subjects are optional at the senior secondary level with respect to around half (50.5%) of HKDSE Examination candidates who did not take any Science subjects in 2019. Over 40% of candidates (41.1%) took two Science subjects, and a mere (6.8%) took three Science subjects (Research Office, Legislative Council Secretariat, 2020). Although the newest survey on elective subjects' enrollment indicates the popularity of Biology, Chemistry, and Physics subjects in the 2020/21 school year, the phasing out of Combined Science and Integrated Science signifies the disregard for science education (Education Bureau, 2022b). The Academy of Sciences of Hong Kong's study (2016) revealed that the overwhelming workload of this subject as a normal full elective and few schools offering this subject implies this subject has not been posited well in the senior secondary curriculum structure. The same scenario also can be found in the enrollment of Information and Communication Technology (ICT) subjects, while the enrollment decreased more than 30% from 8092 candidates in 2012 to 5162 candidates in 2022 (see Table 10.1). Considering that STEM education was formally launched in 2015, but ICT remains an inferior elective subject choice for our HKDSE candidates, it

Table 10.1 Elective subjects' enrollment in HKDSE between 2018 and 2022 (Complied by authors from Hong Kong Examinations and Assessment Authority's annual report)

Elective subjects	2018 (Total No. sat: 57,649) No. sat	2019 (Total No. sat: 54,642) No. sat	2020 (Total No. sat: 50,809) No. sat	2021 (Total No. sat: 49,976) No. sat	2022 (Total No. sat: 47,891) No. sat
Mathematics compulsory part + Module 1 (Calculus and Statistics)	2692 (4.67%)	2679 (4.90%)	2389 (4.70%)	2404 (4.81%)	2232 (4.66%)
Mathematics compulsory part + Module 2 (Calculus and Geometry)	4839 (8.40%)	4840 (8.90%)	4675 (9.80%)	4 436 (8.88%)	4501 (9.40%)
Biology	14,148 (24.50%)	13,361 (24.50%)	12,824 (25.20%)	12,342 (24.70%)	12,297 (25.70%)
Chemistry	13,496 (23.40%)	12,967 (23.70%)	12,226 (24.10%)	11,648 (23.30%)	11,235 (23.50%)
Physics	11,118 (19.20%)	10,692 (19.60%)	10,011 (19.70%)	9366 (18.70%)	9467 (19.80%)
Science: combined science	765 (1.33%)	612 (1.12%)	428 (0.84%)	298 (0.60%)	262 (0.55%)
Science: integrated science	106 (0.18%)	73 (0.13%)	100 (0.20%)	74 (0.15%)	79 (0.16%)
Design and applied technology	583 (1.01%)	576 (1.05%)	475 (0.93%)	508 (1.02%)	405 (0.85%)
Information and communication technology	5793 (10%)	563 (10.30%)	5330 (10.50%)	5357 (10.70%)	5162 (10.80%)
Technology and living	239 (0.41%)	219 (0.40%)	190 (0.37%)	213 (0.43%)	179 (0.37%)

raises a query about the strategy of STEM education promotion and unattraction of ICT subjects to our students.

Regarding the enrollment in additional mathematics and advanced mathematics, the decline is varied because around 25% have enrolled in Additional Mathematics in the *Hong Kong Certificate of Education Examination*[3] *(*The Academy of Sciences of Hong Kong, 2016). In comparison, around 15% of matriculation students enrolled Pure Mathematics or Applied Mathematics in Hong Kong Advanced Level Examination,[4] the enrollment drops approximately 10% of advanced mathematics compared to the initial cohort in 2011/12 (22.9%) in HKDSE (see Table 10.1) (The Academy of Sciences of Hong Kong, 2016). As the Mathematics Extended Part is gaining higher recognition by local universities because all eight publicly-funded universities will regard the Extended Part as an elective subject in their general entrance requirements from 2024 entry, the recognition seems to be improving. The government also encourages more schools to incorporate lessons of the Extended Part into the regular school timetable, and further support will be provided (Education Bureau, 2021). However, it should be noted that Advanced Mathematics, Combined Science, Integrated Science, and ICT's popularity is still far lower than Physics, Chemistry, and Biology (see Table 10.1). This leads to a problem of articulation with higher education studies or pursuit of a career in engineering and technology development when universities observe that teaching STEM specialty subjects is increasingly arduous. Unavoidably, the HKDSE system seems to jeopardize the science and technology development and the STEM literacy advancement of our society. With the optimization of senior secondary core subjects from Secondary four in the 2021/22 school year, students could be motivated to study additional elective STEM subjects. Besides, when ApL becomes one of the channels to help equip them for pursuing further studies in science or STEM-related disciplines and meet students' aspiration of STEM careers in the future, it is hoped that more STEM-related courses can be offered in existing areas[5] of studies while only 18 ApL courses available in "Applied Science" and "Engineering & Production" (STEM-related) areas, in which totally 58 courses will be offered between 2023 and 2025 (Education Bureau and Labour and Welfare Bureau, 2022).

Even the newest curriculum renewal has briefly stated that STEM education can be embedded into various KLAs, yet it does not specify how the integration between KLAs and STEM should be carried out. The alignment among the three KLAs is seemed improperly intertwined and results in a restriction on the development of secondary STEM education (Ali, 2021). Therefore, the following section will further suggest an evolution of integrating STEM education with another new initiative to

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[3] The Hong Kong Certificate of Education Examination was a standardised examination between 1974 and 2011 after most local students' five-year secondary education, awarding the Hong Kong Certificate of Education secondary school leaving qualification.

[4] The Hong Kong Advanced Level Examination was taken by senior students at the end of their matriculation in Hong Kong between 1979 and 2012, which made it the major university entrance examination until academic year 2011/2012.

[5] The six areas of studies are Creative Studies, Media and Communication Business, Management and Law, Services, Applied Science, Engineering and Production.

embed a comprehensive transdisciplinary curriculum to promote secondary STEM education in Hong Kong.

10.4 Discussion and Ways Ahead

The above illustrations highlighting the missing links of current Hong Kong secondary STEM education, such as ineffective curriculum integration, alarming decline of STEM proficiency, unfavourable elective subject choice and career prospects and unclear positioning in the education system. While the common public discourse regarding STEM and liberal arts education is to "top up" the skills that students can gain in the traditional liberal arts through sharpening their creativity, diagnostic skills, and design in real-world life, it is also expected that *STEAM* (Science, Technology, Engineering, Art, and Mathematics) can frame the value of the humanities and arts as a way of "topping up" or "rounding out" the perspectives of STEM graduates (Stewart-Gambino & Rossmann, 2015), which aligns with VET's goal to nurture students to have a successful pathway beyond into their workforce and serve as necessary for every student in developing their twenty-first century skills. Given humanities have become an enabler to help us understand the values that we live now and have lived in the past when the COVID-19 epidemic causes enormous challenges to our daily life, the value of the arts and culture to our well-being and sense of community is all the rage again (Black, 2021). Considering that the pandemic has reinforced how essential STEM subjects are to overcome real-world problems, Hong Kong secondary STEM education is suggested to integrate with Social Sciences, Humanities, and the Arts for People and the Economy (SHAPE) initiative so VPET can move ahead to 5.0 evolution.

10.4.1 From Multidisciplinary to Transdisciplinary Approach: Integrating STEM and SHAPE Initiative with VET

10.4.1.1 SHAPE Initiative as a Transdisciplinary Integration

SHAPE was launched in 2020 and aimed to harness the collective power of social sciences, humanities, and the arts to shape a brighter and more prosperous future. These subjects empower us to analyze, interpret, communicate and collaborate with rigour, clarity, and energy—knowledge creation and crucial skills for today (Gillen, 2021). It also helps us explain the value and relevance of SHAPE disciplines to encourage more youth to study them further and apply the knowledge and skills gained in their future careers. SHAPE focuses on the human world, especially how we behave, organize ourselves, express ourselves, exert power, and create markets, states, families, religions, cultures, and communities on people and societies across time and space (Black, 2020). Therefore, the SHAPE initiative is significant nowadays because of the post-COVID-19 pandemic. It can navigate how the globe should respond to the dramatical alternations from the routines and change communication and thinking so we can effectively tackle the extraordinary challenges in the present context.

According to Quiglet and Herro (2016), the transdisciplinary approach is mainly beyond the disciplines, inspiring students and teachers to use collaborative expertise to pose and solve problems in a way that foregrounds the problem outside a single discipline. While it purposes to create knowledge and ideas and connect with society by identifying the problems that occurred in reality, students can learn in authentic and meaningful contexts as an experiential learning approach (Bush & Cook, 2019). As an explorative enquiry, the transdisciplinary approach can allow students to use previous knowledge to acquire new knowledge from multiple disciplines, leading the learning process and knowledge required to find solutions to the societal, environmental, industrial, scientific, and engineering problems in real-world (Edelen et al., 2019). When a transdisciplinary approach integrates the natural, social, and health sciences in a way that focuses on a humanistic context and transcends traditional individual boundaries, it is observed to be most challenging to achieve as it requires a shared perspective among members of different disciplines working together to have shared visions (Choi & Pak, 2006). In this connection, the SHAPE initiative is regarded as a transdisciplinary approach because it facilitates students to apply one discipline knowledge to another fluidly; they are using the skills necessary to solve problems while making connections to the world around them (Caton, 2021). Besides, transdisciplinary teaching helps students explore content areas using a multiple enquiry process in which they connect to the disciplines naturally through problem-solving (Herro & Quigley, 2019).

10.4.1.2 Integrating SHAPE Initiative with STEM: A Driving Force of VET Revitalization

SHAPE is understood as offering social sciences, humanities, and the arts coherence to a heterogenous set of subjects in a way that celebrates their diversity but emphasizes the human world. It draws joint attention to the contribution to society, making sense of the human experience, co-developing an understanding of global issues, and seeking solutions. In this sense, the SHAPE initiative is deemed to complement STEM in myriad ways (Percival, 2021). As Donnelly (2004) Identified about the contributions of the humanities to science education, it contains an appeal to an autonomous self with the right and capacity to make independent judgments and interpretations; a focus on meaning in the context of human responses, actions, and relationships, and especially on the ethical, aesthetic, and purposive; indeterminacy in the subject matter of these judgments and interpretations; and the possibility of commonality in standards of judgment and interpretation, under conditions of indeterminacy.

Thus, the SHAPE initiative and STEM education can be interlinked. SHAPE disciplines allow inter- or multidisciplinary engagement across STEM subjects, and both are required to adopt stances towards the other in ways that are, or have the potential, to change how each is conducted (Black & Goldsworthy, 2021a). Although the core disciplinary pillars within SHAPE and STEM subjects remain strong, the combination emerging in a new way can be increasingly seen. It is critical to illustrate STEM and SHAPE subjects enhancing together as the new knowledge and how can this new knowledge be created.

The STEAM education curriculum prepares students for an innovative economy rather than a knowledge-based economy (Fantauzzacoffin, Rogers, & Bolter, 2012, p. 4). Narum (2013) emphasized that STEAM components should represent where original ideas developed, and any intellectual action taken for innovation should not be limited. STEAM education could be an approach to integrating liberal arts curriculum, and cross-disciplinary ideas should not be kept or limited to their department of origin. When STEAM is often conceptually understood as a particular subset of SHAPE within STEM, it captures the 'A' but not the 'S' and the 'H.' While art and design are hugely valuable to the design of products developed by technology or as ways to visualize the natural and physical worlds, STEAM captures the value of integrating art and design with STEM rather than the value of the integration between SHAPE and STEM (Jones et al., 2020). In contrast, SHAPE focuses more on the broader set of disciplines related to people and societies to recognize the value of human interactions. Frankly, STEM subjects are equally heterogenous with their internal factions, but their shared branding masks these. As the SHAPE initiative highlights the human world context, it is essential to integrate with STEM if we want to understand how humans interact with the natural and physical world. The new ideas gained from connecting both sets of disciplines can bring opportunities for future generations to use the knowledge and insights from each to inform the other (Bakhshi et al., 2021).

In respect of SHAPE subjects are critical to understanding people's interactions and solving problems in the natural and physical world, incorporating the SHAPE initiative, and STEM disciplines with VET can help build meaningful lives and make future workplaces more innovative to benefit everyone. SHAPE graduates will become highly employable with multiliteracies, bringing a wealth of skills to the workforce. They help bring human experiences sensible and develop individual capacity for twenty-first century skills and STEM literacy. Future generations will foster empathy to solve the problems in humanistic manners and angles for a resilient workforce that will help us respond to these challenges, identify future opportunities, and nurture innovation (Black & Goldsworthy, 2021b). Consequently, this incorporation can provide the solutions with a meaningful context so students can transcend the boundaries of a single discipline and form their learning and understanding as they seek resolutions to the problems in the workplace and real world. SHAPE is coined to enable us to clearly communicate the value that these disciplines bring to not only enriching the world and society to which we live and belong, but also enhancing our application and understanding in the workplace (British Academy, 2021).

10.4.2 Transdisciplinary STEM Education in Hong Kong: A Suggested Direction for Secondary Level VPET to Actualize Education 5.0

The liberal arts education approach emphasizes multidisciplinary nature to foster creative thinking by combining studies in STEM fields, so the SHAPE curriculum is critical to providing innovations in modern science and technology. On the one hand, it can address the complicated issues that sophisticated problem-solving skills and innovative solutions can be provided to tackle the real-world problems of more significant populations, global interconnection, and technological advancement (Madden et al., 2013). On the other hand, it can also be regarded as supplementing STEM-related knowledge and skills into VPET, which can better prepare SHAPE graduates with the skills required for the twenty-first century innovative economy and teach them to participate as full partners in the making of the world around them (Lam & Ng, 2020).

Based on Dixon and Hutton's (2016) suggestion about integrating STEM at the secondary level and VPET 4.0 conceptualization by Wang (2021), the VPET revitalization initiative is recommended to situate the local development of secondary STEM education (Diagram 10.1). Under the new approach, transdisciplinary secondary STEM Education manifests allowing students to apply the knowledge from STEM to their daily lives. Transdisciplinarity defines a system that involves merging disciplines beyond their disciplinary boundaries, and creating new conceptions of disciplines, so that the new knowledge can be transferred from the classroom into real practice (Wu et al., 2021). The knowledge gained can be applied to other subjects to solve problems, work on projects, and apply the knowledge to develop the community and society (Wannapiroon et al., 2021). For senior secondary students, the new secondary transdisciplinary STEM curriculum should be integrated with the ApL and CLPE as a part of local secondary VPET to ensure that students are not only prepared for future careers but are also fostered with the necessary competency required in Industry 5.0 (Yau & Chun, 2020), which is a call to complement Industry 4.0 and mainly focus on a sustainable, human-centric and resilient industry (Breque et al., 2021). In this integrated curriculum, students will acquire 21st-century skills and STEM literacy at the appropriate proficiency while they are still in secondary schools and develop an interest in STEM-related careers that they can pursue further and foster transdisciplinary thinking (International Labour Organization, 2021). In addition, secondary VPET can echo with various KLAs (mainly in Science, Mathematics, Technology, and PSHE) to infuse science, mathematics and humanities concepts while teachers were probably challenged to look beyond their discipline and skills, thinking in a more transdisciplinary and cross-curricular way (CDC, 2017c). In this connection, it is necessary to bring teachers from across a range of disciplines to teach the same materials through collaboration so they may be more competent to teach 'beyond their subject area' and think in transdisciplinary ways in valuing humanization higher. Teachers can even learn more extraordinary from one another's skills and broaden their SHAPE perspectives in terms of digital

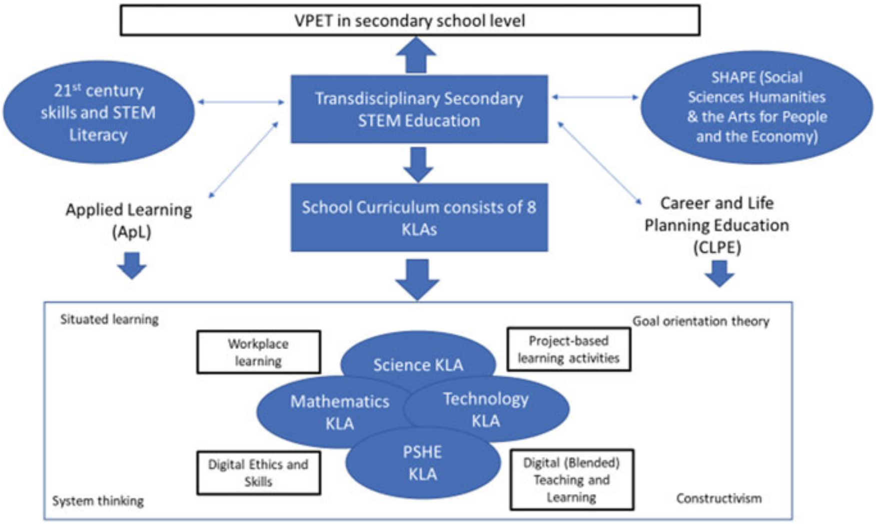

Diagram 10.1 Suggested direction of Hong Kong transdisciplinary secondary STEM education

ethics and skills through project-based learning activities and workplace learning in blended teaching and learning (Lantada, 2022). To align with Education 5.0, transdisciplinary secondary STEM education is designed based on the inputs given by the students to become a modern, contemporary multidisciplinary, and dynamic curricula to learn actively and effectively and better prepare for the future. This student-participatory curriculum can also further facilitate a personalized education approach in the post-pandemic age, when Education 5.0 focuses on catering for and exploring individual differences, technological power will be mindfully managed to accomplish rehumanization as an educational evolution (Uysal, 2021). Ultimately, STEM students can not only complement their employability skills in the SHAPE initiative and VPET, but they can also understand and explore scientific discovery and technological advancement from different aspects, demonstrating that creativity and STEM literacy can be cultivated in humanities for real-world problem solving (Lee & Siu, 2016; Falloon et al., 2020).

10.5 Conclusion

STEM becomes the concentration of policymakers across different nations targeting to enhance their national competitiveness and future economic prosperity, including Hong Kong. Countries such as Finland, Switzerland, Taiwan, and China have well-designed national STEM policy frameworks to promote STEM education at all academic levels and increase the numbers of STEM graduates and workers (Marginson et al., 2015; Yang et al., 2020). Under the STEM movement worldwide, policymakers realized the importance of arts which can facilitate STEM education and educate students with innovation and creativity (West, 2013). However, STEM alone misses several key components essential for our next generation to thrive in the present and fast-approaching future. The current linkages of articulated local secondary STEM curriculum, effective STEM proficiency enhancement of students, desirable STEM-related career pathway, and certain positioning remain missing. Hence, the SHAPE initiative has been deemed a way to take the benefits of STEM in order to integrate these principles into the humanities. It facilitates STEM to a higher level because students can connect their learning in these critical areas with humanistic practices, elements, design principles, and standards to provide the whole pallet of learning at their disposal. Providing that Education 5.0 requires a *holistic educational transformation* to lead our future generations toward a bright and sustainable world life (European Commission, 2020b), humanities will be embedded with technology to rehumanize education for our students in lifelong learning and lays the foundation for a wide range of skills that go far beyond the digital (Oliver, 2022). On the one hand, the SHAPE attributes can offer a breakthrough innovation that comes from adding humanities to STEM education and research and contributes to economic development. On the other hand, VET becomes the driver to help our STEM graduates develop the aptitude and ability to pursue lifelong learning in Industry 5.0 (Said, 2021). It all depends on whether every education system can nurture creative people who might be strong at transdisciplinary knowledge of arenas.

Currently, EDB (2022c) has officially renamed STEM education as STEAM education in the primary school education curriculum. STEAM education will not be a stand-alone curriculum/discipline but rather integrates relevant elements into the existing curriculum in a diverse cross-curricular/discipline learning model inside and outside the classroom. The aim is to strengthen students' ability to integrate and apply knowledge and skills, which entirely aligns with the SHAPE initiative. Following this new policy change, the critical rationale for integrating the SHAPE initiative and Hong Kong secondary STEM education into VPET is to enable these activities to "focus on problem-solving and transdisciplinary thinking" through the explorations and connections made between humanities and VET elements (Henriksen, 2014, p. 2). This integration could be considered an effective approach in light of their interactive components, in which the SHAPE initiative is highly connected with humanities to act in concert as the newest policy initiative of STEAM education. It is expected that the utilization of creativity for problem-solving in a VPET setting can impact positive learning outcomes, and students will be easier to have a better understanding gained from the presented information (Ghanbari, 2014, p. 1). However, given that this paper mainly focuses on the Hong Kong context, it is worth further investigating how STEM and VET can be carried out by transdisciplinary integration in other regions so as to respond to the call of Education 5.0 timely.

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Part III
Learner Transformations: Active Learning, Deep Learning, Engagement and Students' Success

Chapter 11
Active Learning Opportunities Outside Classroom and Laboratory

Po Yee Chung, Kim-hung Lam, Chi Wah Leung, Chee Leung Mak, Kai Pan Mark, and Jenny Lam

Abstract This paper presented a case study for the foundation year subject Greenhouse Gases and Life (ABCT1D09) launched in PolyU in 2019/2020 semester one. We investigated the implementation of blended learning with outside classroom learning component and TAL pedagogies (technology-assisted laboratory classes, virtual lab and remote lab) in the traditional face-to-face (F2F) lectures with the use of institutional virtual learning environment (Blackboard LMS) to improve students' learning experience by enhancing students' engagement in this large GE class (90 students). Feedbacks from survey and students' reflective journal (i.e. 91% of students satisfied with the designed class activities and 75% of students found the learning experience was enjoyable), as well as the students' academic performance suggest this model brings positive impact to students' learning. The results obtained in the present study may offer more new learning opportunities in tertiary all-round

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education and inform the design of "new-normal" learning after the COVID-19 pandemic.

Keywords Technology-assisted active learning · Blackboard · Science foundation subjects · General education · STEM

11.1 Introduction

Incorporation of active learning tools into class activities to improve student learning outcomes is of great interest in development of novel teaching strategy to transform traditional classroom into a student-centered classroom (Lom, 2012, Darling-Hammond et al., 2020). The expected outcomes of this type of classroom emphasize on improving students' intrinsic motivation and developing their attitudes towards self-regulated learning. In view of the intense current interest in this transformation, the study of the effectiveness of student-centered classroom is crucial for the rational design of teaching plan to help students achieve the learning outcomes.

Students usually take a passive role in learning and knowledge actively transfer from teacher to students in traditional classroom. In contrast, student-centered classroom allows student to acquire basic knowledge or relevant concepts through designed activities. Students' views and opinions are more emphasized, and they can work through problems and assignments collaboratively through peer learning. With the digital media advancement nowadays, and studies in past decade reported that digital means are effective in foreign language learning (Basal et al., 2016; Kolikant, 2010; Lu, 2008; Smith, 2015; Thornton & Houser, 2005).

"Digital native" learning behavior (Marchetta et al., 2018) can provide a better direction and empowerment for students to learn and they can easily to take an active role in learning in this type of classroom. This learning experience provides an effective approach to help students develop their independent thinking and learning, as well as the altitude towards lifelong learning.

Implementation of active learning techniques in science education have been investigated and found to be effective to improve students' learning (Freeman et al., 2014; Michael, 2006; Stockwell et al., 2015). Various formats of active learning pedagogies have been used in flipped classrooms and investigate their effectiveness and roles to support a satisfactory and effective flipped classroom. For examples, interdisciplinary workshops (Taly et al., 2019), service-learning based chemistry course (Najmr et al., 2018), outdoor education programs (Thomas, 2019) and chemistry course equipped with laboratory experiments (Bell, 2014; Rodriguez & Towns, 2018). These tools apparently foster students' interest and curiosity in science subjects. Due to the easier and more common in accessing of computers or mobile devices, technology-assisted learning tools (TALs), such as video games for biotechnology lab (Sadler et al., 2013), computational modelling to visualize chemical reactions (Chang et al., 2009), virtual laboratory illustrating scientific phenomena and concepts (Jagodziński & Wolski, 2015; Stahre Wästberg et al., 2019) and smartphones' built-in sensor for physics students (Hochberg et al., 2018), thus provide an alternative mode for teaching and learning with the use of technology.

Learning management system (LMS) is a systematic computer-assisted approach to implement and manage a learning process, allowing educators to administrate, track, report and deliver educational programs in a systematic and constructed manner.

Various LMS have been developed for the electronic educational and training purpose, such as Blackboard, Moodle, WebCT and Sakai. These systems provide a platform for teachers, or even students, to create a specialized and tailored-made virtual learning environment for courses. LMS also features of automated assessment, like quizzes and self-test exercises, which is a particularly favorable aspect for a class with large number of students (Chirwa, 2015). The role of LMS in our study mainly helps to build up a virtual learning environment that can used as auxiliary tool in traditional face-to-face classroom. Lecturer used the LMS as a platform to deliver notice and make reminder to students for the course management. In addition, lecturer shared the lecture and laboratory materials before the face-to-face sessions. This allows students to learn relevant concepts and materials before the class according to their own pace and without the limitation of time and places (Lau González et al., 2014). Students can devote more attention on the difficult topics they identified in their pre-reading time. Furthermore, LMS system helps lecturer to conduct data-driven review about students and their learning contexts, aiming to analyse students' learning experiences. For examples, track on students' click and time spent in LMS. As a consequence, learning analytics in higher education could build up a connection between lecturer, students and learning resources collaboratively and cooperatively, reflecting indirectly their learning behavior and progress and helping lecturer to extend and develop students' capabilities (Ferguson, 2012). With learning analytics, lecturer can improve teaching by identifying problematic learners (Sclater et al., 2016) and forming better learning design and effective pedagogy. Lovatt and coworkers (Lovatt et al., 2007) attempted to investigate the effectiveness of the learning in chemistry with the support of Moodle interacted with model named Drop-in Science Clinic and analyze students' usage pattern of resources available on Moodle. They found more encouragement on students. For example, students interact with their courses more actively and they are being encouraged to adopt a deep learning approach instead of surface approach. Students are very familiar with the LMS because it is the centrally provided tool that is used across all subjects.

This paper presents a case study of applying a strategy of interactive and student-centered learning in face-to-face lecture at undergraduate level. This investigation seeks answer to the following research questions:

1. How effective is implementation of outdoor active learning activities to enhance students' engagement in learning science subjects?
2. How effective is the TALs and laboratory sessions in facilitating students' engagement in face-to-face learning?

11.2 Methods

11.2.1 Use in Traditional Foundation Undergraduate Classroom

In 2019, we developed an approach incorporating a set of science-related active learning techniques into a commercially available LMS (Blackboard) for a GE subjects with the learning topic of greenhouse gases and life. This foundation year subject (subject title: ABCT1D09 Greenhouse Gas and life) is an environmental science subject and help students to understand the principles to tackle problems and provide possible solutions. This class is a large class with size of around 90 to 100 and the enrolled students with diverse background, leading to a challenge in this classroom if using traditional lecturer-centered learning. In the past, students only attended face-to-face lecture with a one-way knowledge transfer from lecturers to students. In addition, we have the following challenges, such as students having broad academic background, groups of students who were studying non-science major may have difficulty in understanding the fundamental scientific concepts.

The learning plan was presented to students using active learning approach. In the past, we identified the limited usage of LMS (Blackboard in our case) in traditional classroom, which was mainly for distribution of lecture notes to students. In present study, we aimed to create a virtual learning environment using LMS and implement a variety of active learning tools in traditional classroom. As a result, we were expected to transform the traditional teacher-centered classroom into a "semi-traditional student-centered classroom". This transformation aimed to address the learning need of students with broad disciplines and build up their attitude of life-long learning. The role for the designed out-of-classroom activities is to motivate students to learn independently and help them to develop personal skills, not only limited to the course contents. The outside classroom activities (activity 1 and 2) offered to students were voluntary basis that we expected students could take their active roles in learning and responsible for their ownership of education.

11.2.2 Survey Design and Data Collection

We designed our survey questions to seek for students' experience on their active learning, critical thinking, creative thinking, problem solving skills, inquiry-based learning skills, communication skills, interpersonal skills, group work, their understanding for various activities. The survey questionnaire is based on the work by Bell (2014), Jagodziński and Wolski (2015), Kolikant (2010), Lovatt et al. (2007) and Thomas (2019). We collected students' feedbacks from two ways, including survey using questionnaire in both the beginning and the end of the courses and focus group interview at the end of the course. In 2019/2020 semester 1, this course involved more than 90 students. 8 postgraduate laboratory demonstrators were involved to assist in the laboratory sessions to ensure students' learning and laboratory safety. Most of the course activities were carried out in the form of group, where group size of 6–7 students.

11.2.3 Active Learning Pedagogies Implemented

This course implemented three outdoor active learning activities. First, public seminar was recommended to students. Second, site visit was arranged for students. They were required to visit the museum in a group. Third, we assigned four weeks of lecture time to do indoor and outdoor experiments with students in a group, aiming to encourage students to work collaboratively and allow students to learn from each other.

11.3 Results and Discussion

The course in this study aimed to achieve different learning outcomes, from knowledge transfer to personal skills development. These learning outcomes can only be achieved by planning and designing teaching plan during the course or learning process. After the completion of this course, students are supposed to understand the causes and environmental impact of greenhouses gases and realized the responsibility of different related parties in greenhouse gases reduction, as well as the sense of awareness towards the impact of greenhouse gases. The students can also develop teamwork and communication skills throughout the activities designed in this course, leading to their appreciation of the importance of lifelong learning. We designed out-of-classroom activities to enhance students to learn independently and help them to develop personal skills, not only limited to the course contents.

11.3.1 Active Learning Activity 1: Reflective Journal About Public Seminar

Students were recommended to join a public seminar, which held either in September 2019 or November 2019, in the Hong Kong Science Museum on the topic of global warming and wrote a reflective journal on that seminar. The purpose of this activity was to enrich students' knowledge in the area of course content by exposing them into an intensive content to a topic through presentation given by experts. Furthermore, it aimed to develop a self-reflection process in students and train students' communication skills by expressing their thoughts through writing. Summarizing skills of students were trained by writing their reflective journals, which summarizing what they learnt from the seminar.

Writing reflective journals provides students an opportunity to have a self-reflection on what they have learnt from a learning experience, for example, the seminar they attended. In addition, this is also a channel for lecturer to get a better understanding on students' learning progress and offer a more suitable suggestion on their learning pattern.

Table 11.1 shows the students' reflections after the public seminar in the form of reflective journal. Students can gain new knowledge about the global warming other than their classroom lectures. Moreover, it also provides evidence that reflective journal is a good platform for instructor to communicate with students via writing. We can know what they have learnt from resources outside the lecture content.

Students attending the recommended seminars could help them in learning the course or inspire their thoughts about the current environmental issues through the talks given by the environmentalists. For example, student D wrote the thoughts about the seminar as follows: "after the seminar, I understand that the problem of global warming and climate change is really urgent and serious. If we do not take action to tackle the problem, human will live in danger soon. Being part of the earth, everyone should take the responsibility to save our climate by live a greener life. Government and cooperation should also implement plans to cope with the issue. Only by every parties working together, can we alleviate these situations and save our earth." Student G stated that "Though controlling climate change requires lots of effort and challenging, I believe Hong Kong government will try hard to solve the problem."

11.3.2 Active Learning Activity 2: Group Site Visit

Students were encouraged to have a group visit of the Jockey Club Museum of Climate Change (MOCC) and a group reflective journal was required to submit after the visit. This activity was designed to help students to build a team spirit with other students and develop a culture of collaborative learning. Work collaboratively helps students to learn about teammate's strengths and weakness, leading to improve their communication skills. More important, this designed site visit was prone to enjoyable learning experience for students. Students were not only learning in classroom via lecture and notes, they would also learn from different media and formats.

Table 11.2 summarizes the feedbacks from students after the group site visit. Similar to the feedbacks obtained in activity 1, most of the feedback are written about the new knowledge they learnt in the museum. However, some feedbacks from students have demonstrated that they have gained their global perspective and developed their higher order of thinking on the issue of global warming after the visit (Entries 3, 9, 10, 12, 15 and 16, Table 11.2). Their feedback demonstrates that they have realized their awareness and responsibility in solving the problem of climate change.

Table 11.1 Examples of reflective journals from students on a seminar

Seminar	Student	Quotes extracted from the reflective journals
Seminar in September	A	*"Below I would like to talk about five points that I have learnt from the talk. First is the concept of sponge city…….Second point is the way to provide information of escape warning of natural disaster like flooding and typhoon…….Third point is the works of Hong Kong Red Cross………..Fourth point is the details of the measures of avoiding the catastrophe effects to the citizens' life by Hong Kong Red Cross…….Last point is the role of Red Cross after natural disaster."*
	B	*"What I have learnt from the Seminar:* *1. The elders and those who live in low-lying areas are the most vulnerable groups of people during disasters* *2. To face the natural hazards, it is essential for the corporations between government, citizens and businessman* *3. To cope with the problem of climatic change, it is important for us to know how to reduce the greenhouse gas emission and also know what measures should be taken during disaster* *4. Public education is needed to raise people's awareness of global warming* *5. In Hong Kong, when there's flooding, NGOs like Red Cross will help the elderly (especially those who live alone) to face the problem."*
	C	*Student wrote five points that he found interested in the seminar in the reflective journal, including climate resilience, climate change for citizen, the work of government, elderly living alone and facing flooding and typhoon*
	D	*"In the seminar, I have learnt a few points about climate change and global warming. The first point is storm surge……The second point is "mitigation"…The third point is "adaptation"…The fourth point is "Resilience"…The last point is the Paris Agreement"*
Seminar in November	E	*Student summarized the content of seminar into five points, including the effect of temperature on the growth of bacteria, the effect of temperature and humidity on the fungi mycotoxins production, the effect of climate change on extreme weather events and characteristics, and environmental pollution*
	F	*"There are the points I have learnt from the seminar: 1. Higher temperature prompts the growths of viruses in food. …0.2. Higher temperature leads to more severe floods and more widespread of diseases….0.3. Higher temperature causes rapid growth of super-weed and pests……4. To ensure food safety, raw and cooked food needs to be separated…."*
	G	*Students described and gave a summary on what the seminar mentioned in the reflective journal. "To start with, food pollution can be caused by virus and bacteria…Furthermore, there are several ways to prevent food being contaminated by bacteria…."*

Table 11.2 Examples of students' feedback extracted from their reflective journal on group site visit

Entry	Student	Quotes extracted from the reflective journals
1	1A	*"From visiting MOCC, I have learnt that some greenhouse gases will not only enhance greenhouse effect, it will also harm us in different ways."*
2	1B	*"I have learnt some history of China's Arctic research station which contributed a lot to the investigation of climate change."*
3	1C	*"After visiting the MOCC in CUHK, I notice that the problem of climate change is more and more serious now and we should take actions to solve it immediately."*
4	2A	*"The impacts of climate change* *– Loss of biodiversity* *– Effect on yield of rice, maize, wheat and soybean* *– Lower the reproductive rate of marine animals*
5	2B	*"The Industrial Revolution may be a great cause for global warming as the carbon dioxide concentration had rose drastically since Industrial Revolution."*
6	3A	*"I have learnt the effects of global climate change on the Himalayas."*
7	4A	*"Not only will the climate change greatly affect the Land species in the polar region, but also the vegetation in the polar region and the crop yield around the world."*
8	5A	*"After the journey of visiting Jockey Club Museum of Climate Change, I figure out how graves that climate change is. First of all, it will change the environment of different places, especially the polar regions."*
9	5B	*"Air pollution is a silence killer that always stay with us. We must act to prevent enhancing air pollution."*
10	5C	*"After the tour, it refreshed my imagination on how much impact human activities do on the environment….It scares me that we might be close to the tipping point."*
11	5D	*"After visiting Jockey Club Museum of Climate Change, I have learnt some knowledge which are related to climate change. This museum taught me that how climate change affects different stakeholders."*
12	5E	*"The first thing I have learnt is the seriousness about how air pollution affect our health."*
13	6A	*"After the visit to MoCC, I was very impressed by the 'Beyond 60° S' exhibition. I have discovered that Antarctica is the only continent on Earth where no mineral deposits have been explored by drilling."*
14	6B	*"Second, there is an amazing map, we can use that map to simulate how's the world-changing while sea level is rising…….Thus, global warming can be a disaster, we should treat it immediately."*
15	6C	*"First, I have learned about how climate change affects our daily life…..In addition, I have also learned the importance of lowering carbon emission…..To conclude, changing lifestyle is an effective way to improve the environment."*

(continued)

Table 11.2 (continued)

Entry	Student	Quotes extracted from the reflective journals
16	6D	*"After visiting the MoCC, I have a more vivid understanding that global warming has already put strain on us humans. I was impressed by the augmented-reality module in the 'Arctic Moves' area. By learning the characteristics and habits of different arctic animals can I face the fact that the Arctic region are already uninhabitable. Worse still, we are still exacerbating the situation. Furthermore, cutting on the greenhouse gases emission has to be carried out. To be frank, today's carbon emission target to a large extent cannot alleviate the problems. Bigger, quicker, deeper carbon cuts should be enforced"*
17	7A	*"It was a fruitful learning experience vising the museum. The first thing I have learnt is how climate change affects the biosystem in polar regions…."*
18	7B	*"It was a precious experience for visiting the Museum of Climate Change…The first thing I have learnt from the visit is the changing of the climate threatening the living environment of different animals,…..the second thing is the richness in recycle products."*

Furthermore, this group site visit renders a learning environment for peer learning. For example, students from Group 1 stated "It is unavoidable to have only four members visiting MOCC as time do not allow us to wait any longer, so we decided to tell them about what they have learnt from the museum after out visit so we can all know more about greenhouse gases and climate changes", this shows students are willing to interact with each other to attain a learning goal. This is the first step of peer-to-peer learning, which is valuable in student-centered learning.

The designed out-of-classroom activities are to motivate students to learn independently and help them to develop personal skills, not only limited to the course contents. All these outside classroom activities offered to students were voluntary basis, which we expected students could take their active roles in learning and responsible for their ownership of education. The response rate of group activity (i.e. active learning activity 2, 78.9%) is higher than that of individual activity (i.e. active learning activity 1, 16.7%). This reflects students may have larger motivation to join the voluntary activity carried out in a group format. One possible reason for this is the positive effect of peer encouragement and the positive learning environment created within peers.

11.3.3 Active Learning Activity 3: Inside and Outside Laboratory Experiments

Experimentation can foster the learning of scientific principles and knowledge by exploring scientific procedures in laboratory. Peer learning is an educational strategy that involves the sharing of knowledge and learning experience between peers. Therefore, we integrated these two approaches into our activity 3. In this activity, we divided students into group to perform a series of subject-related experiments in

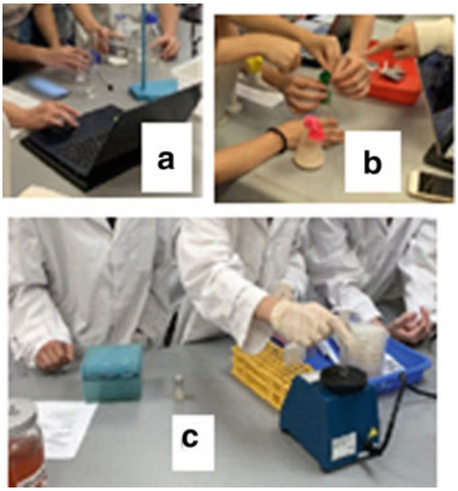

Fig. 11.1 **a** Students were monitoring the change of temperature over time in a chemical reaction which mimics greenhouse effect using vinegar and sodium hydrogen carbonate, allowing students to actively learn and understand the greenhouse effect by experimentation. **b** This experiment was to observe the fermentation process of yeast by recording the changes in size o balloon over time. Students worked together to measure the circumference of balloon using the string. **c** This experiment allowed students to gain a first-hand experience in microbial culture to learn the basic laboratory techniques

a time-restricted laboratory session. They worked collaboratively and set up their experiments through discussion within equal-status learners (i.e. their peers or group-mates). We examined the effect of peer learning in teaching practical skills in this study. Figure 11.1 shows the situation of students conducting experiments within groups.

Experimentation in group offers the combined advantages of peer learning and active learning pedagogies in science education. First, Nelwati and coworkers (Nelwati, Abdullah & Chan, 2018) suggested that peer learning can equip students both personal development and professional development. Our observation in this study provides evidence on the personal development using peer learning. During the laboratory session, students can learn from and with their group mates, and enables them to exchange ideas and knowledge, as well as build up their own relationship and community. As shown in Fig. 11.1, students could enhance their self-confidence via peer encouragement and support, improve communication skills when discussing the laboratory set up and underlying scientific principles of the experiment, and gaining socialization though the peer learning experience.

Second, experimentation is a valuable learning experience for students and professional training for students. They were able to acquire the technical skills and the corresponding theories. This can enhance students' interest in studying science. During the practical classes, students can communicate and work with each other, and they can develop the communication skill and teamwork experience. Lastly, the group laboratory sessions were carried out within two hours, and students were required to complete their experimental observation and data collection within the time allowed, which can create a sense of team collaboration and time management.

In addition, our laboratory session featured the use of videos and remote laboratory as well as incorporation of the LMS platform (i.e. Blackboard) to enhance the learning experience in practical class. First, a remote laboratory, which is a platform that students can do their experiment online anytime and anywhere, is designed and created for students to perform experiment outside the classroom (Fig. 11.2a). This remote lab can help them to understand the scientific concept with the help of remote laboratory technology and allow them to compare with the experimental results. This can promote their critical thinking through experimentation in both face-to-face and online platforms.

Second, we well-designed some pre-lab materials in order to support and help students in learning experimental procedures, such as use of auto pipette, and other practical techniques which are hardly described by word in laboratory manual. We prepared a series of video clips outlining the laboratory demonstrations and data analysis, and uploaded in our subscribed LMS (Blackboard) early in advance, allowing enough time for students to prepare their laboratory work and orienting students to relevant practical techniques and safety procedures. Students were more prepared and familiar with the procedures so that they would conduct their lab work in a

Fig. 11.2 **a** Remote laboratory for students to study the greenhouse effect using chemical reaction. **b** Picture recorded students watching lab demonstration video clips in briefing session. **c** Picture showing students who was conducting experiment in group using our hand-held developed device to measure air pollutants in campus

more smoothly way during the practical classes. We anticipated, with these interactive pre-lab materials, student would gain a better understanding on the conceptual principles/theories through the experiments and may be more motivated in learning science. As shown in Fig. 11.2b, instructor played the recorded video clips for laboratory briefing, which allowed students to get familiar with the experiments and review the concepts before the experiment. Croker and coworkers (Croker et al., 2010) reported that the use of videos is a good teaching approach that can guide students systematically and completed the practical more efficiently and effectively.

Furthermore, we designed outdoor laboratory-based learning experience for our students, and they can measure the air pollutant measurement in PolyU campus and other designated locations outside the university. This experiment allowed student to have a hand-on experience for monitoring the air pollutants. Instead of doing experiments in laboratory, students moved to the campus, or even the place where they live, in group at different locations to monitor the air pollutants. Our students can learn about the scientific principle with the help of our hand-held device connected with tablet (Fig. 11.2c). We expected our students equipped the practical skills for their future career and learned the basic concept for the air pollutants monitoring. Therefore, students are not limited to learn from text in lecture notes and the knowledge transfer from teachers in lecture time, they also learn from their actively participation in laboratory sessions and group work with their peers anytime and anywhere.

11.3.4 Evaluation of the Effectiveness of TALs Implemented

Students actively involving in learning to achieve learning outcomes is the focus for an effective student-centered learning process. As a result, we implemented active learning tools in the form of designed activity 1, 2 and 3 to enhance students' engagement in GE subject. We measured the effectiveness of these activities in students' engagement by three methods, including overall subject grade, survey and focus group interview.

11.3.4.1 Academic Performance: Overall Subject Grade

The overall subject grade reflects the academic achievement of student in this subject. We evaluated their academic achievements from three aspects, including depth of knowledge, high-level thinking (i.e. analytical, logical and summative analysis) and creativity of their work. 70% students got an average grade (B+ or B grade) and about 20% of students were below average. About 10% of 90 students got A or A + grade in this subject, where they demonstrated an excellent performance in these three areas.

11.3.4.2 Feedbacks About Students' Learning Experience: Survey and Focus Group Interview

Students in this course were asked about their learning experience of this course by questionnaire in the beginning and at the end of course. The questions asked were in response of like scales 0 (strongly disagree) to 5 (strongly agree). There were total twenty-five questions covering the aspect of active learning, critical thinking, creative thinking, problem solving, inquiry-based learning, communication skills, interpersonal skills and groupwork, and teaching for understanding.

Figure 11.3 shows the feedbacks from students about the course. Most of the students (>90%) satisfied with the course supported with the active learning components and they found that attending this course was an enjoyable learning experience. Most of the students (among the thirty-six feedbacks) satisfied with the laboratory class in the existing course (Response 1–27, Table 11.3) and they found the experiments were interesting (5 out of 36, Table 11.3). Some students also satisfied with the course with respect to the learning environment of this course (Response 30, Table 11.3), assessment format (Response 29, Table 11.3) and instructors (Response 31–33, Table 11.3).

Based on the academic performance and feedback from students, we conclude the implementation of outdoor activities and TAL (Technology-Assisted Laboratory) sessions coupled with remote laboratory, use of video clips, laboratory manual

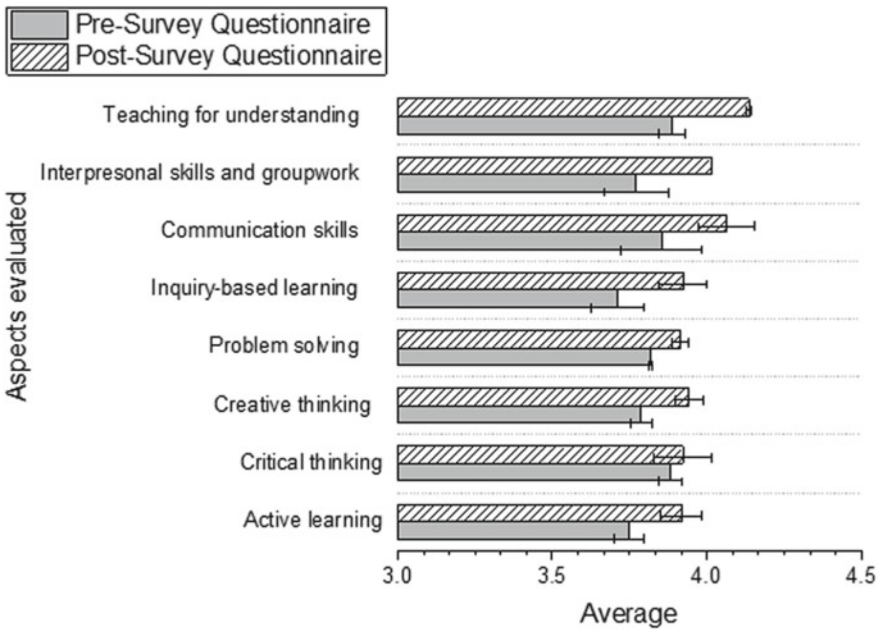

Fig. 11.3 Results of questionnaire showing students' view towards the course

Table 11.3 Summary of the feedback from students about the question of "what are the best aspects of the existing course?"

Response	Students' verbal feedback
1–27	About the laboratory class description:
	Laboratory sections that can let us to understand and try different techniques and experiments that are difficult for us to have in daily life
	Lab teachings, very kind to explain questions
	Doing lab experiments, interesting
	Lab is interesting.:)
	Lab, they are quite fun and easy
	Lab experiment make learning more fun & interesting
	Working in lab with groupmates
	Lab done was fun and I can learn from it, though some errors happened
	The experiments: they were very fun
	Lab, notes
	The lab section is the best aspects in this course we can have fun with the experiment
28	*Conducting group presentation*
29	*No Final examination*
30	*Learning about GHGs*
31	*The teacher, the teaching staff*
32	*Flexibility*
33	*Lecturer very experienced*
34	*Interesting*
35	*Worldwide perspective of understanding GHGs*
36	*Learn more about climate change*

distribution on Blackboard (LMS) in advance, can effectively enhance students' engagement and offer enjoyable learning experience in in this science GE subject. The implementation of TAL sessions coupled with designed team-building and self-reflection activity in traditional face-to-face classroom, i.e. group site visit and writing reflective journal for attending public seminar, respectively, can foster the student-centered classroom, helping students to develop communication skills, enhanced students' motivation in science, and the culture of peer learning.

11.3.4.3 Challenges Encountered When Implementing New Teaching Strategies

The present case study documented a framework of the implementation of active learning pedagogy in a large class size with diverse academic backgrounds for instructors who consider to incorporate active learning components in their science courses. The designed active learning components offer a learning model to support instructors to optimize their course components for students to learn actively and collaboratively.

Developing class activities that are not only able to engage students, but also well aligned with the learning outcomes and reinforce the lecture contents is always challenging. According to our survey results, the integration of laboratory class into the traditional lectures (i.e. active learning activity was highly satisfactory by students, suggesting experimentation in group could be a good active learning tool that could help non-science major students to understand scientific concepts, promote students' engagement in lecture and encourage peer-peer interactions.

The impact of traditional face-to-face classroom equipped with active learning approach appears to be beneficial to students, but, students who are resistant to active learning may feel stressful in this type of "new" delivery mode and result in a discouragement in their learning. Therefore, managing the active learning environment with positive learning impact to students is demanding for instructors. Compared with traditional classroom, instructor requires to put much more effort on creating an active learning environment by choosing an appropriate active learning strategy and facilitating the students' engagement and encouraging peer learning by designing various active learning activities. In addition to a highly structured teaching plan, technical supports for both instructors and students to adopt the "virtual learning environment" and academic supports for preparing lecture materials and carrying out the active learning activities in lecture are two important resources for instructors to contribute a better management in classroom applying active learning pedagogy.

11.4 Conclusion

In conclusion, our undergraduate course integrated a TAL session with the support of LMS as facilitator for student-centered classroom renders a case for developing a TAL-facilitated classroom that effectively implemented of active learning tools in traditional classroom. TAL session (i.e. use of experiments, outdoor experiment using hand-held sensor with tablet and remote laboratory) enhances students' learning experience in the area of professional development and personal development, as well as their engagement in learning, receiving a high satisfactory rate of the course from students and providing them an enjoyable experience in learning. Two voluntary activities (i.e. group site visit and public seminar) also supported this TAL-facilitated classroom by helping students to build up a sense of self-reflection and the culture of peer learning. Complemented with the support of the LMS, this study also gives insight into the role of LMS empowering TAL-facilitated classroom, which is, developing a platform for students to learn actively and independently after the class. Consequently, our study model of traditional classroom coupled with TALs and LMS reflects implementation of active learning pedagogy in face-to-face teaching may offer more new learning opportunities in tertiary all-round education.

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Chapter 12
Macro Business Simulation Games Towards the Adoption of Education 5.0: Evidence from Hong Kong Maritime Logistics Students

Yui-yip Lau, Eve Man Hin Chan, and Chan Kwai Nam

Abstract The emergence of macro business simulation games has created the transformation of learning pedagogy, curriculum design, and student learning experiences in maritime logistics programmes. This study explores the background and main elements of the macro business simulation game and identifies the students' learning experiences of the macro business simulation game. As such, 50 survey questionnaires are gathered from sub-degree students who have enrolled in the maritime logistics courses from Introduction to Procurement Management and Fundamentals of Logistics and Supply Chain Management. The research findings suggest that the macro business simulation game remarkably influences the motivation of students to understand of course complex concepts and the effectiveness of learning. As expected, the study provides valuable insights into the educators to revamp the curriculum and improve the teaching pedagogy to foster the growth of professional maritime education in the future.

Keywords Macro business simulation game · Sub-degree students · Maritime logistics · Motivation · Education 5.0

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12.1 Introduction

Technology was widely adopted in games, from the former TV video games, computer software games, and electronic toys up to the newest online game, people have been engaged in these electronic games. There is a strong association between learning and educational simulation games in the current research studies (Tao et al., 2009). Prensky (2003) expressly indicated that from the viewpoint of positive learning, games may increase students learning motivation. Schwabe and Göth (2005) further reinforced that applied games in their learning activities not only improve students learning motivation but also create an interactive learning environment. Moreover, the game encouraged interest and engagement among students and was effective in stimulating teamwork. As such, games provide students with an interesting, useful, and rewarding learning experience (Buil et al., 2019). The simulation was considered as being useful in giving students a recognition of the global environment and the difficulty of cross-national decision-making (Rogmans & Abaza, 2019). Also, games can foster students to identify the significance of incorporating functional knowledge and creating an interdisciplinary lens. Nevertheless, Wolfe (2016) criticized that tacit knowledge acquisition and critical thinking skills are still difficult to be measured by game. Also, Buil et al. (2019) addressed that games can generate frustration and anxiety in students, which may bring an adverse impact on their learning. The rationale behind this is the intrinsic stress of decision-making in a restricted time or the highly competitive nature of the game. To the best of the author's knowledge, a majority of computer games focus on the leisure aspects or commercial advantages. Relevant studies on the learning pedagogies, curriculum design, and student learning experiences are under-researched (Rogmans & Abaza, 2019; Tao et al., 2009; Wolfe, 2016).

In the higher education sector, maritime logistics is one of the key higher education programs in Hong Kong. Based on the Census and Statistics Department, The HKSAR Government, the maritime logistics industry is identified as one of the four economic pillars of Hong Kong. The maritime logistics industry contributed 176,200 jobs (e.g., ports, terminals, shipping lines, ship agents, ship brokers, marine insurance) and 2.9% of Hong Kong's GDP in 2019 (Fung, 2021). In the recent decade, Hong Kong has arisen as an international hub for finance, business, and trade. Indeed, Mainland China participated World Trade Organization in 2001; Hong Kong and Mainland China Closer Economic Partnership Arrangement were launched in 2003; the "Belt and Road Initiative" was introduced in 2013; The Guangdong-Hong Kong-Macao Greater Bay Area appeared in 2017. To this end, the maritime logistics industry has created remarkable economic contributions to the dynamic worldwide environment (Lau et al., 2018).

Hong Kong's maritime logistics industry has encountered stiff competition from surrounding countries in the Asia region. To reinforce the competitiveness of Hong Kong's maritime logistics industry around the globe, it would be vital to create a thorough maritime logistics education. Nowadays, professional education has become an urgent demand due to recruiting talents for improving productivity and responding to ongoing changes. In recent years, there has been a dramatic growth in higher education institutions identifying non-academic learning methods, and apprentice-style to supplement 'practice-based' and 'professional' programs (Lau & Ng, 2015; Lau et al., 2018).

In existing maritime logistics programs, logistics associations (e.g. Hong Kong Sea Transport and Logistics Association, Hong Kong Shippers' Council) offer various maritime logistics short training courses to logistics specialists. Higher education institutions offer different levels of maritime logistics programmes ranging from professional diplomas, higher diplomas, associate degrees, bachelor's degrees, and master's degrees. It covers maritime and transportation law, shipping operations, maritime transport engineering, and maritime logistics (Lau & Ng, 2015; Lau et al., 2018, 2021a, 2021b). Nevertheless, most of the current maritime logistics programs are either theoretical-based or practical-based. Such programs only provide fundamental maritime logistics knowledge, logistics operations, and general education. However, the new elements of innovative education have been seriously overlooked in the current maritime logistics programs. Innovative education fosters students to improve their problem-solving, critical thinking, creativity, technological, communication, and ethical knowledge which is crucial to develop students as 'preferred graduates' in the practical workplace. The adoption of innovative education fosters maritime logistics students to obtain decision-making skills, generating the process as near as possible to an actual environment. The advancement of e-learning game-based technology may train students to learn how to organize and analyze complex maritime logistics decisions (Kabashkin & Grakovski, 2021). Recently, educators inclined toward exploring possible simulation games in maritime logistics courses. The simulation games encourage students to absorb the up-to-date maritime logistics knowledge, as well as try to maximize benefits and minimize costs. Although there are simulation games have appeared in the academic world, most simulation games are complicated control interfaces and concentrate on specific areas of related operations lacking focusing the adoption of use-made artificial intelligence (AI) (Liu, 2017). In doing so, we illustrate a macro business simulation game in this study. This study identifies the background and key elements of the macro business simulation game and investigates the students' learning experiences of the macro business simulation game.

This research study is mainly divided into four main sections. Section 12.1 provides the research background, objectives, and settings. Section 12.2 describes the background, format, features, and content of the macro business simulation game. After that, it discusses the students with learning experiences of the macro business simulation game in Sect. 12.3. The concluding remarks, limitations, and future research directions are given in Sect. 12.4.

12.2 Macro Business Simulation Game

12.2.1 Background

Macro business simulation is a single product, one-to-four markets business game. Product demand is seasonal and influenced by individual market prices, product image and quality, and other economic factors. Each round of the game can be viewed for a quarter of the calendar time. Macro business simulation has four main models of the game with several decisions. The game can accommodate up to 20 groups of players, up to 6 players with different management roles in a group. The CEO is a ‘super player’ and can take on any extra role if needed. All players save their decisions temporarily and only CEO can submit the decisions for the company. Once decisions are submitted, no change will be allowed. In general, macro business stimulation has provided for four main models in Table 12.1.

Models 1 and 2 games are appropriate for practice purposes as they have only one market and fewer decisions. These games will give all players an understanding of the basic structure of the game, decision-making logic, and available reports and analysis.

Models 3 and 4 games extend the business scenarios with four individual markets with various marketing investments and pricing decisions. The production mode also enables up to three shifts a day to enlarge the capacity required to fulfill the possible demand.

The macro business simulation game is built in with the “Analytic Hierarchy Process” which is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology in decision making. It represents an accurate approach to quantifying the weights of decision criteria. Individual experts’ experiences are utilized to estimate the relative magnitudes of factors through pairwise comparisons. Each of the respondents compares the relative importance of each pair of items using a specially designed questionnaire. It is a scientific methodology

Table 12.1 Four main models of macro business stimulation

	Model 1	Model 2	Model 3	Model 4
Raw materials planning	1	1	1	1
Production quantity Allocation	1	1	1	4
Retails (Prices and Markets)	1	1	4	4
Marketing expenses	1	1	4	4
Equipment/maintenance		1/1	1/1	1/1
R&D expenses		1	1	1
Dividend		1	1	1
Loan				1
Number of decisions	4	8	14	18

to measure the importance of a key performance index across a wide broad audience for the weight of decision-making.

12.2.2 Key Elements of Macro Business Simulation Game

A participating company is composed of 3–4 students, and the participants play the roles of planning, marketing, production, procurement, finance, and CEO, compete fiercely in the macro environment and microenvironment set by the system, and pursue the maximum profit of the company as the goal of continuous efforts. They make their own judgments after carefully analyzing all the market information, operating statements, and financial statements from inside and outside the company. Eight decisions in level 2 for the management direction are required to submit into the system environment. In the process of mutual competition, the market situation changes immediately, the profits and losses of each enterprise are immediately realized, and all kinds of business reports and charts are presented. Under the expectation of maintaining or improving the company's existing market advantages and disadvantages, the report is re-analyzed and entered another decision-making cycle goes on and on, and finally, the facilitator judges the performance and winners of the business according to a set of KPI scoring matrix to determine which team is the best to drive the growth of their company. The key elements of the macro business simulation game are summarized in Table 12.2.

The primary element of the business simulation management learning method is to create the scenario and produce numerous data on the dashboard through the business simulation of the actual operation of the enterprise. Students are trained on problem-solving of the consequence and derivation, thereby inspiring students to analyze environmental information, deal with group relations, and ability to make decisions from alternative solutions. Business professors at more than a quarter of universities in the United States use Business Game courses, and most large enterprises have adopted business management competitions as in-house training courses.

The student's learning experience can be identified as below:

- To create a learning environment that is close to the real situation of the enterprise;
- To generate learning objectives that are clear and challenging with fun and thrill;
- To produce a dynamic learning environment with a business intelligence dashboard with operation information given;
- To give quick feedback on learning outcomes;
- To make simulation scenarios of e-enterprise;
- To emphasize numerical analysis and rational judgment;
- To identify the effect of role-playing and cultivating the ability to participate in decision-making; and
- To assist in building a holistic view of how a business operation management is operated.

Table 12.2 Key Elements of the macro business simulation game

Item	Description	Content
Management dashboard	Once the user logs in to the system, the management dashboard will be exhibited with key performance indicators (KPIs) and relevant information	*SIREN index* • Market share • Inventory rate • Revenue • Expense ratio • Net profit *Financial index* • Current ratio • Debt ratio • Total asset turnover • ROE • Net profit margin
Basic game settings	The user needs to review critically the main economic and business conditions in the business overview before making any decisions. These game settings are decided by the teacher and will change when starting a new game	• Market shares deferred effect • Price elasticity • Marketing campaign impact • Product lifecycle (Market growth rate) • Research and development effect • Production mode • Maintenance effect
Economic status report	The economic report gives useful information like economic growth rate, price index, product lifecycle, and seasonal indicators in each market. These indicators will determine the overall market to the same extent, except for product lifecycle, which is market dependent	• Price index • Economic growth rate • Seasonal indicators • Product lifecycle
Business status report	The business status report gives users a quick overview of the firm's sales volume and production capacity. The user can review the main information at each round to have a better understanding of how to synchronize the potential demand with the next production capacity	• Potential demand • Current production • Finished goods inventory • Market share (%) • Sales volume • Next production capacity
Production/sales analysis	The production/sales analysis gives the user with core information such as sales volume, raw material inventory, production capacity, and finished goods inventory	• Sales volume • Production volume • Next production capacity • Raw material inventory • Finished goods inventory (Total)

12.3 Student Learning Experiences: Macro Business Simulation Games

This section highlights a study assessing the effect of course satisfaction and context interests on learning impacts on maritime logistics-related courses by adopting new, innovative pedagogical manners. The macro business simulation game is part of a module to meet employers' expectations and improve students' employability. 50 survey questionnaires are gathered from sub-degree students (i.e., higher diploma and associate degree) via their in-class exercises. Those students have taken the courses Introduction to Procurement Management and Fundamentals of Logistics and Supply Chain Management during March 2021. The survey questionnaire results are exhibited in Table 12.3. The survey questionnaire is commonly adopted for other student learning activities. Through the questionnaire, we investigated how an existing macro business simulation game is an effective way for students to achieve their professional reputation and generates students with the required skills to prepare for the workplace. As such, the survey questionnaire has been reviewed by teachers and administrators. In other words, it can make sure the validity of the content and improve the accuracy of the survey instruments. Especially, blurry wordings and double-barreled questions have been thoroughly minimized (Lau et al., 2021a, 2021b). They were invited to respond with their preference for various teaching approaches that were used in the course and given valuable comments on the macro business simulation game design, content, format, and implementation. To keep highly confidential, all the participants' personal particulars were not disclosed, and their answers have merely been adopted for academic purposes. The participants have every right to withdraw from the study before or during the survey without penalty of any kind. The research findings propose that the macro business simulation game significantly affects the motivation of students to understand course complex concepts and the effectiveness of learning.

Macro business simulation games incline to be more effective as a complement to other instructional approaches by producing an application of the ideas or notions students understand. During this time, students are expected to form small groups (i.e., 3–4 students for each group). Through taking multiple training sessions, students improve content understanding and knowledge acquisition. The enhancement of software resources and the Internet has created various changes to human daily lives. The success of simulation and the possibility to diminish various barriers and the actual adaptive business context of traditional educational approaches have been highlighted progressively in educational models. Macro business simulation game commonly adopts a business game-based learning object model (BLOM). The six main steps of BLOM are shown in Fig. 12.1.

Specifically, a research study examining the urgent demand for a macro business simulation game in maritime logistics courses is conducted. This enables us to create a macro business simulation game effectively and quickly, for online instruction by adopting robust BLOM steps. Through functionality and heuristics tests, we will

Table 12.3 The results of the survey questionnaire

Questions	Scores
This activity has taught me something that I would not normally learn in the formal curriculum	4.12
This was a worthwhile learning experience	4.08
This activity has facilitated my holistic development	3.96
I would recommend this activity to my fellow students	3.94
This activity would be useful for my current/future study	3.92
This activity stimulated me to visualize different knowledge and skills that I learned	3.90
This activity would be useful for my career development	3.86
This activity has helped me recognise the need for continual learning for my further academic or other self-determined development	3.84
This activity has activated my potential	3.84
This activity has boosted my self-confidence	3.78

Notes 5 = Strongly Agree; 4 = Agree; 3 = Neutral; 2 = Disagree; 1 = Strongly Disagree

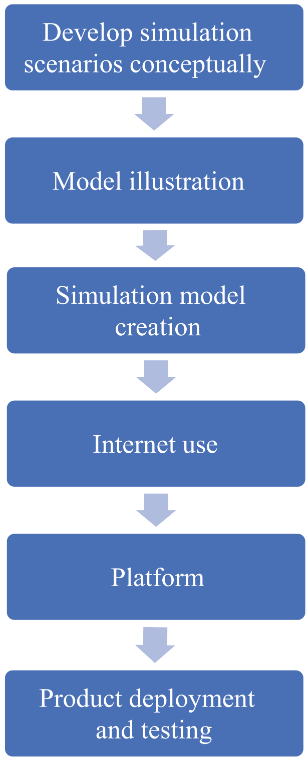

Fig. 12.1 Six steps of BLOM

evaluate the model's accuracy and validity and apply what we have understood to produce the model perfectly in the forthcoming years.

Numerous past research studies have pointed out that maritime logistics business learning may not be the prime advantage of business simulation games. However, it can identify what kinds of student profiles perform better in classroom education with macro business simulation games. Although skills and knowledge are crucial to boost the results, communication skills and team collaboration can make better performance. Some students are fascinated to learn macro business simulation games while some students are reluctant to learn through macro business simulation games in a traditional classroom because they prefer auditory learning. Thus, the association between the perception of macro business simulation games and learning performance in preliminary studies demonstrated significant results. As expected, macro business simulation games would improve students' educational experience in terms of social presence, cognitive presence, and teaching presence. A purposeful learning community will be created and sustained in near future (Lau et al., 2021a, 2021b). In reality, there is a trend of research studies addressing the use of macro business simulation games that have changed to non-performance viewpoints like encouraging students to pay attention to their classes. Students realized the courses that employ macro business simulation games with horizontal learning in the instructional tasks or activities are more interesting since games create a dynamic maritime logistics business interactive marketplace for education and give an imperative motivational status.

12.4 Conclusion

In the last decade, the macro business simulation game has emerged as a generic approach to informal learning in the world, along with being marketed for adoption in formal education. Students' participation in macro business simulation games is a vital indicator of the popularity of simulation games in a sector of higher education. Apart from maritime logistics students, maritime logistics professionals are also interested in improving their experience and business knowledge via learning by doing. The research study addresses the macro business simulation games that may be a possible tool in learning as the success of business simulation is convincing. In reality, a number of higher education institutions expect to educate their students via their core maritime logistics subjects teaching practices. Also, students can absorb new knowledge with the use of interactive learning platforms that contains comprehensive and thorough macro business simulation games. Moreover, most postsecondary institutions still rely on the traditional examination approach which expects students to memorize the key concepts and illustrate the basic knowledge into simple case studies. In the future, educators may collaborate with corporations to allow students to engage in designing and implementing business simulation games. The tasks can link up with the students' group project with presentations for their continuous assessment components. A capstone exercise may also consider as the student's final year project. To increase students' learning motivation, postsecondary institutions may work with corporations to provide scholarships and internships for students to achieve outstanding academic achievement. To this end, it improves the abilities and professional skills of the students, as well as allows students to create connections with people working in the industry (Lau et al., 2021a, 2021b).

In general, traditional business school learning methodology rides on vertical learning with book teaching, case study or tutorial, etc., and barely the opportunity to practice their professional knowledge across the disciplines like the practical working experience in the real world. Business School might be looking for any opportunity to provide students with an interdisciplinary learning approach that learning is no longer limited by face-to-face teaching but self-learning with synthesizing multiple perspectives to tackle the problem on an entire business case. Business management is a social science. It is not as maneuverable as most physical or chemical experiments. The experiments of business management often involve huge social costs, and they are not repeatable and maneuverable. Each experiment is very likely to produce Unique results that are neither repeatable nor reproducible.

In the business simulation game, a team of 3–4 students plays a role in different positions in a company based on their professional knowledge and interest to manage the business operation of their company in the way to achieve the maximum return to the company in view of different key performance index objectives. It is connected literature with accounting, finance, marketing, economics, supply chain management, operation management, etc. Being said that students are immersed in the virtual business environment with a strong connection between their own identities, they are empowered to manage their work performance seriously about their own identities with self-motivation. This experiential learning allows students to inspire their critical thinking from the way of different data analysis and logic thinking in the dashboard of the simulation platform and it is imperative to transform their theoretical knowledge intelligence into a practical skill with their potential intelligence across disciplines. Macro business stimulation game uses interdisciplinary learning to encourage students to be more aggressive in the form of contributing their profession and ethics to their society, they should be able to resolve the problem with their own analytic skills and perspective. To a certain extent, a macro business simulation game generates a roadmap for developing Education 5.0 in future higher education development.

This paper constructs a preliminary study that facilitates building up a theoretical business simulation game research study in the future. Hence, it will carry out a large-scale survey questionnaire to validate the research findings and strengthen the observations and argument. Also, this study only focused on the survey questionnaire from the students' perspectives. To offset the limitations of the quantitative research methodology, we will take into account of qualitative research approach via semi-structured, in-depth interviews with relevant stakeholders including educators, business simulation game developers, policymakers, and associations to gain valuable insights for the study. Furthermore, this study only concentrated on Hong Kong. To generalize the research study, we may consider other Asian countries like China, Thailand, and Indonesia in the next research.

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Chapter 13
Personal Learning Environments and Personalized Learning in the Education Field: Challenges and Future Trends

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Abstract Personal Learning Environments (PLEs) represent a paradigm shift in the educational field. PLEs empower learners to take more ownership of their learning and to be successful lifelong learners. In the digital era, the development of Information and Communication Technology (ICT) makes Personalized Learning (PL) possible, which is a major step toward the implementation of Personalized Learning Environments at all levels of education. Through tailoring the design to students' personal strengths, weaknesses, and interests, PLEs are gradually gaining ground in applied degree education. However, being new educational approaches, PLEs should start from K-12 and go through lifelong education. This study tried to investigate the status quo of PLEs and PL applications in primary and secondary schools worldwide, especially in the U.S., the U.K., and mainland China. Through literature review, the study analyzed the main challenges of PLEs implementation and predicted its future development. It was suggested that future research in PLEs and PL should focus on systematic reforms rather than single or limited variable interventions.

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13.1 Introduction

Teaching students to be lifelong learners, to study at their own pace, pursue their own goals, and monitor their own progress is the major change in public education. We have to rethink the role of education and educators, curriculum and the future of work, collaboration and work integrated learning, vocational and professional practices, employability skills and qualities for the 21st-century world of work. Under this context, Personal Learning Environments (PLEs) and Personalized Learning (PL) are gradually receiving attention from higher education and applied degree education. The number of papers published on PLEs research has grown exponentially since 2019. The topics on PLE are becoming more diverse. Most papers focus on teaching guidelines or the latest technologies in higher education, such as learning analytics and augmented reality (Lin et al., 2013). Some are about the academic achievements of PLEs and their relationship to standardized tests. However, authors such as Attwell (2021) showed their concern about the slow implementation of PLEs after two decades of development. This study believed one of the major reasons was the little efforts devoted in the implementation of PLEs in primary and secondary education. Since PLEs represent new teaching approach, to have its potential into full play, kindergarten and primary school should be the starting point.

A few studies investigated K-12 personalized practices and how they related to students' academic performance. The increasing demand for education reform has pushed a good number of schools to move toward PL systems (Basham et al., 2016; Bingham et al., 2016). Education systems in the United Kingdom and the United States were making efforts to realize it, with the goal of addressing the increasingly diverse student population and providing quality education for all (Peterson, 2016). The research in PL mainly covered two themes, including the investigation of (a) the role of various technologies and (b) contextual factors that impacted the implementation of PL (Zhang et al., 2020). Few studies have examined the effects of PL on student learning outcomes. Due to the difficulty in obtaining large-scale data (Underwood et al., 2007), there are only two studies regarding the relationship between personalized learning and students' academic performance at the national-scale level in the UK and the US, respectively. (Gross et al., 2018; McCarthy & Schauer, 2017). Meanwhile, when implementing PLEs, many challenges pop up, including the failure to define what PLEs and Personalized Learning mean and why they should be adopted; Besides, there is an utterly wrong assumption that PLEs are all about putting digital devices in students' hands, while PLEs actually represent a learning paradigm shift, and effective personalized learning demands major shifts in teachers' roles and practices.

13.2 Concepts of PLEs and Personalized Learning

13.2.1 Concepts of PLEs

Personal Learning Environments (PLEs) is generally seen as a collection of individual systems and external services. It can also be broadly defined from the perspective of knowledge management as well as from a technical perspective. From the perspective of knowledge management, PLEs is seen as a virtual learning ecosystem (Attwell, 2007). Harmelen (2006) treated PLE as a personal e-learning system that allows users to set a mixture of their learning objectives and content and monitor their whole learning process. PLEs are viewed as technology-based methods for learners to select the proper tools and resources to improve their studies. FitzGerald (2006) defined PLEs as “a set of free, distributed, web-based tools, usually blog-centric, that aggregate content together using RSS (Really Simple Syndication) feeds and simple HTML scripts”. Downes (2005) considered PLEs as “a personal learning center where learners reuse and remix learning content according to their needs and interests”. It is a collection of interoperable applications, an environment rather than a system. Malamed (2014) considered PLEs as self-regulating and developing environments that consist of tools, services, and resources where learners can get a convenient way to acquire knowledge, communicate with others who have similar interests, and set lifelong learning objectives by recreating their own PLEs. PLEs are used to gather the resources learners need to solve their learning problems and obtain and share information for individual and group learning. Downes (2005) defined Personal Learning Environments as “a node in a content network that connects to nodes and content creation services used by other learners”. “It is more than an institutional or corporate application, as the content is reused and remixed for the user’s own needs and interests”. “PLEs aim to bring all types of learning, including informal learning, workplace learning, home learning, problem-solving-driven learning, and personal interest-driven learning, together by participation”. The above definitions and descriptions indicate that PLEs can be seen as a technical as well as a pedagogical concept. This study defines PLEs as “knowledge-based, learner-centered teaching assistance platform, where users can customize resources they need in a virtual community to share and co-construct knowledge.”

13.2.2 Concepts of Personalized Learning

Personal Learning Environments should be distinguished from Personalized Learning. The Oxford Online Dictionary defines “personalized” as “the design or production of (something) to meet the requirements of one’s personality,” while “personal” is defined as “done or produced by a particular person; involving the actual presence or conduct of a particular individual”. Personalized learning is a new global education policy on learning and curriculum that supplies more freedom, personal responsibility, and customized knowledge for learners rather than the acquisition of specific formal knowledge. Personal Learning Environments are “how people build environments for themselves: the tools they choose, the communities they join, the resources they collect, and what they write about”.

As a learning model, personalized learning aims to adapt itself to the learners’ strengths, needs, and interests by using interactive digital resources and data (Bill & Melinda Gates Foundation, 2014; Pane et al., 2015). Personalized learning aims to provide learners and teachers with high-level, diverse choices via digital resources and online courses (Bill & Melinda Gates Foundation, 2014). Learners can use the digital platform to browse different content at different speeds, getting learning outcomes to demonstrate their understanding of learning. Some proponents argue that personalized learning has the potential to help learners with high or low talent (U.S. Department of Education, 2016). Nonetheless, personalized learning aimed at improving learners’ academic performance has gained widespread attention in high-tech schools as a model of action theory. (Bill & Melinda Gates Foundation, 2014). Increased opportunities or promotions to a specific group of universities and vocations. The concept of personalized learning has recently become a major goal of the education system. Historically, personalized learning can be traced back to the early twentieth century, when John Dewey put the learner at the center of teaching and doing some long-term work (Keefe & Jenkins, 2008; Redding, 2016). Later, the concept of personalized learning began to appear when educational reformers began to denounce the standardized methods of industrialized education systems and sought ways to enrich the learning methods (Redding, 2016). The Personalized Instruction System (PSI) introduced by Keller (1968), which emphasizes the learning monitor and learning groups tutored, is usually regarded as the predecessor of personalized learning (Keefe & Jenkins, 2008; Keller, 1968). Personalized learning is applied in some areas (e.g., special education, personalized instruction, educational technology). However, the future of its large-scale use is unknown (Basham et al., 2016).

13.2.3 Relationship Between PLEs and PL

Personalized learning is a teaching method as well as a kind of educational philosophy (Sebba et al., 2007). The Personal Learning Environments can be seen as a system, a platform, an idea, or a path. Personalized learning is a part and a goal of the Personal Learning Environments. The primary purpose of PLEs is to “create an environment for handling learning in the hands of the learner”. The goal of personalized learning is to make learners know how to learn. Customizing learning to each student’s strengths, needs, and interests—including giving students a self-chosen mode on what, how, when, and where they learn—to provide flexibility and support for their high-quality learning. Students choose the resources and tools that are suitable for them and build a network of peers, teachers, and experts to support and guide their learning. The main difference between the two is that the PLEs emphasize the construction and application of platforms and systems, with the path and method to realize personalized learning. It involves not only technology but also teaching concepts, scholarly literacy, social interaction, and the coordination of various stakeholders. Schaffert and Hilzensauer (2008) proposed seven foundations that compose the PLEs:

- The role of the learner: PLEs focused on the learner as an active, autonomous participant who was also responsible for creative learning, evolving from a mere "consumer" to a "producer and prosumer" of learning (p. 4).
- Personalization: The goal of personalization in PLEs was defined as “access to information about learning opportunities and content from multiple communities and services tailored to learners’ interests” (p5). tools, materials, appearance, etc., and the source of information chosen by the learner.
- Content: The centralized use of “Learning Opportunities and Content” (p. 6) was what differentiates PLEs from traditional learning management systems. That was, PLEs contained not only teacher-created content but also content from experts and a broad “peer” community.
- Social Engagement: PLEs acknowledged the importance of social engagement as "PLEs always need and build on the community" (p. 7) to find contributors, collaborators, sources, and suggestions for learning content.
- Ownership: Access to information, database creation, and acquisition in traditional learning management systems were often in a “sealed” system that can only be used by authorization. PLEs pursued the opposite extreme, where all available data and information were "almost completely open to the whole world" (p. 7).
- Education and Organizational Culture: It involved not only the change of individuals but also the change of the whole society and culture, including the various stakeholders of PLEs.
- Technical aspects: PLEs were not designed to replace previous systems, but rather to enable coupling: (1) integrating PLEs into existing learning management systems; or (2) deploying loosely coupled tools within existing learning management systems (p. 8).

13.2.4 Policies Related to the Development of PLEs

The widespread implementation of Personalized Learning and PLEs was being driven by Government through policy changes. For instance, in China, the Outline of the National Medium- and Long-Term Program for Education Reform and Development (2010–2020) pointed out, “Information technology has a revolutionary impact on the development of education and must be given high priority.” In recent years, with the rapid development of information technology such as big data, cloud computing, and mobile internet, the internet has stimulated profound changes in the field of education. Internet technology provides great potential for the innovation and development of education. It respects each student’s individual characteristics, supports students’ differential learning with technology, and then realizes each student’s all-around development. The Ten-Year Development Plan for Informatization of Education (2011–2020) stated that "We should provide each learner with an information-based environment and service for personalized learning". The construction of Personal Learning Environments has been put forward in the development plan of education informatization all around China.

Abroad, the Every Student Succeeds Act (ESSA) promulgated in the United States in 2015, provided sufficient policy support and financial guarantee for the individualization of learning. Jenkins et al. (2019) designed the State Policy Framework for Personalized Learning to help states and stakeholders define and navigate their pathway from the exploratory phase of system design to statewide transformation. In the UK, personalized education emerged as an official government policy in 2004. Publications such as "Pedagogy and Personalization" (DCSF, 2007b) emphasized the need to establish a shared language for discussing pedagogy to transform learning and teaching, while major research programs like 'The Making Good Progress' pilot (DCSF, 2007a) were trialing new personalized teaching and learning strategies to raise rates of progression throughout the Key Stages.

Recent advancements in Information and Communications Technology (ICT), data science, and machine learning help to boost the popularity of PLEs. To have a general understanding of the PLEs and PL development in primary and secondary schools the world around, the next section would discuss the status quo of PLEs implementation in China, the U.S., and the U.K.

13.3 The Implementation of PLEs and PL in Primary and Secondary Schools

The implementation of PLEs and PL in China, the U.S., and the U.K. have reported some benefits to students' learning achievement, learning autonomy, etc., however, challenges and problems also existed. The following sections would focus on reporting the status quo of PLEs and PL implementation in the above-mentioned three contexts.

13.3.1 The Implementation of PLEs in Primary and Secondary Schools

Proponents of PLEs argued that personalization could help close achievement gaps and promote student success and positive outcomes because it allowed students to become masters of learning (Pane et al., 2015). However, some early research on PL and PLEs models suggested that schools and teachers may face challenges in implementing PLEs, hindering their effectiveness in pedagogical applications (Bingham et al., 2016). For example, research indicated that teachers and schools may

Keywords	Number
Personalized learning	6
Personal Learning Environment	2
Digital bag	1
Web2.0	1

Fig. 13.1. Searched keywords results

have difficulty transitioning to new practices in individual learning environments. Bingham et al. (2016) also found that the optionality of digital and online resources in an individual learning environment could facilitate or limit the orderly delivery of instructions. When online courses were poorly designed or did not provide useful data, students said they were overwhelmed and dissatisfied with the patterns of their individual learning environments. This was because learner autonomy, control, and choice were also key components of the Personal Learning Environments, which posed challenges for the application of PLEs. Most of the experimental results on the use of PLEs in teaching showed that assisted classroom teaching could improve students' academic performance to a certain extent. However, applying learning models to the classroom required a lot of practice and long-term research.

In China, using the keywords "Personal Learning Environment", "personalized learning", and "primary and secondary school" to search in CNKI, regardless of the year, we retrieved 13 academic papers, of which only 8 are in line with the topic of the Personal Learning Environment. The searched keywords are analyzed and grouped using topic analysis. The results obtained were shown in Fig. 13.1.

In general, there were few studies on the PLEs of middle schools in mainland China, leaving a huge space for exploration in this field. The research on PLEs in Chinese primary and secondary schools mainly focused on the following three aspects: (1) how to promote Personalized Learning in the secondary education system; (2) how to construct a model of PLEs in junior high schools; and (3) how to promote Personalized Learning. The application of PLEs software and platforms in middle schools was rarely mentioned, and the interpretation of the PLEs in middle schools was still unclear.

Although the vision of PLEs is based on the collaborative design of teachers and students for responsive learning opportunities, few empirical studies have explored the application of Personalized Learning in practice. A series of studies commissioned by the Bill and Melinda Gates Foundation (Pane et al., 2015, 2017; RAND Corporation, 2014) found that compared with the matched control group, students in the PLEs setting had higher reading and mathematics levels and greater progress. However, the researchers also noted that "considerable variation exists in the details of school instruction models," and the schools in the study did not adopt "a single standardized model of personalized learning" (Pane et al., 2015, p. 3). Indeed, follow-up studies focusing on PLEs implementation found that students rarely choose teaching materials or classroom focus topics independently, which indicated that teachers and students in these schools had relatively little co-construction (Pane et al., 2017). Zeiser et al. (2014) found that the personalized practice network has a positive impact on many aspects, including interpersonal and personal achievements, cognitive development, complex problem-solving strategies, and the university admission rate of middle school students. However, they found that the results varied greatly across schools.

13.3.2 The Implementation of PL in Primary and Secondary Schools

Both continuous research and new understandings have supported the ability to develop and scale systems that implement PL across diverse student populations in a variety of settings (Arroyo et al., 2014; Basham et al., 2016; Robinson & Sebba, 2010; Walkington, 2013). School districts in the United States were increasingly turning to personalized learning (PL) as a way to improve academic performance and meet the diverse needs and interests of their learners (Bingham et al., 2016). The "Top-District competition" proposed by the U.S. Department of Education (DOE) in 2013 encouraged schools to implement personalized learning environments.

School districts in the United States were increasingly turning to personalized learning (PL) as a way to achieve better academic performance and meet the diverse requirements and interests of learners in the districts (Bingham et al., 2016). The “Top-District Competition” proposed by the U.S. Department of Education (DOE) in 2013 encouraged schools to put PLEs into effect. Personalized Learning emphasized transferable or interdisciplinary development skills such as goal setting, metacognition, problem-solving ability, and self-directed learning.

With support from the U.S. Department of Education, McCarthy and Schauer (2017) conducted a national study of the practice of PLEs in charter high schools by using a case study methodology. This study was not only conducted to investigate the practices of Personalized Learning in these schools themselves, but also some common issues found in schools practicing personalized learning. Based on the advisory panel’s recommendations and a review of achievement data, they whittled down the 70 charter schools to 26, all of which showed excellent academic performance and rising grades. Besides, most of the students from the 26 schools came from low-income families or ethnic minority families. At the end of the study, merely eight schools were selected with demographic differences, promising practices, geography, and achievement data taken into consideration. At each school, informal observations and interviews were conducted among school-wide learners, parents, teachers, board members, administrators, and school partners. In addition, data including school timetables, sample assessments, instructional planning sheets, teacher planning agreements, newsletters, application forms, brochures, charter plans, and transcripts were analyzed. McCarthy and Schauer (2017) identified four prominent characteristics of Personalized Learning in schools: (1) providing authentic experiences to learners; (2) teaching for mastery; (3) developing independent learning capability and metacognition skills; and (4) assessing data-driven instruction. Research has found that in schools, learners were highly encouraged to enrich their experience and actively learn something outside the classroom. Learners engage in a variety of real-world experiences, including internships, trips to various places, school activities, and university lectures, that provided meaningful learning experiences. In addition, the study employed learning assessments to provide norms and guidance for personalized instruction. Mastery-based instruction required continuous assessment and data-driven instruction. In schools, learners' needs were identified based on assessments, and the curriculum was continuously updated. Another US study funded by the Bill and Melinda Gates Foundation investigated the general picture of personalized learning in K-12 education in the US (Gross et al., 2018). 908 teachers from 38 schools responded to the survey. The study's findings showed that nearly 80% of primary and secondary school teachers reported that competency-based teaching was practiced less. Only one-third of learners reported setting learning goals at least half the time. This was consistent with only 19%-29% of teachers reporting that the learning goals and instructional requirements set by their learners were consistent. Moreover, most teachers were reluctant to let learners control their own learning pace, content, and learning activities. In the interviews, teachers mentioned that the pressure to meet learning standards was the main reason hindering the development of personalized learning.

Overall, Personalized Learning was showing a growing trend in thousands of classrooms in the U.S. and beyond. However, there were not many studies on different models of personalized learning and their effectiveness (Bingham et al., 2016; Bowles, 2019). Romano (2013) described experiential teaching in which learners enhance their understanding of mathematics by establishing their own Personal Learning Environments. In building the PLEs, learners needed to develop and strengthen their critical analytical skills as well as overcome personal difficulties and misunderstandings about mathematics presented by their individual learning environment. The UK Department for Education launched a five-year strategy for UK children and learners in 2004 to promote personalized learning practices from primary to secondary school. Funded by the UK Department of Education, Sebba et al. (2007) conducted two separate national studies. The two studies used large-scale national data to reveal academic testing and achievement in personalized learning. Sebba et al. (2007) investigated personalized learning methods in K-12 schools and proposed five components of Personalized Learning based on previous research: (1) learning assessment; (2) effective teaching and learning; (3) curriculum rights and choices; (4) school organizations; and (5) beyond the classroom. Using a representative sample of K-12 schools across the United Kingdom, Sebba et al. (2007) investigated how schools implemented the Personalized Learning Initiative launched by the Five-Year Strategy for Children and Learners. His research found that many schools used the following learner-centered teaching methods: collaborative learning (88%), inquiry-based learning (69%), teaching in a preferred learning style (66%), encouraging self-directed learning, and self-directed learning (64%) and classes by ability (41%). In terms of assessment, more than 80% of schools indicated that they routinely provided personal feedback (94%), conducted personal goal setting (92%), self and peer assessment (86%), and academic tracking (81%). Additionally, 45% of schools utilized technology to assess learners. In contrast, their case study found that assessment was not consistently embedded in learning in most schools. He further explained that across all types of schools, teachers reported that the following factors had a positive impact on academic performance: continuous learning assessment, individual learning goal setting, tracking learner progress, and self and peer assessment. Primary teachers put forward group-based, targeted intervention strategies such as catch-up and reinforcement programs. Some secondary school teachers emphasized the importance of career or alternative pathways and flexibility in the curriculum. Research by Sebba et al. (2007) helped to identify effective teaching and assessment strategies for personalized learning. Another UK national study on Personalized Learning commissioned by the UK Educational Communication and Technology Agency was "Impact 2007: Personalized Learning and Technology". The purpose of this study was to collect perception information about the role of the five-year strategy in promoting the individualization progress of teachers and students. Underwood et al. (2007) conducted a survey of 67 schools, where the number of primary and secondary schools and high and low technological sophistication were relatively evenly distributed in both rural and urban areas. This study applied multi-level modeling to examine the relationship between personalized learning practices and other factors. Results showed that compared with the teachers working in middle school, those working in primary school had a higher degree of recognition and implementation of personalized practical learning and responded more positively. Compared with teachers who teach other subjects, math teachers show more negative views on the implementation of personalized learning. High achievers were often unaware of their strong tendency toward personalized innovation in school. In addition, researchers observed that teaching activities mainly include computer-based activities, project-based learning, collaborative learning, multimedia teaching, and learning beyond the national curriculum. Moreover, assessment activities include learners' online self-assessment, individual goal setting, support, and monitoring of individual performance. What's more, a similar study found that individualized practices had a negative or uncertain impact on student's test scores, but the study did not control the implementation degree of specific practices, nor did it coordinate individualized assessment principles with the established standardized assessment design (Zimmerman & Kuhlmann, 2019). In short, there were still some common and key deficiencies in the existing research on the impact of individualized practice on students' performance: The commonly used measurement standards of students' performance are often inconsistent with the expected results of personalized learning; significant differences in the implementation of different research sites have weakened people's confidence in the research findings. Therefore, there was still much to learn from the implementation of personalized teaching at the classroom and school levels to expand these projects.

13.4 Effectiveness of PLEs and PL in Primary and Secondary Schools

Advocates for PL have argued that students, including those with diverse learning needs and disabilities, could achieve higher levels of learning if they received personalized instruction and supports that were tailored to their specific needs and capitalized on their strengths (Jones & Casey, 2015). Basham et al. (2016) found that PL environments across an entire reform district supported better than expected outcomes in student growth. Positive findings were also reported in engagement (Arroyo et al., 2014), attitude toward learning (Hwang et al., 2012), and metacognitive skills (Chen, 2009). Nevertheless, studies also reported negative positions toward certain aspects of PL (Beach & Dovemark, 2009). Lee et al. (2021) made a comparison between learner-centered high-performing and low-performing schools (as determined by their standardized test results), based on five characteristics of personalized learning (such as personal learning plans, competency-based progress, standard-referenced assessments, project-or problem-based learning, and multi-year mentoring) and the use of technology in planning, learning, assessments, and record-keeping. In general, teachers in high-performing schools were able to carry out personalized learning more fully and complete more tasks via technology than in low-performing ones. When making individual learning plans, sharing project outcomes with the community, and evaluating non-academic outcomes, teachers in high-performing schools paid more attention to learners' career goals, spent more time with them, and conducted more interaction with them to establish close relationships. They also made use of technology more frequently to share resources and boast stronger technology systems than teachers in low-performing schools. In addition, they found that in the UK, high-performing schools were reluctant to shift to a personalized learning system (Underwood et al., 2007). According to a national survey (Gross et al., 2018), in the United States, most teachers have yet to implement competency-based teaching or allow learners to manage their own learning under the pressure to meet academic requirements. However, some teachers in the UK believed that certain characteristics of competency-based teaching were positively correlated with academic performance, e.g., continuous learning assessment, goal setting for individual learning, tracking learners' progress, as well as self-assessments and peer assessments. As was shown by research reports, Personalized Learning practices were among the critical characteristics of high-performing schools, including providing authentic experiences to learners, teaching based on mastery, and developing self-directed learning skills (McCarthy & Schauer, 2017). As for the effectiveness of PLEs, many institutions have developed specific solutions for the development of the individual learning environment on campus, such as customized portals that help learners organize research and resources as well as express their views. However, because the principles of institutional engagement conflict with the individual learning environment, many educators preferred to use free applications such as iGoogle and MyYahoo, which provided solid platforms for a learner-centered environment for individual learning. Despite learning new online tools and computer applications rapidly, many high school learners still lacked the necessary information literacy. Thus, we needed a model that could balance full openness with access to resources and tools, providing useful guidance. Basham et al. (2016) found that PLEs supported better than expected outcomes in student growth. Arroyo et al. (2014) stated that the learning outcomes, motivation, and meta-cognitive skills were improved after using PLEs. Zhao et al. (2020) stated the personalized learning platform could effectively promote teachers' dynamic and layered personalized teaching, solve the learning difficulties of students, and provoke their learning motivation. It helped teachers get data on the learning processes of students and improve teaching performance. Meanwhile, it freed students from traditional problem-solving strategies and provided personalized practice materials, which could improve students' study efficiency within the limited practice time, thereby achieving mutual learning in teaching.

Yang and Zhang (2015) believed that Personal Learning Environments with a social network model as a resource aggregation and recommendation framework could more effectively promote personalized learning. The personalized learning environment could aggregate personalized resources from the learning environment inside and outside, analyzing learning behavior data, recommending personalized learning resources, providing support for teachers, and improving the optimization of the learning process. The development of artificial intelligence technology has enabled more intelligent human–computer interactions. The learning space in human–computer interaction was also called the personalized learning space (Zhang et al., 2017). The core of the personalized learning space was to use the personalized learning engine to provide learners with support services.

Conceptually, the very strength of PL and PLEs was to focus on designing learning experiences at the individual point of learning, accepting student variability and individuality (Rose & Ogas, 2018).

13.5 Challenges of PLEs and PL in Primary and Secondary Schools

Abbott et al. (2014) pointed out that there were five areas that required further research to advance personalized learning. Summit attendees found that, as a field, there was a need to learn how educators and researchers use data, how to design technology to support learners and related teaching practices, how to educate people who are prepared to work in personalized environments, and how to explore curriculum to support personalized learning. These fields should be supported by the research and development agenda that promoted the practice. Partnerships between practitioners, industry and researchers can be leveraged to support further understanding of these areas (Basham et al., 2013). Given the current growth in online and Personalized Learning, investments should be made to get a further understanding of interactive dynamics and potential outcomes in these environments. In future research, it is important to put personalized learning outcomes beyond standardized academic tests. Developing PLEs to organize learners' academic performance is different from creating a transformative environment that helps learners make greater progress. To fully understand the potential of Personalized Learning, research efforts need to be invested in system-wide reforms rather than single or limited variable interventions (e.g., personalized LMS, self-directed learning).

In addition, to have the potential of PLEs and PL into full play, all the stakeholders involved in PLEs should reach a consensus on the meaning of PLEs and be fully aware of its values. From a technology perspective, individual learning environments should respond to the vast differences in student identities and needs (e.g. cultural, cognitive, physical, social, emotional, and moral) and focus on prioritizing the development of 21st-century essential skills such as citizen consciousness, problem-solving ability, and so forth. From the users' perspective, learners, teachers, and PLEs designers need to have a consistent understanding of PLEs and PL, be equipped with the necessary competencies/skills, and collaborate to design and implement PLEs and PL. From an administration perspective, schools' academic administrations need to support and guide the implementation of PLEs, including political support, financial support, staff training, etc.

13.6 Future Trends of PLEs and PL in the Education Field

The application of artificial intelligence in Personalized Learning Environments is mainly reflected in answering questions, learning emotion capture, learning resources, intelligent thrust, and rapid positioning of learning methods as well as learning content. AI boasts functions such as intelligent cognitive algorithms, pattern recognition, and intelligent sensing technology. The adaptive education model supported by AI technology can realize a virtuous circle between the domain model and the teaching model, thus giving learners a better experience. Within PL research, it is important to consider the moderating interactions in relation to the final goal and the variability within a given experience. The emergence of more sophisticated mobile devices, including wearables, faster wireless, and more feasible data connections, along with technologies such as augmented reality, virtual reality, and improved data models, should not only enhance feasibility and interest but also the variability in ubiquitous PL research (Bhattacharjee et al., 2018). PL is growing by leaps and bounds with the integration of advanced technologies so that it can achieve better student interactions with the learning environment. However, the lack of consistency in the conceptualization of PL is likely to result in confusion and misunderstanding in implementation and poses challenges in conducting research that can optimize the practice. To establish an effective PL ecology, it would be beneficial to contain all the factors identified in the current studies, all acting together under a unified research-based framework. The research documented in this review (Abawi, 2015; Basham et al., 2016), U.S. policy (ESSA, 2015), and educational guidance documents (NETP, 2016) have often associated PL with the UDL framework. UDL might serve as a starting point to begin the development of a unified framework that could foundationally build PL through research, practices, and policies. The operationalization of PL and PLEs is such a complex process that it requires leveraging many different components of the education system to satisfy the needs of each individual student (Abbott et al., 2014). Research remains to be conducted on the foundations of learning, human growth, variability, and measurement to support PL model development. As more schools gravitate toward PL, research in the field should be ultimately focused on examining the positive effects as well as side effects of practices (Zhao, 2017).

Furthermore, as for applied degree education, significant change and transformation are occurring with the above-mentioned blended learning, artificial intelligence, and PLEs, along with curriculum renewal with industries and professions. We initially find that there is a strong need for the employment of Culturally Responsive Teaching to boost self-directed learning for learners receiving applied degree education. Culturally responsive teaching is a research-based pedagogy that makes meaningful connections between what learners learn in school and their culture, language, and work experiences. These connections are conducive to the learning of course content, develop learners' high-level academic skills, and interconnect classroom content with learners' lives and work.

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Chapter 14
New Zealand Architectural Technology Graduates' Employability: How the Work-Integrated Learning Performance During Studies Contributes to Graduate Employment and Future Career Success

Kam Yuen Cheng and Gang Hao

Abstract This study examines the value of WIL performance in developing graduates of architectural technology's employability abilities in New Zealand, evaluating its impact on a range of competencies and identifying variations in outcomes specific to soft skills, academic performance, and technical capability. The model may illustrate the notion of employability to students and their parents who are new to the topic. It will benefit personal tutors, career counsellors, and other practitioners interested in employability. It will also be utilised to create an employability measuring tool. This paper aims to bridge the gap between in-depth, academic, and sophisticated articles or books on employability and relatively basic essential pieces. The model proposes ways for the various parts to interact in different ways. Anyone interested in concerns about employment will find it helpful. Our findings show that academic achievement is a strong predictor of whether a graduate would find work after graduation, a graduate with high technical capability is more likely to find a job in the architecture sector and soft skills are highly correlated to a graduate's career progression.

Keywords Work-integrated learning · Employability · Employment · Architecture · Career success

14.1 Introduction

Work-integrated learning is popular in more and more universities and colleges. This model is embedded into the curriculum by education providers in cooperation with industry, allowing students to be introduced to real work scenarios early, rather than

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just sitting in the classroom and improving graduates' employability WIL experiences link the theory you study in school with application in a genuine working setting. Undoubtedly, this is a constructive method in the field of curriculum education, which essentially makes up for the traditional teaching method that teachers and students use their mouths and ears but rarely do; more importantly, it improves students' awareness of the combination of academics and industry and creates high-skilled newcomers to the industry who can work confidently after graduation. It is worth noting that with the development of work-integrated learning, the implementation process and evaluation have also undergone some changes, resulting in some controversies in the operation process of the industry. Therefore, there is a strong demand for case analysis to track whether students improve their employability and whether they can be hired after going through the work-integrated learning process. This study investigated work-integrated learning feedback and employment destination of construction graduates in the past two years, analysed the logical relationship between the two, identified the career progression model, and provided valuable information for all parties in the industry to improve students' decisions and behaviours.

14.2 Defining Work-Integrated Learning (WIL)

The International Journal of Work-Integrated Learning (IJWIL) defines "work-integrated learning as an educational strategy that uses relevant work-based experiences to enable students to purposefully combine theory with meaningful work practice." This educational system requires students to participate in practical and relevant work-related activities, including their educational institutions, and the company or community. This collaboration enables learners to combine studying with practice in the learning process to enhance learning outcomes (Cooper et al. 2010; Cote & Emmett, 2015; McRae & Johnston, 2016). From employers' perspectives, this approach can also be a channel for them to pick the graduates with potential in advance with more convenient access to the human resources they need.

In recent years, the development of work-integrated learning has faced significant changes due to the COVID-19 pandemic, with the traditional physical workplace work-integrated learning structure being replaced by more novel forms. Over the past two decades, the work-integrated learning model has been undergoing innovation and development. The pre-2020 work-integrated learning focused on supporting graduate diversity and the transferability of work skills to adapt to new trends. However, innovative work-integrated learning models are on the way as educators look for innovative practices that move away from just providing traditional benefits and incorporate time out of the office into the work-integrated learning process (Jackson & Bridgstock, 2018; Smith et al., 2019).

Work-integrated learning's innovative development includes mini-internships, hackathons, contests and events that no longer worry about paying enormous time costs. Short and realistic events attempt to attract a new generation of student experiencers (Kay et al., 2019). In addition, work-integrated learning organisations have integrated entrepreneurial work experience into their programs. They work with small and medium-sized start-ups to promote the growth and growth of start-ups, consultants and incubators, providing an opportunity pipeline for new types of human resources and a platform for win–win cooperation between companies and employees (Kay et al., 2019; Smith et al., 2019). As more and more work-integrated learning programmes are introduced into courses of study in different specialities, the benefit is that they can attract interdisciplinary participants. Many forms of work-integrated learning are no longer limited to the local community. The participation of the global scope dramatically increases the opportunities for the internationalisation of work-integrated learning (Bayerlein & Jeske, 2018). In addition to removing physical limitations, digital platforms facilitate online modes such as remote virtual experiences and even virtual reality work-integrated learning experiences (Al Shehri, 2012; Wood et al., 2020).

14.3 Evolution and Development of WIL

As early as the nineteenth century, educational providers in the United States provided their students with some social work educational resources, including institutional visits, industry lectures, and internships. This is an early form of work-integrated learning (Larkin, 2018). In the 1920s, work-integrated learning was operated and developed in education as internships (Reeders, 2000). However, this work practice-based curriculum was not valued in the era of theoretical academic achievement. In the 80 s, work-integrated learning was starting to gain traction among education providers, with increasing emphasis on the need for human resources to improve employability and not just gaining qualification on paper (Agnew et al., 2017, 2021; Ferns & Zegwaard, 2014; Orrell, 2011; Smith, 2016). As governments increasingly understood that the ultimate purpose of education is to train people to join the workforce, it was essential to ensure that graduates have industry-matched attributes and experiences. As a result, work-integrated learning has developed rapidly in educational providers, especially universities and colleges. Programmes such as internships, community projects, cooperative education, and work placements have been successively introduced and operated in educational practice (Agnew et al., 2017).

Studies found that the operation and development of work-integrated learning over the years have had significant advantages for all parties. From a learner's perspective, work-integrated learning has been increasingly standardised in its operation and development over the years, positively contributing to students' career planning and employability (Jackson & Collings, 2018; Oliver, 2015; Yorke, 2006). Singapore Institute of Technology has done research showing that when programmes are matched to the market's needs, students who engage with employers during their studies have a substantial positive impact on confidence, motivation, and access to job opportunities. After all, students with real-world experience can turn their theoretical knowledge into learning resources for job-related skills development. Most importantly, the operation of work-integrated learning not only enriches students' understanding and awareness to improve their employability. The process also allows industry practitioners to express their opinions on workforce expectations in quality and quantity. Through the maintenance of corporate and institutional relationships, providers of higher education and vocational education providers updated labour market needs and expectations of vocational skills of new entrants (Jackson, 2014). An expected positive outcome of work-integrated learning is to develop graduates' job skills and allow all providers to continuously review the curriculum and improve teaching quality (Rowe & Zegwaard, 2017). Additionally, WIL's positive impact is creating a pipeline for the industry to cope with the industry demand. There is no doubt that before and after the COVID-19 pandemic, most organisations face common challenges in identifying, attracting, retaining and developing human resources (Gallardo-Gallardo et al., 2018). An essential aspect of the operation of this system is to identify and attract talents from other organisations and assign them to the correct positions to contribute to the industry and meet the skill shortage demand (Cappelli & Keller, 2014). The work-integrated learning process provides an excellent place to replenish their talent pool.

At the same time, some literature on work-integrated learning has expressed concerns about this model. A 2021 study by Fleming & Hay expressed cautious optimism about work-integrated education. The report examines a range of risk perceptions and definitions of existing work-integrated study programmes at eight New Zealand higher education institutes. Compared to the on-campus learning experience, workplace study has financial, reputational and legal consequences for all parties. This includes exploiting the emergence of high-risk behaviours and safety. These possibilities will affect the reputation of universities and institutions. Finally, the report recommends that all parties have a clear understanding and awareness of such risks and conduct risk management and control in the project design and implementation of the risks. The risks faced by participants in work-integrated learning are summarised in the following scenarios. The first is that the work scene is more uncertain than the campus environment. The campus environment is largely predictable, with more structural options depending on the course (Smith et al., 2019). All aspects of the work-integrated learning experience are fluid. For example, work-integrated learning can be paid or unpaid, with or without overtime. Different majors also lead to significant differences in the organisation's work-study integration.

Furthermore, work-integrated learning in the education and health industries is primarily in the government or public sector, while other industries may be mainly in the private sector (Fleming & Hay, 2021). The study's findings also detail the risks for different groups. For students, physical and psychological traumas were the respondents' most identified risks, including trauma, injury, anxiety and even death. Especially in industries such as catering, engineering, medicine, and agriculture, personal safety risks are considered a priority. For example, when working in the kitchen of a restaurant, it is easy to slip and burn the hot pot. The risk of exploitation was also highlighted in the report. The form of exploitation is gratuitous rather than a realistic demand, and this power imbalance is seen as a challenge. It is also evident from the literature that the work-integrated learning process poses risks to employers, and participation can be very reactive and passive, posing a potential danger to institutions. For example, their improper attitude towards customers or patients can cause losses and delays. As mentioned above, combining work and study without the participation of high-quality students brings high maintenance costs to the employer and risks to the reputation of educational institutions.

14.4 Relationship Between WIL on Graduate Employability and Actual Employment

An investigation of business students from thirty-eight UK higher education providers compared their learning process with career data for the first four years after graduation. The effects achieved in the work environment are inconsistent. "Contributing to the greater achievement of graduate-level employment on one measure and not on another" (Wilton, 2012). A survey of UK graduates in 2009 and 2010 showed no clear, logical link between their employability and employment outcomes, meaning that high employability does not mean being employed more efficiently (Okay-Somerville & Scholarios, 2017). This result contradicts people's stereotypes. Conventional wisdom holds that the accumulation of work experience provided by work-integrated learning can enable students to acquire more positive professional behaviours, thereby improving their employability and being more popular with employers.

However, the report showed that this option has no obvious advantage in the situation of "graduation is then unemployment". Similar results came from a set of data from Australia (Jackson, 2014). The respondents were 28,000 college students in 2011 and 2012. The results showed no significant positive correlation between taking a new job in the last year of a college course and subsequent employment status (Jackson, 2014, p.147). Certainly, there is an argument that the final year of previous work experience does not equate to participation in work-integrated learning. Some literature suggests that the benefits of reducing unemployment through internships are not evident among business or management graduates, which leads corollary that any positive gains in employability through work experience decline rapidly after graduation (Wilton, 2012).

A report from 2017 noted that education and training institutions generally attach importance to students' employability. To this end, they have incorporated many professional skills into the curriculum, promoting the popularity and development of work-integrated learning as a symbol of their positive work. However, these responses do not address or identify the broader factors affecting graduate employment. The literature presents a graduate employability model, which includes human capital (including WIL) and personal, behavioural and social resources. Although the study is more theoretical, many results based on survey data have identified some factors that influence employability outcomes. (Clarke, 2017). Divan and McBurney (2016) found in a survey of postgraduation alternative career development survey of graduate science students. Despite the low response rate, more people chose the option of not selecting the employment same as their majors. This uncertainty of career planning harms the employment status of graduates. Conversely, students who focus on their career development actively participate in work-integrated learning or other internship programs during college, and their career development results are often positively related to their career plans (Bridgstock, 2009).

Some literature also expresses the concern of the graduate labour market about graduation ability. This is a change from students' perspective (for example, knowledge, skills, emotional intelligence and other attributes), where the demand-side view is also important. Some studies have found that in the relatively fixed number and structure of the graduate labour market, the level of employability does not necessarily increase the probability of successful employment (Artess et al., 2017). Australia's national census shows that the number of engineering graduates exceeds the demand for professional jobs. There are also some external factors influencing this result, such as employment agencies or employers. These factors are very subjective than neutral. Some employers even have a negative attitude towards work-integrated learning feedback. Negative thoughts also included their attempts to understand students' involvement in the workplace and their self-perceptions of their ability to graduate. As a result, these experiences are likely to privilege well-resourced middle-class students, increasing the risk that students will experience racial and gender discrimination. This is confirmed in another interview report based on the internship managers of the undergraduate study industry; that is, among the students applying for internship programmes, there is indeed an indirect discrimination phenomenon (Wilton, 2014).

Undoubtedly, the definition of core words is required before delineating the scope of any research. The concepts of employability in many kinds of literature are controversial, developed, weakened and differentiated (Artess et al., 2017; Stott et al., 2014). The key is whether it can be standardised and the measurement method. More macroscopically, how to operate different definitions, the simple unity of multiple coexistences and various definitions for employability are dazzling (Harvey, 2001; Stott et al., 2014; Mason et al., 2003). The employability criteria can be clearly defined in the literature in the following categories regarding operability. Some, known as graduate career fitness, have four suggested elements—attention, control, curiosity and confidence (Savickas & Porfeli, 2012). The tool is used in the UK as an indicator of students' employability. The other set of criteria specifies six employability dimensions, writing preparation, lifelong learning, effective decision making, professional practice and the combination of theory and practice (Smith et al., 2014).

Most educational providers separate the encouragement of improving employability from the employment outcome of graduates and always emphasise the individual attribute of employability (Clarke, 2017). This situation has led to a greater focus on the educational process. This type of statistic is often better than realistic graduate employment statistics. Nevertheless, the possibility of employment and then unemployment remains. The ability of students to get a full-time job in their major is very important (Jackson, 2014).

The internship has shown some relationship with graduate employability. A 2014 report from the Graduate Careers Association of Australia showed an increase in graduate employment between six months and three years after course completion (Graduate Careers Australia, 2015). Data from the UK shows that among 192 graduates six months after graduation, students who took part in an internship were more likely to be still working and to enter a higher learning stage. The results became less apparent as the timeline was stretched to one to three years (Mason et al., 2003). In summary, all employability benefits due to WIL will diminish over time, and the time interval is important (Wilton, 2012).

14.5 Controversy and Research Gap

Some pieces of literature specifically discuss the role of work-integrated learning in employability and employability. What is clear is that graduate employability is now recognised as a core strategic concern of higher education worldwide (Divan & McBurney, 2016). Many universities and colleges add work-study integration to their curriculums to enhance employability (Artess et al., 2017). Moreover, WIL offers a range of benefits to students, including improved academic performance, better employability and an increased likelihood of immediate employment upon graduation. All this has pushed work-integrated learning to the position of faith (Surridge, 2009; Wilton, 2012; Artess et al., 2017). What interests the authors is that the potential contribution of the three aspects, especially the latter two outcomes to work-integrated learning versus the actual situation of architecture graduates in New Zealand, will produce positive or negative factors that will be the focus of the study. The concept of employability is understood differently and even controversially from political, academic and professional perspectives. They pointed out that employability and successful employment is not the same thing. In other words, high employability but still unemployment is a reality. Some reports match work-integrated learning experience with graduate employment status on a specific geographic scale, and the literature results are optimistic (Artess et al., 2017).

This study critically reviewed the literature on work-integrated learning. Still, it failed to provide a clear analysis of the interaction between New Zealand architecture graduates and social resources and their employment status. This also brings the possibility of risk to work-integrated learning's operation. This paper will draw on the review of the above literature to recognise the differences in terms used by different researchers and formulate a basic principle of the relationship between the graduate employment status of New Zealand architecture students and their work-integrated learning experiences.

Many researchers who have studied the intrinsic relationship between employability and graduation status believe that more research is needed to understand better the complex role of different types of employability in leading to outcomes. Another motivation for additional research is understanding the industry context and local environment. The relationship between employability and employment status across periods and locations may lead to opposite results. This is also a notable gap in the literature review.

14.6 Research Significance and Questions

Recent graduates' earnings and job prospects have received much attention in the growing literature. More importantly, these investigations were conducted in a very different institutional setting than in New Zealand. Using a freshly obtained unique dataset from the 2019/2020 and 2020/2021 periods, the research contributes to the body of knowledge by examining architectural technology graduate employment and career challenges in the New Zealand context, thus devising different strategies for career development.

1. How is WIL performance related to employability?
2. How is WIL performance related to the career prospects of graduates?

We also address a gap in the literature by undertaking an empirical investigation into how WIL performance influences where new graduates sit on the career development continuum. As a result, our piece serves five goals. To begin, we look at the link between WIL performance success and job prospects for graduates. Second, we look at the connection between WIL performance and contribution to narrowing the skill shortage gap in the market. Third, we look at the link between WIL performance and WIL providers. Fourth, we look at how WIL's performance affects its position in the company. Finally, we look at how a good career start determines career progression after graduation.

14.7 Methodology

The study's target audience is Architectural Technology graduates with Work-integrated learning from the 2019/2020 and 2020/2021 academic years. Currently, only two polytechnics are offering Architectural technology programmes with Work-integrated learnings. This study looks at 31 respondents from a Polytechnic in South Island, accounting for more than 65% of the Architectural Technology graduates with Work-integrated learning in New Zealand in 2019/2020 and 2020/2021. 31 out of 47 have been identified, representing over 65% of the graduates in the polytechnic. Their performances during their WIL are also recognised.

The research method is a combination of quantitative and qualitative analysis. It collects data in the form of questionnaires collected after their placement and a short interview on the phone to track their current employment. The author used uniformly designed questionnaires to learn about the situation or seek opinions of how well the learners performed during their placements from selected respondents who were the work-integrated learning providers.

Through the literature review and national graduate profile by New Zealand Qualification Authority (NZQA), relevant persons engaged in the architecture industry were interviewed separately and asked to conduct a preliminary analysis. The requirements of the relevant architectural technology graduate's competencies in the table are analysed and evaluated. Afterwards, the questionnaire's content was adjusted according to the interview results to generate a formal questionnaire. The standard questionnaire consists of two main parts. The first part is the respondent's feedback on learners' competencies demonstrated in the workplace. The second part is on how well a learner performs academically fulfilling the graduate profile. Both parts use the Likert scale to score the requirements of the architectural technology graduates' competencies. (1 point: below the expectation; 2 points: meet the expectation; 3 points: exceed expectation). The data is only for restricted use due to privacy.

The binary logit model and the ordinary least-squares (OLS) model are the two models described in this article to satisfy the five research goals. The primary goal of this research is to use a binary logit model to assess the marginal effects of students' performance during WIL on graduates' chances of finding jobs six months after graduation. Graduates with higher performance are thought to have a better chance of finding a job (Hypothesis 1). The binary logit model is used to regress the graduates' actual employment outcome (y) on a vector of explanatory variables (X), with $y = Xb + c$ and c as the intercept, which is the vector of error, b being the slope. X is an n x k matrix containing k explanatory variables and n observations. The dependent variable y is a binary variable with the value of 1 for employment and 0 for unemployment (Soon et al., 2020). We characterise the three outcomes of full-time, part-time employment, or self-employment as "employment." The number of graduates who work for themselves is minimal. We think this is partly due to the New Zealand License builder professional framework, where graduates must have at least two years of relevant work experience before establishing their own companies and working in the architectural technology/design field. Soft skills, technical capability, and academic performance are relevant explanatory variables in the binary logit model. These variables are also used as explanatory variables in the next two models. Indeed, this paper aims to calculate WIL performance's marginal impacts on the dependent variables in each of the two models.

The second goal is to assess the marginal effects of students' WIL performance on graduates' chances of finding related jobs after graduation. Graduates with higher performance are thought to have a better chance of finding a job related to the study (Hypothesis 2). The binary logit model is used to regress the graduates' actual employment outcome (y) on a vector of explanatory variables (X), with $y = Xb + 1$ and the dependent variable y is a binary variable with a value of 1 for relevant work and 0 for unrelated work (Soon et al., 2020). This reflects the effectiveness of learning to meet the expectation of the industry by providing graduates with the competencies they are looking for. We think this has been a skill shortage issue in New Zealand for many years, where graduates cannot find related work after graduation, and employers cannot find suitable graduates to fill the skill gaps due to the mismatch between the graduate profile and expected competencies of the architectural technician.

The third objective of this study is to assess the marginal effects of students' performance during WIL on graduates' chances of being employed in the same WIL company after graduation. Graduates with higher performance are more likely to be hired by the same WIL company (Hypothesis 3). The dependent variable y is a binary variable with a value of 1 for working in the same WIL provider company and 0 for other companies. Students always do their best to impress their future potential employers, hoping they can secure a job offer before graduation or start working immediately after graduation without searching again in the market for other opportunities, which is quite a mind-draining experience for job seekers.

We use an OLS model with the dependent variable (y) being the pay received by employed graduates to achieve the fourth goal of this study. The OLS model $y = Xb + 1$ estimates the conditional mean function of the dependent variable, i.e., $E[y|X] = Xb$. 0 means jobless, 1 lower rank than the technician, 2 average ranks as Architectural technician, 3 is leadership or managerial position. The marginal effect of WIL performance on the position of recruited graduates is calculated using this model. A better performance average, we hypothesised, would have a positive marginal influence on the position and, thus, the salary (Hypothesis 4).

The OLS model is also used to assess the marginal effect of a good starting point (working in a related job, preferably in the same WIL provider within six months after graduation) on the career progression (position) of recruited graduates. A better career start, we hypothesised, would have a positive marginal influence on career progression (Hypothesis 5).

14.8 Findings and Discussion

14.8.1 Discussion of Findings I, II and III: Effects of WIL Performance on Employability, Being in a Related Job, Employment in the Same WIL Provider

Table 14.1 shows the marginal impact of WIL performance on the chance of employment. In our analysis, we employ one logit model (M1). The M1 criterion considers the impacts of variables—soft skills (C1), technical capability (C2) and academic performance (C3) in WIL performance on the dependent variables (i.e., probability of being employed).

Table 14.1 presents the marginal effects on the probability of being employed. Academic performance exhibits the highest marginal effect of 1.55 on employability, and soft skills have a positive effect of 0.58. It is interesting to note that technical capability—drawing skills has a negative effect of −0.60 on employability (see Table 14.2).

Table 14.1 The marginal effects of WIL performance on the likelihood of finding a job within six months

Dependent variables	Soft skills	Technical capability	Academic performance
Being employed within six months	(C1)	(C2)	(C3)
M2	0.58	(0.60)	1.55

Table 14.2 The marginal effects of WIL performance on the likelihood of finding a related job

Dependent variables	Soft skills	Technical capability	Academic performance
Being employed in a related job	(C1)	(C2)	(C3)
M3	1.56	0.42	1.94

All three capabilities positively affect the probability of being employed in a related job. Particularly, Academic performance exhibits the highest marginal effect of 1.94 on employability, with soft skills of 1.56. Technical capability also plays an important role, but not as much as the other two. It is interesting to note that soft skills have three times marginal effect on whether graduates can find a related job than just finding a job.

Table 14.3's statistically significant marginal effects (4.90) indicate that graduates with superior academic performance have higher employment probabilities in the same WIL providers. The marginal effects on soft skills—communication skills and technical capability—drawing, on the other hand, are only 1.64 and negative 2.93. Most WIL providers are academically connected to the education institute and participate in the consultation of graduate profiles and curriculum. Since the academic graduate profile is designed based on this curriculum, this could be explained why more emphasis is being placed on the academic performance of WIL providers. They also favour technical training capability such as drawings where different companies may have different styles after joining the company because they believe it is easier to train the graduates according to individual company requirements than someone with previous practice.

Our findings are consistent with previous research. According to Pinto and Ramalheira (2017), graduates with superior academic credentials and a diverse range of

Table 14.3 The effects (4.90) indicate that graduates with superior technical capability have higher employment probabilities in the same WIL providers

Dependent variables	Soft skills	Technical capability	Academic performance
Being employed in the same WIL company	(C1)	(C2)	(C3)
M4	1.64	−2.93	4.90

extracurricular activities are more employable (Pinto & Ramalheira, 2017). Furthermore, perceived employability was linked to soft skills rather than subject-matter expertise (Jayasingam et al., 2018).

Interpersonal qualities, a nice attitude, a good work ethic, and job competency were more essential to employers than sophisticated software (Hogan et al., 2013). Graduates believe their university degrees do not equip them with the skills necessary for the labour market (Figueiredo et al., 2017). Graduates with exceptional academic achievement were statistically considerably more likely to get interview call backs if they had internship experience; good technical application skills had no statistically significant influence on job opportunities. This might also be explained by graduates who utilise their technical talents more successfully being choosier in their employment searches. Piróg (2016) obtained similar results, noting no statistically significant association between graduates' final grades and career opportunities (Piróg, 2016). The results of previous research back up the claims we make in this section.

14.8.2 Discussion of Findings IV and V: Effects of WIL Performance on Ranking and Effects of Good Career Start Related to Career Path (OLS)

Table 14.4 displays the OLS estimate results, which demonstrate statistically significant marginal effects of WIL performance on the ranking and thus earnings. The natural logarithm of recent graduates' ranking is the dependent variable. A 1.0-unit improvement in soft skills may escalate the position from technician to leadership level, depending on the model design. The model demonstrates that soft skills could be the key to promotion. Technical skills such as drawing skills are a supplement to leading and mentoring junior staff. Academic performance does not have much effect on the promotion since it is more relevant to the graduate profile, not the leadership role.

The three control criteria differ from those mentioned in the previous section on logit estimation. M5 comprises employment within six months in a related field and starting their career in the same WIL provider. Most people think that career advancement could be more promising if they start their career with the same WIL provider. We are challenging this hypothesis. Table 14.5 demonstrated that regardless of whether one gets employed by the WIL provider and stays in the same company during their first or second year of career, they are used. It shows that a one-unit

Table 14.4 The effects of WIL performance on the ranking and thus earnings

Dependent variables	Soft skills	Technical capability	Academic performance
Ranking after graduation	(C1)	(C2)	(C3)
M5	0.61	0.28	0.02

Table 14.5 The effects of WIL performance on career progression

Dependent variables	Within six months	Related works	Same Company as WIL
Career progression	(C1)	(C2)	(C3)
M6	0.58	1.62	−0.56

increase in whether they work in a relevant field is associated with a large 1.62 times more likely to be promoted to a managerial position within one or two years after graduation. Table 14.5 also shows what happens when one gets employed in the same WIL provider after graduation so-called very lucky one with a good career start, their future career progression would be negatively impacted. They are 50% less likely to be promoted in the same company than others who graduated working in other companies. It also demonstrates that employment within six months is crucial to one's future career development. The discovery of the importance of employment that drives the results was made possible by further classifying them into with job, is it related or same WIL company.

14.9 Conclusion and Suggestion

This study looks at a sample of 31 newly graduated university students from Polytechnics in New Zealand during the 2019/2020/2021 academic years with an over 65% response rate. The research focuses on the marginal effects of the dependent variable—academic success as evaluated by their performances—(i) the chance of finding related work after WIL, (ii) the chance of being employed in a related job, (iii) the effect of employment in the same WIL provider (iv) effects of WIL performance on ranking and (v) the effects of good career start related to career path (OLS). By examining graduate career prospects in a New Zealand institutional setting, this research contributes to the core of knowledge. We address a gap in the literature by conducting an empirical study of the association between WIL performance and where new graduates lie in the income distribution; such studies are often overlooked in the literature.

The following are the paper's main results: (i) A strong academic performance or qualification achievement significantly influences the likelihood of employment. (ii) Academic performance exhibits the highest marginal effect of 1.94 on employability, with soft skills of 1.55. (iii) Based on the marginal effects of academic performance, having a higher academic performance score is most beneficial for graduates who want to continue working in the same WIL provider after graduation. (iv) A 1.0-unit improvement in soft skills may result in an escalation of position from technician to leadership level, depending on the model design. (vi) Working in the same WIL provider negatively affects future career progression.

Our findings show that academic achievement is a strong predictor of whether a graduate would find work after graduation. The graduation from the programme demonstrates to companies persistence. Companies assess applicants on various factors, including their communication skills, ability to express their ideas effectively, exposure to real-world circumstances, work ethics, professional attitude, and academic performance. Based on academic accomplishment, the existing academic performance system does not adequately handle these attributes. The findings also show that employment in the related industry and application of what they learnt is highly correlated with their soft skills. To help the sector grow sustainably, career progression with job satisfaction offers graduates motivation to stay in the industry. Moreover, soft skills play a crucial role in career progression. To solve the skill shortage in the construction industry in New Zealand, a dynamic approach is required to ensure graduates can be employed in a related sector and develop their careers gradually.

ROVE—reform of vocational education, on the other hand, is now changing the way how the curriculum is designed. Work development councils are established to improve industry results by reshaping the vocational education and training system to produce more appropriate education and skills, guaranteeing national uniformity in graduate outcomes, and solving skills shortages. It also works with their respective industries to develop and maintain a long-term view of the skills that their companies will need in the future. They convert these criteria into expectations for vocational education. Te Pukenga, Private Training Establishments (PTEs), and te Wananga, the education and training providers, will be expected to satisfy these standards. Indeed, as stated in the New Zealand Construction Sector Accord, One of the objectives is to increase capacity or to have a competent workforce capable of meeting New Zealand's growing housing and infrastructure demands. The Accord established a framework for companies and the government to collaborate on some of the industry's most urgent concerns. These difficulties include a shortage of qualified and competent people, imprecise regulations, disorganised leadership, an unreliable career pipeline, and a risk-shifting culture.

The Accord also set a framework for resolving some of the industry's most critical concerns. The building and construction business is an ecosystem, and the Accord brings all interested parties together to collaborate in favour of a common goal. The first programme of action that the government committed to implementing as part of the Accord to improve the sector's performance included a Construction Skills Action Plan, a new Infrastructure Commission, and revised Construction Procurement Guidelines for government agencies. Along with addressing the building industry's skills shortfall in New Zealand. Our findings have political ramifications, notably in terms of study link loan repayment. Since its launch in 2009, it has been the most often utilised education loan among New Zealand students seeking higher education at neighbouring public institutions.

Graduates with strong soft skills and academic performance can achieve higher positions within the first and second years compared to academic performance alone, thus having higher resilience in loan repayment. This outcome may unwittingly steer students toward soft skills achievement and academic brilliance. Given that our findings indicate a strong statistical link between academic performance, non-academic performance, and employment, it may be time for the Ministry of Education to change the weights and put a higher value on non-academic achievements. Our results might be used to fuel legislative debates over the undue emphasis on academic achievement in higher education curriculum development.

Using normal OLS estimation, we find that the effects of working in the same WIL company are not positively correlated with career development. According to the computation, though very strong academic performance can help students go to the same WIL company after graduation, it harms one's career development. It is less likely to promote within the same company compared to others working in different companies after graduation. Employment in a related industry within six months had a stronger impact on future positions and thus income for graduates. This is understandable, given that they are most likely entry-level jobs for recent graduates. Academic brilliance is only advantageous up to a point since higher entry-level or technical level salary jobs need more than academic knowledge. Soft and specialised skill sets are often required for employment in a management or leadership role.

From this vantage point, educational practices might be tweaked to include related soft skills in architectural technology programmes. On the other hand, graduates with professional degrees with excellent soft skills would be more suited for management and leadership roles that can improve the sustainability of the construction industry workforce ecosystem. By the objectives of the New Zealand Education Blueprint, graduates should also develop entrepreneurial skills to become proactive job creators as opposed to passive job seekers.

Combining the data conclusions and the analysis of the results obtained in this paper, the authors strongly recommend that graduates, especially newcomers to the construction industry, can develop the employability skills identified to meet the increasingly fierce industry challenges to stand out from the many candidates. Undoubtedly, employability skills are an integration of the many skills required to make graduates "employable". It contains the applicant's academic knowledge, technical capability, soft skills, job experience, and attitude. These can be understood as the core behaviours and competencies for the job. They are seen as crucial to successfully winning job opportunities and career development. Especially in the construction industry, job seekers must demonstrate the qualities and attitudes of being part of the project team during the WIL process. Such as building and developing relationships, solving problems, taking initiative to achieve team goals, etc. How a graduate will demonstrate their experience to an employer who believes they can be a good fit for the organisation to benefit from.

The results show that the excellence of technical and soft skills is a very important in the whole WIL evaluation results. How graduates use technical knowledge and soft skills to deal with and solve problems is a core need for employers. As a newcomer in the industry, a sufficient level of technical expertise learnt from academic and technical capability are the key factors to reflect the ability to solve problems. Employers want to see that they can use them to tackle challenges and problems and expect several different ways to overcome them. At the same time, excellent academic performance can be regarded as a talent with good learning ability. Whether graduates are keen to learn new things, or even learn from failures and adapt better, is crucial for talent-seekers. This can also fully reflect the positive attitude and initiative of the graduates. Good learners can think independently without always being told what to do next, an important quality for newcomers to the workplace. This is seen as a core benefit throughout the WIL process. Evaluators want to see that students are not afraid to come up with new ideas, solve and approach challenges differently, and get results even if it's not optimal.

Soft skills and teamwork skills are also good qualities that architecture students should demonstrate at WIL, even the core qualities. This directly contributes to improving WIL evaluation. Through the data research in this paper, the authors found that the gap in soft skills is an important part of students' WIL evaluation. Communication plays a key role in any job. Co-workers are eager to know that their co-workers can listen, execute, and articulate ideas, even challenging their ideas for positive outcomes. Talk to customers, collaborate competently, and more. Most construction projects require teamwork to complete the work results according to the plan. Good communication skills can greatly solve the time cost and increase work results. Effective teamwork is critical to the success of the project, so in WIL, how can you demonstrate that the student can execute positively to support the organisation in achieving its goals and demonstrate their willingness to work closely with team members, delegate and listen and Taking responsibility for the shared workload directly affects the evaluation of WIL. Furthermore, balancing one's wishes with the ideas of others and ending negotiations and communication with a positive and steady attitude is a challenge and an excellent option for all graduates during the WIL period.

Going a step further, the study results show that if students can demonstrate stronger soft skills during the WIL, it will undoubtedly become a plus. Senior employers also want to crave the leadership skills of staff, even if they are only entry-level. This is a good indicator that students are looking for progress in the business and can motivate team members, complete tasks to a high standard and be a positive factor in the team. And these abilities can indicate that students can effectively organise and plan workload and self-required to complete tasks on time and quantity, even complete their responsibilities under certain intensity and pressure, and handle project challenges calmly and objectively.

All contents above are some suggestions given from the perspective of the participating subjects of WIL, which can easily be understood as taking the initiative and winning. However, the authors also found from the data research process that the organiser of WIL, the education provider, also has some thoughts. From the perspective of WIL's organisation and managers, WIL is undoubtedly a high-quality solution that benefits all parties. In the WIL environment, theoretical information obtained by school teachers is verified and examined, and feedback and data are obtained from students and enterprises to strengthen teaching quality management. For example, this study found that in addition to professional academic background and industry skills, soft skills such as communication skills are also strongly concerned by employers. How to increase the involvement of this content in relevant professional courses has become a new topic for teachers. For example, adding assignments such as classroom interaction and student teamwork can be beneficial attempts to improve this skill. In addition, education providers need to examine the WIL program and reflect on it. For example, during the placement process, ask yourself: Are you clear and understand the learning goals of students participating in WIL? Can constructive feedback be added to the WIL experience? Has the set goal been achieved after the entire WIL is over? And does WIL provide students with new technology or skills? Is it necessary to improve the goals or themes of student participation in WIL? Undoubtedly, as the organiser of WIL, properly coordinating and managing the relationship and potential risks between students, enterprises, and schools is also a major challenge in the implementation of WIL. For example, the occupational health and safety of the participants will directly lead to the quality and reputation of WIL. Critical thinking has always been critical in improving the efficient operation of WIL.

Our findings complement the Te Pukenga Consultation, a comprehensive nationwide survey of industry graduates conducted by the Ministry of Education. To make better judgments about upcoming educational initiatives, ministry officials may review our outcomes.

Limitations of study

The study's modest sample size is one of its flaws; It would be ideal if it included recent graduates from more public and private colleges. Another restriction is the sample's cross-sectional character; an ideal benchmark would be a dataset that tracks graduates throughout time.

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Chapter 15
Learner' Online Self-regulated Learning Skills: A Comparison Between Chinese Undergraduates and International African Undergraduates

XiaoFang Ye, TingZhi Chang, KeXin Zhong, XiaoShu Xu, and Yunfeng Zhang

Abstract The outbreak of the COVID-19 pandemic forced students to move from face-to-face learning to online learning. Online learning has high demands on students' Self-regulated Learning (SRL) skills. In this study, a questionnaire that used five-point Likert scale was administrated between international African undergraduates and Chinese undergraduate students to investigate their online learning behaviors. The questionnaire was composed of six categories: environment structuring, goal setting, time management, help-seeking, task strategies, and self-evaluation. 441 valid responses were received, 89 from international African students and 352 from Chinese undergraduates. The collected data were analyzed with SPSS Version 24.0. The results showed that there was no significant difference between Chinese student' and international African students' SRL skills in the six sub-scales. This may be due to the small sample size of African students and the similar learning environment. Larger samples are needed in future research to further verify the conclusion. The research results can be used as a reference for the future online learning design to strengthen learners' SRL skills.

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15.1 Introduction

Many universities were forced to close temporarily in 2020 due to the COVID-19 pandemic outbreak (UNESCO, 2020). Almost half a million international students returned to their home countries and had to study online from their homes to continue their education in mainland China (Bao, 2020). The pandemic of coronavirus disease 2019 (COVID-19) undoubtedly posed a significant challenge to global education systems, disrupting normal teaching and learning (Li et al., 2021). The COVID-19 pandemic had shifted university teaching and learning activities from physical classrooms to online platforms (Klimova et al., 2022; Li et al., 2021; Zhou et al., 2021). The abrupt change not only impacted the learning mode, but it also raised concerns about students' learning performance, assessment, and self-regulation. Despite being promoted for many years, online learning was still not a popular teaching and learning method in many educational settings (Mou, 2021). Online learning, according to research, increased students' available time because the online environment did not require the student to be physically present to attend class, allowing students to be more flexible in how they manage their time and attention to their work and/or family responsibilities. Students' online self-regulated learning skills were required for successful online learning. Previous research on students' self-regulated learning in online environments found a link between students who used self-regulated learning strategies and their academic achievement. Students could be aware of their learning behaviors and persist in learning when they encounter difficulties, finding possible solutions and thus achieving good learning performance as long as they use self-regulated learning methods (Mou, 2021). In the COVID-19 pandemic, students had to do a lot of self-study, which requires effort, self-determination, and motivation. And if they were not able to do this, they failed. The COVID-19 pandemic had placed a particular emphasis on the need for each student to develop their ability to be a self-regulated learner.

Previous research had concentrated on self-regulating general learning. Few empirical studies had looked into the SRL behaviors of online learners (Li et al., 2021). Many studies had been conducted on university students, but few studies had been conducted on international students. Students from various social backgrounds may perform differently in the learning process. (Peng, 2012a). However, no research had been conducted to compare the characteristics of college students and international students' online self-regulated learning and online self-regulated learning skills. As a result, the primary goal of this study were to uncover the various behaviors and skills of Chinese students and International African students in an online learning environment.

15.2 Literature Review

15.2.1 Definition of SRL

Self-regulated learning (SRL), according to Pintrich (2000), was an active, constructive process in which students set learning goals and then attempted to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features of the environment (Peng, 2012a). Self-regulated learning occurred when learners think and act systematically to achieve their goals. These students were motivated, active participants who thought about the learning process (Zimmerman, 1989). SRL involved students' awareness of their own thoughts and some strategic actions like planning, monitoring, and evaluating, as well as individual motivation. Students could benefit from considering their thinking. If students could understand the learning process and their own relationship to that process, they could improve their ability to successfully plan and perform tasks.

15.2.2 Review of Online SRL

Over the last three decades, extensive research on SRL strategies had been conducted to improve students' academic achievement and learning capacity. Initial attempts were also made to classify the use of SRL strategies in general learning contexts and to investigate how learners' proficiency levels influenced their use of these strategies. Self-regulated learning (SRL) skills had long been recognized as critical to the success of traditional classroom learning. As a result, it was reasonable to expect that they were more prevalent among online students due to the lack of face-to-face interaction and the need for greater autonomy to remain motivated (Barak et al., 2016).

However, research on online learners' SRL was limited, despite the fact that the number of online learners had grown dramatically in recent years, particularly following the worldwide COVID-19 pandemic (Lin et al., 2021). The need to research and comprehend how online learners could use self-regulation strategies to succeed in online learning environments was becoming increasingly important. Previous research on students' self-regulated learning in online environments found a link between students who used self-regulated learning strategies and their academic achievement. Time management, online interaction, peer learning, metacognition, reflection, rehearsal, and self-learning management were examples of these strategies (Mou, 2021).

Broadbent and Poon (2015) conducted a review of the literature on SRL strategies as predictors of academic achievement in online higher education settings published between 2004 and December 2014. This systematic review found nine strategies linking online educational success and the use of SRL strategies such as metacognition, time management, effort regulation, peer learning, elaboration, rehearsal, organization, critical thinking, and help-seeking. The study found that four of these SRL strategies were significantly related to academic achievement (metacognition, time management, effort regulation, and critical thinking).

15.2.3 University Students' SRL

SRL was used to close academic performance gaps in students based on cognitive ability, socioeconomic status, and educational quality (Zimmerman & Schunk, 2001). SRL focused on motivational and metacognitive strategies a result. It was critical for students to take ownership of their metacognitive actions. SRL students demonstrated proactive strategies for managing academic work. When students engaged in high-quality forethought rather than reactive responses, they engaged in metacognitive actions. Students with SRL skill sets could self-select strategies for approaching course assignments or exams. They created and used study guides, as well as organized study groups. They could also take feedback on academic work and processed it before incorporating it into revisions or future assignments. This list of behaviors assisted students in directing and supervising their own learning practices.

Because SRL skills improved student performance and progress, improved motivation and focus emerge, enriching the overall learning experience. For campus-based college students, the role of self-regulated learning (SRL) in academic success has been extensively researched. Sun, et al. (2018) investigated the link between academic achievement and three key self-regulatory constructs: prior domain knowledge, self-efficacy, and learning strategy use. The study included 151 undergraduate students from 16 flipped Calculus I and II sections at a large Midwestern university. The study's findings revealed that students' self-efficacy in learning math, as well as their use of help-seeking strategies, were all significantly and positively related to academic achievement in both pre-and in-class learning environments.

Previous research on online self-regulated learning primarily focused on SRLS self-regulated learning strategies and indicators of self-regulated learning. More research was now being conducted on approaches to improving self-regulated learning. Mou (2021) claimed that a weekly learning diary was beneficial to students' goal setting, time management, self-monitoring, and self-evaluation, or some factors that are related to student performance. Wolters and Hussain (2014) investigated grit and its relationships with college students' self-regulated learning and academic achievement metacognition learning and concluded that students' engagement in SRL may serve as a mediating pathway through which this aspect of grit is associated with improved academic outcomes.

University students' continuous intention to learn online has also been studied from the perspectives of learning motivation and capability, perceptions or attitudes, and online learning experiences. Zhu et al. (2020) investigated 94 university students' attitudes and experiences with online learning in a blended course. The researchers looked at how participants' attitudes toward online learning changed over time, as well as the relationships between their self-regulated learning capability, online interactions, attitudes, and online learning intention. Xu (2021) investigated Chinese university students' attitudes toward written corrective feedback (WCF) and their use of self-regulated learning (SRL) strategies in online English writing courses during COVID-19.

During COVID-19, students generally had positive attitudes toward online WCF, and teachers provided more tutorials and feedback that could be reviewed indefinitely, creating a comfortable learning environment for students. (Xu, 2021) The online interactions between teachers and students in response to the teachers' feedback motivated students to engage more in their subsequent writing practices. (Zhou et al., 2021) stated that the COVID-19 pandemic has shifted university teaching and learning activities that were previously held in physical classrooms to online platforms. There was an urgent need to investigate university students' experiences and perceptions of online learning during the pandemic in order to optimize online learning strategies in tertiary education during and after the pandemic.

15.2.4 International Students' SRL

The number of online learners had grown dramatically in recent years, especially since the worldwide COVID-19 pandemic. As a result of the worldwide COVID-19 pandemic, international students enrolled in Chinese universities were required to take Chinese language classes in their home countries via the internet (Ministry of Education, 2020). Online classes were very different from traditional classroom settings in that they require learners to be more autonomous and self-regulated (Stevens & Switzer, 2006). Furthermore, research showed that international students face significant pressure and difficulties with online learning. Li et al. (2021) conducted a survey of international students at a Chinese university and discovered that only 36.5 percent were pleased with their online education. Teachers' professional titles, students' years of study, their continent of origin, and current residence all had a significant impact on online education satisfaction. Michael et al. (2021) conducted research to investigate the impact of COVID-19 on international students enrolled in a higher education institution in Sarawak, Malaysia. They discovered that, while the majority of international students perceived their studies to be impacted, the majority planned to continue with the programs in which they were currently enrolled. The students expressed deep concerns about the impact of the pandemic on their exams and classes and preferred reassurance in terms of updates on information related to academic matters.

According to the above two types of research, the ongoing spread of the virus, strict isolation measures, and delays in the opening of schools, colleges, and universities across the country had influenced the mental health of international students who were facing significant challenges and obstacles as a result of the COVID-19 epidemic.

Nonetheless, previous research on student academic performance had placed a high value on motivational and cognitive components in learning. In addition, many recent types of research had examined the contextual differences in these components. Pintrich (2000) created a broad conceptual framework with various motivational, cognitive, emotional, and conceptual components (Peng, 2012a). The self-regulated learning model assumed that students are active participants in the learning process. Individuals established learning standards or goals, tracked their progress toward these goals, and then adapted and regulated their cognition, motivation, and behavior to achieve their goals. The model's emphasis on the context of learning was one of its most notable features. Considerable evidence suggested that students with different contextual differences, different growing experiences, different social backgrounds, and being educated in different social backgrounds might perform differently in their learning process. These distinctions could be found in self-regulated behavior when completing a specific task. Peng (2012b) concluded that students from different social backgrounds, or more specifically, students from different growing and educational environments, performed differently in motivational and self-regulated behaviors after conducting research on students from big cities, middle and small towns, and the countryside.

Furthermore, there was mounting evidence that individuals differ in SRL (Barnard-Brak et al., 2010; Dörrenbächer & Perels, 2016). Learners in SRL might combine their motivation and learning strategies in an unusual way (Vansteenkiste et al., 2009). The majority of studies on SRL had used a variable-centered approach rather than a person-centered approach. To identify different groups of online learners with different SRL profiles, a person-centered approach should be taken. Klimova et al., 2022) conducted a study to determine whether Central European students, specifically Slovak and Czech students, were able to perform self-regulated learning during their online classes during the COVID-19 pandemic to achieve their learning goals and improve academic performance and whether there were any differences between these students in terms of year of study, gender, or nationality. The results showed no significant differences between Czech and Slovak students. Nonetheless, Slovak students (particularly females) appeared to be more self-disciplined and goal-oriented in their learning.

Liu, et al. (2010) published the findings of a case study that examined international students' perceptions of the impact of cultural differences on their learning experiences in an online MBA program. The study also revealed that online instructors must design courses in such a way that potential cultural barriers, such as language, communication tool use, plagiarism, time zone difference, and a lack of multicultural content, are removed, as these may affect international students' learning performances. According to the study, a culturally inclusive learning environment should consider diversity in course design to ensure full participation by international students.

Chinese and international students came from different learning contexts, different growing experiences, and different social backgrounds, and were educated in different social contexts. And there were numerous differences between them. How do they differ in their online learning processes, and what caused the differences? The current study was carried out in order to provide answers to these questions.

15.3 Research Design

15.3.1 Research Instruments

Barnard, et al. (2009) demonstrated that the Online Self-regulated Learning Questionnaire OSLQ is a reliable and valid instrument for measuring self-regulation in the online learning environment. The OSLQ was a 24-item scale with a 5-point Likert-type response format, with values ranging from strongly agree (5) to strongly disagree (1). It was developed from an 86-item pool and then examined for its internal consistency and exploratory factor analysis results for the data collected. Students with higher scores on this scale demonstrated better self-regulation in online learning. The OSLQ consisted of six subscale constructs, including environmental structuring; goal setting; time management; help-seeking; task strategies; and self-evaluation. This study redesigned the OSLQ scale into a five-point Likert scale questionnaire by adding some demographic information questions based on the research objectives. Two electronic version questionnaires were created based on the OSLQ scale. The questionnaire for international African students was written in English, while the questionnaire for Chinese undergraduates was translated into Chinese.

15.3.2 Research Questions

The main research question of this study was: what were the differences in students' SRL levels between Chinese undergraduates and international African undergraduates? The sub-questions were listed as follows:

RSQ1: What are the characteristics of Chinese undergraduates' Online SRL?

RSQ2: What are the characteristics of International African students' online SRL?

RSQ3: Are there any differences between Chinese undergraduates' and international African undergraduates' online self-regulated learning skills?

RSQ4: What may contribute to the differences?

15.3.3 Participants and Context

The research team contacted Wenzhou University Chinese teachers and EMI teachers who teach international African students and asked them to invite their students to complete the online questionnaires. Students were informed that their participation was entirely voluntary and that their data would be kept strictly confidential and used for research purposes only. Through the link provided by the researchers, both Chinese undergraduates and international African students completed e-questionnaires. The e-questionnaires were completed by 441 students. However, due to Covid-19, most of the international African students in the universities in Wenzhou were locked in their hometowns, thus, only 89 participants joined the study. The rest 352 participants were all Chinese undergraduates. There were 57 males and 32 females among the valid international African student questionnaires, 65 were undergraduates and 24 were postgraduates. The majority of international African students were from Ghana and Zimbabwe. Around 80% of the students have spent more than a year studying in China. The majority of the international African students who took part in this study were from Wenzhou University. They were also from various majors. Meanwhile, of the 352 valid Chinese undergraduate questionnaires, 90 were male and 262 were female. And the majority of them were freshmen, sophomores, and juniors, with 221 majoring in liberal arts and 106 majoring in science.

15.4 Results and Data Analysis

As previously stated, 441 valid responses were received. Among them were 89 international African students and 352 Chinese undergraduates. Data were imported from the web into MS Excel and then into SPSS (version 12.0). Environmental structuring, goal setting, time management, help-seeking, task strategies, and self-evaluation were all analyzed.

15.4.1 Descriptive Statistics of the Variables

The descriptive statistics of the SRL variables of Chinese students and international African students are listed in Table 15.1. Since each dimension of the questionnaire contained 3–5 questions, the highest score for each question is 5, the total score of a dimension may range from 15–25. Thus, the mean score may over 10. Overall, international African students had a higher level of self-regulated learning skills with a total mean score of (M = 86.7386). International African students seemed to have stronger "goal setting", "environment structuring", "time management", "help-seeking" and "self-evaluation" skills but weaker "task strategies" skills than Chinese students. Furthermore, the data shown in Table 15.1 showed that among the six dimensions, both Chinese and foreign students performed best in goal settings: Chinese students (M = 17.4432, SD = 3.62893), vs. international African students (M = 18.5277, SD = 4.67071), while both Chinese and foreign students scored lowest in time management: Chinese students (M = 10.1932, SD = 2.56796), vs. international African students (M = 10.7045, SD = 3.20258). And it was also worth noticing that Chinese students score slightly higher than international African students in task strategies and help-seeking, while in the other four sub-scales, goal setting, environmental structuring, time management, and self-evaluation, Chinese students scored lower than international African students, especially in goal setting. Chinese students (M = 17.4432, SD = 3.62893) vs. international African students (M = 18.5277, SD = 4.67071).

Table 15.1 Descriptive Analysis of t-Test Table

Variables	Source of students	M	SD	Min	Max
Goal setting	Chinese students	17.4432	3.62893	5.00	25.00
	International African students	18.5227	4.67071	5.00	25.00
Environment structuring	Chinese students	15.2614	3.18940	4.00	20.00
	International African students	15.6705	3.98769	4.00	20.00
Task strategies	Chinese students	13.3068	3.34718	4.00	20.00
	International African students	13.2500	4.13355	4.00	20.00
Time management	Chinese students	10.1932	2.56796	3.00	15.00
	International African students	10.7045	3.20258	3.00	15.00
Help-seeking	Chinese students	14.4205	3.33467	4.00	20.00
	International African students	14.1250	3.92988	4.00	20.00
Self-evaluation	Chinese students	13.9773	3.41726	4.00	20.00
	International African students	14.4659	3.77210	4.00	20.00
Total	Chinese students	84.6024	19.4854		
	International African students	86.7386	23.69651		

15.4.2 Independent Sample t-Test

The independent-sample t-test analysis revealed no significant difference in SRL scores between Chinese and international African students. International African students ($M = 86.7386$, $SD = 23.69651$), on the other hand, reported significantly lower SRL skills than Chinese students ($M = 84.6024$, $SD = 19.4854$, $t\,[88] = 3.896$, $p > 0.05$). This finding highlighted the lack of a significant difference in "goal-setting," "environment structuring," "time management," "help-seeking," "self-evaluation," and "task strategies" skills between Chinese and international African students (see Table 15.2).

15.5 Discussion

In general, the self-regulated learning ability of students taking the questionnaire differed significantly depending on their growth environment, cultural background, education level, and other factors (Peng, 2012a; Klimova et al., 2022).

As can be seen from the tables above, the independent sample t-test analysis did not reveal a significant difference in SRL scores between Chinese and international African students. That is, few differences were found in the categories of environment structuring, goal setting, time management, help-seeking, task strategies; and self-evaluation. However, the total score of international African students ($M = 86.7386$, $SD = 23.69651$) was higher than Chinese students ($M = 84.6024$, $SD = 19.4854$, $t\,[88]$

Table 15.2 Descriptive Analysis of Independent Sample t Test Table

Variables		F	Sig	t	df	Sig. (2-Tailed)
Goal setting	Equal variances assumed	3.997	0.047*	1.712	174	0.089
	Equal variances not assumed			1.712	163,983	0.089
Environment structuring	Equal variances assumed	2.252	0.135	0.752	174	0.453
	Equal variances not assumed			0.752	165.986	0.453
Task strategies	Equal variances assumed	4.484	0.036*	−0.100	174	0.920
	Equal variances not assumed			−0.100	166.788	0.920
Time management	Equal variances assumed	7.196	0.008**	1.169	174	0.244
	Equal variances not assumed			1.169	166.153	0.244
Help-seeking	Equal variances assumed	1.341	0.248	−0.538	174	0.591
	Equal variances not assumed			−0.538	169.509	0.591
Self-evaluation	Equal variances assumed	2.808	0.096	0.901	174	0.369
	Equal variances not assumed			0.901	172.329	0.369

$= 3.896$, $p > 0.05$). This result emphasized that international African students perform better than Chinese students in online self-regulated learning. It was assumed that Chinese students could perform better than international African students due to the fact that Chinese students were more accustomed to Chinese education, had a higher sense of safety in China, and received more social support. Online learning lessons brought huge challenges and barriers to international African students since they may have experienced more academic and cultural differences (Cao, et al., 2021). However, the similarity in scores between the two groups of participants rejected the assumption. The reasons behind this could be: first, although the majority of international African students were Ghana and Zimbabwe where the levels of education and information technology were relatively lower than in China, around 80% of them have spent more than one year studying in China. In the same teaching and learning environment, the two groups' learning styles, academic control beliefs, and student self-evaluation which were key constructs of SRL skill (Cassidy, 2011) may gradually converge, thus, resulting in a similar level of self-regulated learning skill development; second, the concept of self-regulated learning was closely relevant to one's learning and academic achievement, especially in higher education, thus, the same higher education environment structuring may bring a similar impact on the two groups' self-regulated learning skill development.

Furthermore, the data shown in table 15.1 showed that among the six dimensions, both Chinese and International African students performed best in goal setting with Chinese students (M = 17.4432, SD = 3.62893) and international African students (M = 18.5277, SD = 4.67071), while both Chinese and International African students scored lowest in time management with Chinese students (M = 10.1932, SD = 2.56796) and international African students (M = 10.7045, SD = 3.20258). Previous research proved that goal setting and time management are essential factors that will impact students' performance in online learning. Both Chinese undergraduate and international African students had definite goals for their online learning and held on to their study plans during the pandemic (Michael., et al. 2021). But the severity of the COVID-19 epidemic and fluctuating pandemic situation brought barriers to students' time management. Time management might be one of their weak points. The COVID-19 epidemic was difficult to control and predict, resulting in a variety of anti-epidemic measures implemented by the government and universities. As a result, having more extrinsic factors than intrinsic factors made it difficult for students to stick to their study plans and manage their time. Time management, on the other hand, was a significant self-regulatory process in which students actively manage when and for how long they engaged in activities deemed necessary for achieving their academic goals (Wolters & Brady, 2020). More assistance with time management should be provided to students.

As we can see in Table 15.1, Chinese students scored slightly higher than international African students in task strategies and help-seeking, while in the other four sub-scales, goal setting, environmental structuring, time management, and self-evaluation, Chinese students scored lower than international African students, especially in goal setting. Chinese students (M = 17.4432, SD = 3.62893) and international African students (M = 18.5277, SD = 4.67071). Chinese education was more teacher-centered and Chinese students usually relied on teachers for instruction on when to learn in secondary school or high school. Furthermore, when attending university, Chinese students no longer had daily interactions with instructors, parents, or other adults who might have previously provided structure regarding when, how long, and under what conditions they engaged in academic work. As a result, perhaps this explains why Chinese students were lacking in time management skills. Currently, in China, particularly in Wenzhou, the epidemic situation was under control, and students were permitted to maintain close contact with their teachers or classmates, to whom they could turn for assistance when experiencing difficulties with online learning.

Overall, our survey found no significant differences in characteristics between Chinese undergraduates and international African students' online learning, which was consistent with the findings of Klimova et al. (2022), who discovered no significant differences between Czech and Slovak students. However, it contradicted Peng's (2012b) finding that students from different social backgrounds, or more specifically, students from different growing and educational environments, performed differently in motivational and self-regulated behaviors. The following two reasons were discovered as a result of the analysis: First, the sample size of the questionnaire from international African students was too small, only 88; second, the majority of the international African students who completed the questionnaire were from African countries, and the source of nationality was relatively single; the results of this questionnaire were therefore unrepresentative.

15.6 Conclusion

The purpose of this study was to determine whether Chinese undergraduate and international African students had the skills necessary to conduct online self-study under new and challenging conditions, as well as whether there were differences between them. The findings showed that both Chinese and international African students could engage in self-directed learning online. However, among the six subscales, both international African and Chinese students performed better in goal setting, which might be less easily disrupted by external interference, while their time management was relatively weak. Overall, international African students outperformed Chinese students in terms of online learning ability, but the difference was not statistically significant. The minor differences in SRL skills between the two groups were mainly caused by the similar teaching and learning environment under Chinese context, involving teaching approach, curriculum design, task strategies, etc. Future studies were recommended to increase the sample size and make the sample sources more independent.In the future online learning design, the strengths and weakness of learners' SRL skills could be taken into consideration to improve online learning effectiveness.

15.7 Limitations

There were several limitations to this study that should be mentioned. First, the study's sample size was unbalanced. There were 352 Chinese students and 89 international African students, with 65 undergraduates and 24 postgraduates among them. Due to limitations, there was a sample size mismatch between the two, and the number of Chinese students was significantly greater than the number of foreign students. However, the sample size of international African students was small because collecting data from international African students was extremely difficult because of the Covid-19 pandemic. Second, the majority of international African participants were from two countries in Africa, where economic development and education levels were low, limiting the generalizability of the findings. Third, because previous research had found that different social support and different teachers' feedback would also affect the time limit of data collection as well as the performance of online learning and learning strategies adopted, there were many variables that might affect the validity of the result. Previous research has found that teachers' feedback, curriculum design, and the school environment all have an impact on students' online learning performance. As a result, if we want to compare the online learning experiences of Chinese students and international students, we should do so in the same course and classroom. Fourth, there was no comparison of male and female performance, despite previous research indicating that female students, in particular, appeared to be more self-disciplined and goal-oriented in their learning than male students (Klimova et al., 2022).

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Part IV
Higher Education Ecosystem

Chapter 16
Evaluating Applied Engineering Education: A Phenomenological Approach

Robin Clark and Jane Andrews

Abstract **Research Aim and Object**: Building on 15 years of engineering education into all aspects of the student journey, pedagogy and practice as well as educational management research, this chapter primarily discusses the methodological steps involved undertaking a critical evaluation of applied degree education. **Methodology**: Drawing upon the findings of a qualitative evaluation conducted with forty-eight colleagues from one of the UK's largest Engineering Education Faculties, a unique phenomenological approach to collecting data is introduced in which an 'interactive SWOT analysis' was used to guide the interview discussion and so enable to the focus to shift to 'the shape of things to come.' **Key Results**: The brief overview of findings focuses on one emergent theme, *colleagues' reflections of the positive aspects of learning and teaching within an organisation whereby applied learning is universally adopted.* In doing so, the chapter provides a distinctive insight into the breadth and depth of the uniqueness of one of the UK's largest faculties of applied engineering education.

Keywords Student journey · Engineering pedagogy · Educational management · Phenomenological research · Applied learning

16.1 Introduction and Background: The Need for Applied Engineering Education in the UK

In the middle of the last decade, a report published by the UK Government saw the then Secretary of State for Business, Innovation and Skills argue, "*A strong British engineering sector is vital to the long-term sustainability of our economic recovery*

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and increasing the supply of engineers is at the heart of this" (Cable, 2015 p. 1). Some seven years later, there have been a number of substantive political changes in the UK, the most notable of which is 'Brexit.' The result of a population-wide referendum in which the UK public voted to leave the European Union, Brexit sparked major political change and saw the UK leave the EU on 1st January 2020, to become an 'independent country'.

Sitting on the edge of a massive socio-political union where free-trade and free movement of people is actively supported, the long-term impact of Brexit have yet to unfold in both the UK and EU. Further complicated by the Global Pandemic, it is not unreasonable to suggest that the future is uncertain. Indeed, a report by the IET suggested that in 2020–2021, 45% of businesses experienced difficulties trading, whilst 40% struggled to deal with the increased bureaucracy Brexit brought about (IET, 2022).

More unsettling, are reports of an ongoing skills gap in engineering, with 67% of the sector experiencing difficulties in recruiting skilled engineers (IET, 2022). An under-reported area of public policy, arguments made over the last decade suggest that the UK's future socio-economic security will be very much under threat should steps not be taken to address the skills gap in engineering (Perkins, 2013, 2017; Armstrong, 2022). Yet, whilst potential future shortages of engineering talent is important both in the UK and EU, it is imperative to note that the need for innovation in how we recruit, and train, future engineers is a global issue. Indeed, for the world to be better placed to address the many current and future transnational challenges, including sustainability, pollution, water shortages and global security (NAE, 2017), those responsible for educating tomorrows' engineers need to look beyond the current tumultuous socio-economic and political epoch in which we all live. Contextualising the need for applied engineering education within the concept of Industry 5.0, this chapter looks to the future by critiquing individual colleagues' lived experiences of educating the next generation of engineers. In doing so it makes a distinctive contribution to current debates particularly in the area of applied engineering education.

16.1.1 Industry 5.0 and Applied Engineering Education

Evolving out of debates and theories pertaining to Industry 4.0, the idea of Industry 5.0 is a term coined in Germany in 2011 (Grabowska et al., 2022). Perhaps best conceptualised as a growing awareness that the link between business, science and political strategic management needs to take account of emerging ecological, economical and energy related global challenges (Grabowska et al., 2022). Industry 5.0 represents an increasingly holistic contemporary paradigm in which the continual impact of the digital revolution (Broo et al., 2022) is resulting in unprecedented change in how society is organised (European Commission, 2021). Taking this perspective one stage further and in considering the humancentric nature of Industry 5.0, Carayannis and Morawska-Jancelewicz (2022) argue that "…*the concept of*

Society 5.0 and Industry 5.0 is not a simple chronological continuation or alternative to Industry 4.0 paradigm. Society 5.0 aims to place human beings at the midpoint of innovation, exploiting the impact of technology and Industry 4.0 results with the technological integration to improve quality of life, social responsibility and sustainability (2022, p. 1). Continuing this discussion, Carayannis & Morawska-Jancelewciz (2022) go on to suggest that higher education institutions need to adopt an active role in redefining their own future vision, making the most out of newly emergent hybrid learning and teaching tools by teaching meta-cognition skills and competencies. The evaluation discussed in this chapter picks up the gauntlet to proactively challenge colleagues to reflect upon the applied nature of the engineering student experience.

16.1.2 The Case-Study Organisation

One of the largest applied engineering and science departments in the UK, WMG, University of Warwick was founded almost 40 years ago. Located in the industrial Midlands of the UK and stretching across the borders of two counties (Warwickshire and West Midlands), WMG has a longstanding international reputation for innovative research. Alongside this, over the last decade or so, a shift in focus to encapsulate teaching has seen an exponential rise in student numbers. Fifteen fulltime post graduate programmes provide a range of technical, scientific, business and managerial study opportunities whilst five fulltime 'traditional' engineering undergraduate programmes are offered in partnership with the School of Engineering. Additionally, over recent years there has been a rise in work-based learning opportunities, with industrial partners from across engineering and other sectors collaborating with WMG to provide a range of different programmes from short-courses through to Degree Apprenticeships (WMG, 2022).

Currently following a modular approach to education in which students are taught in week-long blocks, changes in higher education funding (Belfield et al., 2017) saw WMG expand from providing industrial training programmes for less than two-hundred students 10 years ago, to now providing high quality education to around 1400 fulltime postgraduate students, eight hundred part-time postgraduate students and three hundred undergraduate and apprenticeship students. Supported by over eight hundred academic, professional support, engineering, research and ancillary staff.

16.1.3 Moving Forward in the 21st Century

The unprecedented expansion within WMG over the past decade has not been without challenge, the most recent of which is reflected in the changes brought about as a result of the global Covid Pandemic. However, over the past three years a purposefully designed organisational change strategy based upon the model introduced by Jick

(1993) has been constructed with the intention of promoting an ethos of applied education across all areas of the curriculum. Seeking to construct a solid foundation upon which to build change and termed the 'Looking backwards—Moving forwards' Evaluation around a third of the teaching faculty contributed to the evaluation which, given the unusual demographic profile of the department proved to be a ground-breaking experience for some.

Traditionally, engineering academics have been perceived to be 'old and middle-aged white men' from privileged backgrounds with little or no idea of how the 'real-world' works (Carter-Black, 2008). This stereotypical view does not apply to colleagues within WMG, an industry-focused faculty whereby the majority of teachers are recruited from Industry. Most colleagues have an atypical career path when compared to traditional academics, with many starting their working life as 16-year-old apprentices who and did not attend university until much later in life. Bringing engineering and management experience to learning and teaching, most of the faculty do not have a PhD..; but instead, possess something far more important—real-world experience, hands-on knowledge and strong industrial ties. Whilst one advantage of this is that students are provided with an industrially grounded curriculum, on the negative side, an academic community staffed mainly by colleagues who have worked in industry for much of their careers means that colleagues can be reluctant to embrace change within the academy. Furthermore, following the Pandemic, as pay in academia struggles to keep up with industry, and resources become ever more depleted, many colleagues are beginning to question why they should stay in education. It is in this contested space that this chapter is set. Purposefully highlighting colleagues' reflections of learning and teaching, an overview of the findings is given before the discussion briefly examines how, in moving forward, a more applied curriculum is being introduced.

16.2 The 'Looking Backwards-Moving Forwards' Evaluation

With the over-riding aim of enhancing the student experience, the need to put in place positive and proactive well-thought-out strategies that would effect a cultural change was at the forefront of the evaluation (Jick, 1993; Kotter, 1996, 2008). Aimed at providing colleagues' with the opportunity to positively contribute to strategic development and encapsulating the initial stage of Jick's 10 key steps to successful organisational change (1993), it was acknowledged that the success of the evaluation depended on the academic rigour and validity of the approach right from the start. Thus, in purposefully utilising professional research protocols and practice, a level of academic authenticity was built into the evaluation, engendering a 'safe' research space whereby colleagues were supported and encouraged to provide confidential, insightful and honest feedback-feedforward.

16.2.1 Methodology

Following an action research approach and using phenomenological analysis techniques, forty-eight colleagues employed in a range of different teaching roles took part in semi-structured interviews. Representing around a third of the overall sampling field, purposive sampling techniques were used to make sure that colleagues' from across the wide-range of applied engineering education programmes were included. Purposefully aimed at establishing a solid foundation for change, the interviews captured colleagues' lived experiences of a range of different issues whilst providing the time and space for each individual to reflect on the organisational strategy and policy. In capturing a broad spectrum of views, the interviews provided the means by which colleagues could begin to take ownership of the change processes, sparking off conversations whilst raising questions for consideration at an executive level.

The interviews were conducting adopting phenomenologically grounded techniques. Rooted in early 20th Century European philosophy, phenomenology stimulates a detailed and deeply expressed 'thick' description of participants' perceptions of their lived experiences. It sets out to purposefully encourage participants to express themselves in considerable depth, seeking out individual perceptual embodiment to communicate understanding (Sokolowski, 2000; Stewart & Mickunas, 1974). Asking each colleague to firstly visualise frame their thoughts by drawing a SWOT analysis, this approach encouraged each interviewee to discuss their lived experiences of working at WMG, whilst reflecting upon how change could be positively introduced. This approach, whilst simplistic, proved effective as each strand of the SWOT tool promoted a rich description, enabling colleagues to actively describe their experiences in a manner that appealed to their industry-focused ontology and epistemology.

16.2.2 Sampling Approach: Participant Selection

A sampling framework was developed in which the various roles, positions and duties of colleagues across the department were mapped out. Following this, purposive sampling techniques were adopted so to ensure the sample reflected the wider population (Bryman, 2016). The approach was particularly suitable as it allowed for demographic variables to be set aside whilst assuring confidentiality for those colleagues who accepted the invitation to participate.

16.2.3 Conducting the Evaluation: Two Distinctive Stages

The evaluation was conducted in two distinctive stages. In the first instance, eighteen senior colleagues each responsible for an academic module or programme were interviewed. With the primary research question of *"How do colleagues perceive that the student experience may be enhanced within WMG?;"* three interview questions were articulated so as to encourage individual colleagues to openly discuss their lived experiences as a teaching academic in WMG. These questions were:

1. **What** part of your own and others' teaching practice do you feel to be of high quality?
2. **Which** aspects of teaching and learning could be improved so as to promote an ethos of applied pedagogy across the department?
3. **What** practical and pedagogical innovations could be put into place to help you embed a more applied approach to your own teaching?

The interviews were recorded contemporaneously and transcribed into a Word document. In the second stage of the evaluation an additional thirty colleagues were sampled utilising a purposefully developed technique which incorporated whilst grounded in phenomenology incorporated phenomenographic visualisation (Robertson & Bond, 2001; Trigwell et al., 2005). This involved asking each colleague to draft out a 'SWOT; analysis visualising their perceptions of the Strengths, Weaknesses, Opportunities and Threats relevant to their teaching whilst considering the question of how the curriculum could become more 'applied' in nature. Building on a successful approach to interviewing developed by two of the research team (Clark & Andrews, 2010), the main benefit of this method is that it allows colleagues to use diagrams and models to demonstrate and contextualise their own thoughts and experiences in a manner that is non-threatening and open.

16.2.4 Analysis Techniques

For the analysis, a theoretical sampling approach was used to 'chunk' and 'classify' the data. This meant that no identifying characteristics were discussed, and all demographic variables were removed. This approach allowed for a guarantee of total confidentiality, whereby no data was able to be traced back to individual colleagues or the teaching group to which they belong. By removing barriers to participation in this way the evaluation was able to thoroughly explore the issues, resulting in a depth of understanding that exposed culturally embedded practice, assumptions and traditions (positive and negative) whilst providing colleagues with the opportunity to visualise future options for change.

Applying phenomenological analysis techniques to raw data necessitated the application of hermeneutic circles, whereupon data was decontextualized and recontextualised in iterative and inductive process (Ayres et al., 2003). This meant that following transcription, the first stage of the analysis involved a process by which chunks of data were separated from the main records and decontextualized into units of meaning. This involved bringing data from the first and second stages of the research process together.

Working together, the two researchers then identified codes and patterns within the individual units before recontextualising and then reintegrating the data in a thematically ordered manner. This lengthy process involved a systematic micro-analysis of each transcript and then each code. It allowed for the participants lived experiences to be captured phenomenologically and methodically classified. This process was repeated three times with the researchers initially working alone, then together, to critique their classifications, agree upon and critique the emergent themes and meanings (Cresswell, 1997).

16.3 Summary Of Findings: Application And Applicability

This chapter necessarily focuses on one emergent theme, *colleagues' reflections of the positive aspects of learning and teaching within an organisation whereby applied learning is adopted universally.* Using the iterative and reiterative processes described above the researchers discovered that the vast majority of colleagues viewed Applied Learning as central to their own and others' approach to teaching. The following paragraphs use individual colleagues' verbatim words to illustrate this.

16.3.1 Staff Perceptions of Colleagues' Competencies

Distinctive in the fact that the majority of teachers are employed directly from industry, colleagues in WMG bring with them a plethora of tried-and-testing knowledge and experience. Unusually for an academic department or group, the heterogenous nature of the faculty meant that colleagues are not in competition with each other but instead work as a single and cohesive body of educators. In the interviews, colleagues' respect for each other was evident:

> Some of the teaching is brilliant. [] Some inspirational teaching where they do simulations. The Management of Change [module] is very good. What they deliver sticks in students' minds. If we could get others to at least be as enthusiastic in their teaching, they don't have to use simulations just find their own way of engaging students

> The depth of experience in the teaching staff is remarkable, nearly all on a second career, few are on a third career. We have some really knowledgeable staff who bring a good deal of industrial experience into what they teach. This gives WMG kudos.

Many of those interviewed were confident teachers, in discussing their own strengths and approach to applied learning colleagues expressed high levels of self-awareness; explaining how they applied their industrially grounded skills, competencies and experiences to the classroom:

> The one thing I'm good at resource investigation. I have a workload. I like to network. I communicate well with industry and end up with a more experiential set of modules and programmes.

> My strengths are coming from industry – automotive industry. I'm credible in front of an audience. I teach students who work in the car industry and am running a short course at Crewe People who work in organisations bring with them real-life experience. I bring in my own experiences and using case-study learning constantly work on the blend between theory and application.

The value of 'real-life' experience was present throughout the evaluation, with the processes involved in applying theory to real-life practical learning a core organisational strength.

16.3.2 Pedagogic Practice

As the basis of the primary interview questions, applied learning and teaching practice was widely discussed throughout the interviews. Amongst other key pedagogical concepts, team teaching, active learning, the use of electives and small group learning contribute towards a departmental-wide focus on the student experience:

> Some modules are interactive; students need to be encouraged to move and change.... ...People learn by doing not listening. The way that e-business is set up – they are a perfect team. They all teach together.

> There's team teaching, it works really well. Each teacher has different areas of responsibility. Sometimes the modules run simultaneously, but individuals don't mind because they control their elective choice.

> On the teaching side we have several USPs, we do stuff in small classes, which allows good team working and syndicates. The students don't like teaching in big classes

Whilst 'small group' teaching was almost universally recognised as being one of the positive practices within the department, engendering an environment in which students could actively learn together, for some the positive side of this was that it enabled lecturers to build good learning relationships with students:

> It's pedagogically better to teach in small groups. The fact that we rarely have more than thirty students to teach is great for building learning relationships and engaging the students.

Whilst others utilised personal tutoring and project supervision to provide individual attention within an applied learning setting:

> The relationship between supervisor and student is a strength We use people who know what they're talking about [to guide and] support out students.

16.3.3 Evidence-Based Applied Learning

Across the department the concept of ‘evidence-based learning and teaching’ was divided into two distinctive and very different groupings the first of which related to pedagogic research and the use of reflection and reflexivity, whilst the second concept reflected colleagues’ perceptions of the value of industrial experience in promoting applied learning.

With some colleagues having made the move from industry to academia in the last century, the need for evidence-based learning and teaching was not always fully appreciated. Particularly when colleagues had been teaching for a number of years. However, newer colleagues who had made the shift into academia recently described how they applied critical pedagogy to their practice:

> I have done pedagogic research [] a lot of my teaching reflects on my previous pedagogical research

> My area of teaching is evidence driven. I look at two bodies of evidence. Student feedback and module reviews, chucking into Nvivo – the other is looking at journeys through the use of Moodle – trying to understand where students go, their journey

Whilst the use of such pedagogically driven evidence-based practice was a minority pursuit, many colleagues linked the concept of scholarship with the need to apply industrial experiences to learning and teaching. For some, the notion of involving industrial stakeholders was at the heart of their teaching approach

> Most of what I do is for part time programmes. The externals bring a lot of experience to this. My modules have a lot of more external speakers than others. These are people who currently work fulltime in industry who come and teach on their area of work. I get positive feedback from the students about this.

> I’m involved in apprenticeships. I’m managing the design… …. A workshop at the beginning with a small set of industrial and academic stakeholders meant we could deliver an applied and relevant curriculum.

Such stakeholder involvement, with industry at the centre of teaching practice and curriculum content was highly regarded amongst all colleagues. So much so that ‘links and collaborations’ with industry represented a key part of the applied nature of learning and teaching.

16.3.4 Links and Collaborations with Industry

From a learning and teaching perspective, the opportunity afforded by close relations with industry meant that lectures were both credible in nature and set within a ‘real-life’ and applied context making teaching meaningful:

> On the whole we’re quite traditional. We’re very reliable. We have credible links into industry which enable us to contextualise what we do very well. We use people from industry a lot to make our teaching meaningful

> Contacts in industry our one of our greatest strengths. We invite senior guest speakers from industry. All out tutors have a hybrid of academia and industry – this gives them credibility with the students

> I'm involved heavily with [] in the new course development. The way we interact with business and allow business to drive content is positive.

One of the most striking features of colleagues' reflections of working with industry was the strength of the academic-industrial relationships:

> It's a true collaboration. Completely embedded. Both [companies].

> We meet senior management every two weeks.

> The course development is ongoing. They get involved with every module, we look at the business need, and this is shaken down to course level, then expertise, and then to how we deliver.

For one colleague, the need to maximise the organisation's extant links with industry represented a source of untapped potential that could potentially be used to enhance teaching to a far greater extent:

> I'm not convinced we're fully optimising value from industry. Whether the relationship between us and WMG in research go beyond the lab and into teaching is something that we could build on

This final idea sums up the uniqueness of WMG and in many respects reflects one of the key opportunities expressed across all of the themes emerging out of the evaluation. That is, the need to make scholarship in the department much more than linking research and teaching together through the application of applied and evidence-based teaching practice. Moving forward, a new learning and teaching strategy is emerging, one in which industry and academia work together as equal partners to educate the engineering talent of the future.

16.4 Discussion and Conclusion: Implications for Applied Practice in Engineering Education

Encouraging colleagues to engage in discussion about their teaching is notoriously difficult (Clark & Andrews, 2017). Such difficulties are augmented by the fact that in WMG, the majority of teaching staff are engineering and management professionals; mostly from industrial backgrounds where they are more used to expressing themselves creatively or practically than in prose or in long reflective conversations. The unique methodological approach in which colleagues were encouraged to draw a SWOT analysis encouraged freedom of expression in a non-threatening environment. By focusing on the three key interview questions, and by encouraging the non-senior staff to express themselves visually before the interview began, the interviews have proffered a depth of data.

As previously stated it is important to note that this chapter, and indeed this work, represents a small part of a much larger project which is aimed at promoting and supporting a paradigm shift across all teaching in WMG; a challenge which, at times feels analogous to 'Herding Cats!' (Brown & Wareing, 2016). The driving force behind the work is a top-level desire to promote high quality evidenced-based teaching whereupon individual teachers are empowered to be reflective and reflexive practitioners, conducting their own educational research and constantly developing and evolving an applied approach to teaching (Norton, 2009).

The focus on the single theme '*colleagues' reflections on the positive areas of learning and teaching in promoting applied learning'* provides a distinctive insight into the breadth and depth of the uniqueness of WMG itself. Whilst weaknesses and challenges will be discussed elsewhere, the decision to focus this chapter on the positive aspects of working in Engineering Education is not accidental. At a time when, in the UK, the idiosyncrasies and opaqueness of Brexit has been augmented by as yet unknown long-term impacts of the Covid19 Pandemic, it often feels as if life has been turned upside down. Furthermore, whilst the whole the idea of "managing change in academia" is undoubtedly difficult, WMG has taken the bull by the horns by launching a new organisational structure and learning and teaching strategy. With a focus placed firmly on collegial support through scholarship, empirical investigation and implementation of evidence-based practice, together with an ethos in which student-centred education is paramount, a culture change is underway.

In conclusion, this is an exciting time to work at WMG, a unique academic-industrial department at the forefront of innovation, where teachers bring industrial experience and there is a genuine enthusiasm for applied learning. By purposefully approaching teaching in a scholarly and critical manner, innovative pedagogies continue to be developed, tested and disseminated. This chapter reflects the start of our new journey. Watch this space as the future unfolds…

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Chapter 17
Education for the Future: Cultivating Thinking Through Thinking About Thinking

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Abstract Little research has been done to examine the development of thinking skills in the context of second language learning and teaching. This article reports the results of a study that assesses the effectiveness of a Philosophy in Schools (PIS) programme in developing English as a Second Language (ESL) students' thinking skills in Hong Kong. In the study, training and support were provided for two English teachers to enable them to teach PIS to their Secondary 4 ESL students during English lessons. The students were found to be capable of reasoning and arguing about philosophical problems arising from various stimuli prepared by their teachers according to the English curriculum. Also, PIS was found to play an important role in promoting the students' critical and creative thinking. The findings of this study suggest that integrating philosophy into the English curriculum can promote critical and creative thinking in ESL students.

Keywords Philosophy in schools · Philosophy for children · ESL classroom · Critical thinking · Creative thinking · Hong Kong

> Philosophy is "thinking about thinking", as opposed to the sciences which have the natural world (natural sciences) or the human world (social sciences) as their objects of study. In philosophy we think about *how* we think, not so much about *what* we think.
>
> Karin Murris, SAPERE, 2015, p. 92

17.1 Introduction

As stated by the English Language Education: Key Learning Area Curriculum Guide (Primary 1—Secondary 6) (Curriculum Development Council, 2017), schools and teachers in Hong Kong are expected to foster independent and lifelong learning in students through developing their generic skills, especially critical and creative

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thinking. However, research shows that although language teachers are often good at teaching language forms and skills, many are less confident about the cognitive engagement required to develop specific thinking skills (Fisher, 2001). This results in many teachers engaging students in monologic—typically teacher-led and question-and-answer—rather than dialogic discussion (Reznitskaya, 2012). Such a monologic approach does not facilitate the improvement of thinking skills but mainly encourages the retrieval of information and other low-level cognitive activities. As far as Chinese learners are concerned, a related study shows that their non-participation in class is attributable, largely, to too much teacher control over the direction and content of classroom interaction (Xie, 2010).

In Hong Kong, there seems to be no good grounds for optimism under the present conditions. For one thing, research has indicated that local English language teachers regularly deprive their students of the time and space for critical and creative thinking, due to their application of ineffective questioning techniques (including short wait-time and a predominance of lower-order questions) and product-oriented pedagogy (disregarding self-expression and originality in writing), respectively (Mok, 2009). For another, a recent external school review, involving 140 local primary and secondary schools, concludes that despite the frequent use of questioning in class, "it is not common for teachers to probe or seek to extend students' responses or raise a range of questions to stimulate in-depth thinking" (Education Bureau, n.d., p. 34).

17.1.1 A Philosophical Approach to Critical and Creative Thinking

Research has shown that both critical and creative thinking can be fostered through philosophical dialogue: while a body of empirical evidence links dialogic teaching—in which teachers and students collaboratively engage in the production and evaluation of new interpretations of texts—to such learning outcomes characteristic of critical thinking as enhanced reasoning in new contexts, better conceptual understanding, and improved inferential comprehension of texts (Reznitskaya, 2012); research has revealed that teaching strategies routinely used in philosophical discussion—for example encouraging students to question, explore, imagine, and collaborate—help create an environment which develops creative thinking (Edgar et al., 2008). Indeed, for centuries philosophy has been regarded as an intellectual activity that is focused on both the complex cognitive skills and predispositions connected with critical thinking (Daniel & Auriac, 2011), and the more holistic traits associated with creative thinking. Even today, philosophy is still widely viewed as "a matter of developing a critical mind, rampart par excellence against all forms of doctrinaire passion" (United Nations Educational, Scientific & Cultural Organization, 2007, p. ix). But as many years of experience in philosophy for children also demonstrates, philosophy cultivates creative and imaginative thinking that encourages students to "think outside the box".

According to Murphy et al. (2009), although talk seems to have a significant part to play in text-based learning, simply grouping students together and encouraging them to talk is not sufficient to enhance thinking and understanding. Much depends on the quality of their talk. A promising approach involves engaging students in philosophical dialogues, where philosophical questions are posed and discussed within the context of a community of inquiry (Lipman et al., 1980). This is illustrated by a critical review of 10 controlled studies that evaluates the outcomes of Philosophy in Schools (PIS) programmes, including logical reasoning, creative thinking, reading comprehension, and listening skills (Trickey & Topping, 2004). The review shows a broad range of evidence for positive outcomes of PIS with children of different age groups from different countries. From a theoretical perspective, Winstanley (2008) argues that critical thinking is promoted more effectively through PIS than through traditional school subjects during classroom discussion because philosophy is not determined by a substantial empirical knowledge base. More specifically, in contrast to knowledge-based subjects in which the discussion is usually skewed in favour of those having the most facts, thereby discouraging students who have limited subject knowledge from participating; philosophy enables students to participate with confidence without fear of making embarrassing factual errors in that it is ideas rather than facts that are under discussion in philosophical inquiry. And ideas are potential sources of truth to which all children have ready access.

Although various philosophy, or rather PIS, programmes are currently offered as extra-curricular or supplementary activities in a large number of schools around the world (Hand & Winstanley, 2008), such programmes are extremely rare in Hong Kong schools. Local research on PIS was pioneered by the author of this chapter as part of his Ph.D. study in 2003. In a study that assesses the effectiveness of Lipman et al.'s (1980) Philosophy for Children programme in promoting Secondary 1 students' critical thinking in Hong Kong, Lam (2013) found that the students who were taught philosophy with *first language instruction* showed a greater improvement in the reasoning test performance than those who were not, were capable of doing philosophy, and had a positive attitude towards doing philosophy in the classroom. Also, he found that philosophy played an important role in developing students' critical thinking, and that numerous critical factors contributed to the success of the programme.

But what if students were taught another philosophy programme with second language instruction? This chapter reports a study of a PIS programme for secondary students in Hong Kong. The purpose of the study was to determine the extent to which the PIS programme facilitates the development of critical and creative thinking in English as a Second Language (ESL) students in English classes.

17.2 Method

17.2.1 Participants

The sample for this study was comprised of 57 Secondary 4 students at a well-established secondary school in Hong Kong. The school was Catholic, girls only, and using English as the medium of instruction. The students were all Chinese, used English as a second language, and consisted totally of Band 1 students (i.e. the top one-third of students in Hong Kong in terms of academic achievement). Two teachers volunteered for the study who taught English to two separate classes of the students: 4C and 4D having 27 and 30 students, respectively.

17.2.2 Instruments

The following six instruments were used to collect data pertinent to the research questions of this study.

17.2.2.1 New Jersey Test of Reasoning Skills

The New Jersey Test of Reasoning Skills (NJTRS) was developed by Virginia Shipman to measure elementary reasoning skills in language without contamination from inert items that drew on recollection of content or non-linguistic skills (Institute for the Advancement of Philosophy for Children [IAPC], 1987). In the present study, this instrument was used to assess the reasoning ability of the two classes of students. The NJTRS comprised 50 multiple-choice items that represented 22 reasoning skill areas, including analogical reasoning, inductive reasoning, syllogistic reasoning, detecting underlying assumptions, discerning causal relationships, identifying good reasons, and recognizing dubious authority. Each correct answer scored 1 point, giving a maximum possible score of 50. The NJTRS's content validity, construct validity, and concurrent validity were respectively claimed by the publisher on the basis of its adequate sampling of elementary reasoning skills taxonomy, detailed research for test development, and satisfactory correlations with some standardized achievement tests like the New Jersey College Basic Skills Placement Test (ibid.). With regard to the NJTRS's internal consistency reliability as measured by Cronbach's coefficient alpha, it was not only reported by the publisher to be ranging from 0.84 in Grade 5 to 0.91 in Grade 7, but also found by the researcher to be 0.80 for a sample of Secondary 1 students in a local school, suggesting a consistently high reliability.

17.2.2.2 Cognitive Behaviour Checklist

The Cognitive Behaviour Checklist (CBC) was designed by the IAPC to "evaluate possible changes in teacher attitudes toward students' cognitive potentials" (Lipman, 2003, p. 223). It consisted of 17 items that described three types of cognitive behaviours students might display in dialogical settings, viz. *inquiry behaviours* (items 1–6: "Asks relevant questions" [item 1], "Avoids sweeping generalizations" [item 2], "Asks that claims be supported by evidence" [item 3], "Develops explanatory hypotheses" [item 4], "Recognizes differences of context" [item 5], and "Readily builds on the ideas of others" [item 6]), *open-minded behaviours* (items 7–9: "Accepts reasonable criticisms" [item 7], "Welcomes hearing 'the other side of the case'" [item 8], and "Respects others and their rights" [item 9]), and *reasoning behaviours* (items 10–17: "Offers appropriate analogies" [item 10], "Seeks to clarify ill-defined concepts" [item 11], "Makes relevant distinctions and connections" [item 12], "Supports opinions with convincing reasons" [item 13], "Provides examples and counter-examples" [item 14], "Seeks to uncover underlying assumptions" [item 15], "Draws suitable inferences" [item 16], and "Makes balanced evaluative judgments" [item 17]). Since the 17 behavioural traits included in the Checklist were highly characteristic of the putative critical thinking abilities and dispositions (Ennis, 1987), the CBC was utilized as an instrument in this study to examine whether, and to what degree, the cognitive behaviours displayed by the participating students during philosophical discussions were characteristic of critical thinking.

17.2.2.3 Creativity Checklist

The Creativity Checklist (CC) was designed by Proctor and Burnett (2004) for teachers to "gather observational data about the cognitive and dispositional traits displayed by their students when they are engaged in classroom activities requiring creativity" (p. 428). It consisted of nine items that described nine sets of behaviours indicative of creative students in the classroom context, viz. "A fluent thinker" (item 1), "A flexible thinker" (item 2), "An original thinker" (item 3), "An elaborative thinker" (item 4), "An intrinsically motivated student" (item 5), "A curious student who becomes immersed in the task" (item 6), "A risk taker" (item 7), "An imaginative or intuitive thinker" (item 8), and "A student who engages in complex tasks and enjoys a challenge" (item 9). Since the CC allowed the researcher to structure the observations of the personal creativity characteristics of students, it was utilized as an instrument in this study to explore whether, and to what degree, the cognitive and dispositional traits displayed by the participating students during philosophical discussions were characteristic of creative thinking.

17.2.2.4 Student Questionnaire

The Student Questionnaire (SQ) was developed by the researcher in this study to examine the attitude of the two classes of students towards doing philosophy in the classroom. It consisted of two sections, A (SQA) and B (SQB). The SQA comprised 20 Likert-scale items that asked students to indicate whether they strongly agreed (SA), agreed (A), were uncertain (U), disagreed (D), or strongly disagreed (SD) about the statement in each item. The following point values were assigned to the positive statements, i.e. all but the statements 3, 4, 8, and 10: SA = 5, A = 4, U = 3, D = 2, SD = 1. An example of a positive statement is “Talking about philosophy is fun” (statement 1). A score of 5 or 4 on this item would indicate a positive attitude towards doing philosophy in the classroom. For the negative statements 3, 4, 8, and 10, the point values were reversed—i.e. SA = 1, A = 2, U = 3, D = 4, and SD = 5—so that a high total score across all items on the SQA would be indicative of an overall positive attitude. As regards the SQB, it comprised two free-response items that gave students the opportunity to construct and explain their own responses. The content validity of the SQ as a whole was established through review of relevant literature and consultation with PIS experts. So far as the SQA was concerned, its internal consistency reliability as measured by Cronbach’s coefficient alpha was found to be 0.90 for the present sample, indicating a fairly high reliability.

17.2.2.5 Teacher Questionnaire

The Teacher Questionnaire (TQ) was developed by the researcher in this study to examine the attitude of the two participating teachers towards doing philosophy in the classroom. It consisted of two sections, A (TQA) and B (TQB). The TQA comprised 20 Likert-scale items that asked teachers to indicate whether they strongly agreed (SA), agreed (A), were uncertain (U), disagreed (D), or strongly disagreed (SD) about the statement in each item. The following point values were assigned to the positive statements, i.e. all but the statements 2, 3, 9, 10, and 14: SA = 5, A = 4, U = 3, D = 2, SD = 1. An example of a positive statement is “I enjoy teaching philosophy” (statement 1). A score of 5 or 4 on this item would indicate a positive attitude towards doing philosophy in the classroom. For the negative statements 2, 3, 9, 10, and 14, the point values were reversed—i.e. SA = 1, A = 2, U = 3, D = 4, and SD = 5—so that a high total score across all items on the TQA would be indicative of an overall positive attitude. As regards the TQB, it comprised two free-response items that gave teachers the opportunity to construct and explain their own responses. The content validity of the TQ as a whole was established through review of relevant literature and consultation with PIS experts. So far as the TQA was concerned, its internal consistency reliability as measured by Cronbach’s coefficient alpha was found to be 0.81 for a sample of local teachers, including those in this study, indicating a reasonably high reliability.

17.2.2.6 Video Recording

Twelve PIS classes (six per teacher) were videotaped at different periods to record the complex interactions among students and the teacher during philosophical discussions in the classroom. The video recordings (VR) thus obtained allowed the researcher repeated viewing for in-depth analysis of both visual and verbal data. Specifically, these VR were used in the present study to find out how the students did philosophy in English classes, and to investigate the role played by PIS in developing the students' critical and creative thinking. Moreover, after the completion of the SQ and TQ, 17 student interviews and 2 teacher interviews were conducted, the VR of which were used to explore the attitudes of the students and teachers towards doing philosophy in the classroom, respectively.

17.2.3 Design

A triangulation mixed method design, in which both the qualitative data (including text data transcribed from the SQB, TQB, VR, and those optically scanned from the post-discussion writing tasks [PDWT]) and quantitative data (including numeric scores from the NJTRS, CBC, CC, SQA, and TQA) were collected simultaneously and given equal priority, was adopted to assess both the process (qualitative) and outcome (quantitative) of the present study. The results from the analysis of both qualitative and quantitative data were directly compared, or triangulated, to ascertain whether the two databases supported or contradicted each other.

17.2.4 Procedure

A formal invitation was sent via email to all principals of local primary and secondary schools—excluding English Schools Foundation and other international schools—in Hong Kong to attend a briefing on this research project on 1 June 2016. After the briefing, a 2-day PIS training workshop was organized by the researcher for 5 interested school teachers on 20 and 26 August 2016. The training workshop was modelled on the successful P4C Foundation Course Level 1 run by the Society for the Advancement of Philosophical Enquiry and Reflection in Education (SAPERE) in the UK, including such topics as the aims and processes of the community of inquiry, the role of the facilitator, and philosophical questioning (Society for the Advancement of Philosophical Enquiry & Reflection in Education, 2015). During the project (i.e. from 19 September 2016 to 22 June 2017), 9 onsite training and support sessions were provided for the two participating teachers by the researcher, focusing on lesson observation and evaluation. The NJTRS was administered to the 57 participating students before the start of the PIS lessons on 19 September 2016.

The participating teachers taught the participating students PIS by means of the textbook materials they collected and discussion plans they created based on the requirements of the English curriculum and PIS programme, respectively. The textbook materials, including articles and videos, were easy to understand and filled with philosophical ideas and concepts that the questions in the discussion plans were designed to explore and extend. The PIS lessons, each taking 45 min, were taught to each class once a week for 17 weeks and 6 of them were videotaped every two to four weeks. A typical PIS session operated as follows: after being presented with an article or video by the teacher as a stimulus for philosophical thought, the students first took turns to share with the others what they found intriguing or perplexing about its content in the form of questions, and then decided on a question that was agreeable to the majority for in-depth inquiry in a teacher-facilitated whole-group discussion. After the discussion, in order to develop in the students a critical and creative response to the stimulus, the teacher assigned them various follow-up writing tasks. As regards the videotaped discussions, a selected segment of them was transcribed and analysed in three different ways: first, the philosophical content of the transcript was annotated and used as evidence to demonstrate how the students philosophized in English classes; second, the CBC was used to identify and quantify the students' cognitive behaviours characteristic of critical thinking in the transcript; and third, the CC was used to identify and quantify the students' cognitive and dispositional traits characteristic of creative thinking in the transcript.

In the last PIS lesson, the students were required to complete the SQ. Seventeen of them were randomly selected to take part in a follow-up one-to-one semi-structured interview that addressed the main themes of the SQ on 16 and 22 June 2017. About two weeks after the end of the PIS lessons, the students were administered the NJTRS on 26 May 2017, while the teachers were required to complete the TQ and to take part in a follow-up one-to-one semi-structured interview that addressed the main themes of the TQ on 31 May 2017. The posttest was followed by a close analysis of all data collected in this project.

17.3 Results

17.3.1 Quantitative Data

17.3.1.1 NJTRS

The pretest NJTRS scores and posttest NJTRS scores of the participating students were compared using the paired samples *t*-test. Results demonstrated that there was not a significant difference between the pretest ($M = 35.74$, $SD = 4.49$) and posttest ($M = 35.37$, $SD = 4.98$) mean scores ($n = 54$, $p > 0.05$). These findings indicate that the students performed neither significantly better nor significantly worse in the NJTRS after receiving PIS instruction. Being inconsistent with the well-documented success of PIS in developing students' reasoning ability, the current findings suggest that simply bringing a PIS programme into the classroom does not help improve their reasoning skills. To develop students' reasoning ability, the teacher needs to do more than just encourage them to talk and share; they need to be aware of, and able to overcome, the problems that exist in the process of facilitation (see section on VR below).

17.3.1.2 CBC

To find out what role PIS plays in promoting students' critical thinking, a selected segment of videotaped discussions among the students in class 4C was first transcribed and then analysed with the CBC to identify and quantify the students' cognitive behaviour characteristic of critical thinking. The transcript was made of a 7-min discussion extracted from the discussion in session 16 on the question, "Which one will have more pressure, the winner or the loser?". Overall, the students displayed all but two of the 17 behavioural traits included in the CBC. More specifically, during the discussion, they displayed most frequently the cognitive behaviours "Develops explanatory hypotheses" (i.e. item 4), "Makes relevant distinctions and connections" (i.e. item 12), "Supports opinions with convincing reasons" (i.e. item 13), and "Makes balanced evaluative judgements" (i.e. item 17), followed by "Welcomes hearing 'the other side of the case'" (i.e. item 8) and "Draws suitable inferences" (i.e. item 16); yet, none of them displayed the cognitive behaviours "Ask relevant questions" (i.e. item 1) and "Asks that claims be supported by evidence" (i.e. item 3). Considering that a total of 76 cognitive behaviours characteristic of critical thinking (approximately 11 per minute on average) were elicited from the students, it seemed that conducting philosophical inquiry in the classroom helped stimulate students to think critically. Regardless of the relative frequencies of the 17 cognitive behaviours that were likely to vary with the content of discussion, this result was entirely consistent with—even more positive than—the positive result similarly produced by the application of PIS's pedagogical principles in another local study (Lam, 2013), indicating that PIS might play a major role in promoting students' critical thinking.

17.3.1.3 CC

To find out what role PIS plays in promoting students' creative thinking, the aforementioned transcript was analysed with the CC to identify and quantify the students' cognitive and dispositional traits characteristic of creative thinking. Overall, the students displayed all the nine behavioural traits included in the CC. In particular, during the discussion, they displayed most frequently the cognitive and dispositional traits of "A fluent thinker" (i.e. item 1), "An original thinker" (i.e. item 3), "An elaborative thinker" (i.e. item 4), "A curious student who becomes immersed in the task" (i.e. item 6), "A risk taker" (i.e. item 7), "An imaginative or intuitive thinker" (i.e. item 8), and "A student who engages in complex tasks and enjoys a challenge" (i.e.

item 9). Considering that a total of 78 cognitive and dispositional traits characteristic of creative thinking (approximately 11 per minute on average) were elicited from the students, irrespective of the relative frequencies of the nine cognitive and dispositional traits that probably depended on the content of discussion, it appeared that such philosophical inquiry in the classroom helped stimulate students to think creatively and thus should be promoted in schools.

17.3.1.4 SQA

The participating students were asked to respond to 20 statements in the SQA that examined students' attitude towards doing philosophy in the classroom. For each statement on a 5-point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree"), a mean score of 3 was interpreted as representing a neutral attitude, while a mean score of more than 3 and less than 3 a positive and negative attitude respectively, towards a certain aspect of doing philosophy in the classroom. Table 17.1 shows that the students had a positive attitude towards 19 statements, among which they showed the most positive attitude towards the role of philosophy in encouraging them to think things in different ways ($M = 3.87$, $SD = 0.73$), followed by the role of philosophy classes in helping them think better ($M = 3.75$, $SD = 0.65$) and enabling them to learn to listen carefully to others before expressing their own ideas ($M = 3.75$, $SD = 0.70$). The students had a negative attitude towards the disinclination of philosophy to force them to accept certain beliefs or values ($M = 2.66$, $SD = 0.81$). Although the students were less positive or even negative about certain aspects of doing philosophy in the classroom, an overall mean score of 3.41 indicated that they had, in general, a mildly positive attitude towards doing so.

17.3.1.5 TQA

The participating teachers were asked to respond to 20 statements in the TQA that examined teachers' attitude towards doing philosophy in the classroom. For each statement on a 5-point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree"), a mean score of 3 was interpreted as representing a neutral attitude, while a mean score of more than 3 and less than 3 a positive and negative attitude respectively, towards a certain aspect of doing philosophy in the classroom. As shown in Table 17.2, the teachers had a positive attitude towards 17 statements, among which they showed the most positive attitude towards the statements 6 ($M = 5.00$, $SD = 0.00$) and 7 ($M = 5.00$, $SD = 0.00$), i.e. the role of philosophy in enabling students to handle questions that do not necessarily have one right answer and helping develop critical thinking in them, respectively. The teachers had a negative attitude towards the statement 2 ($M = 2.50$, $SD = 0.71$), indicating that they found it difficult to engage students in philosophical inquiry. The teachers had a neutral attitude towards the statements 9 ($M = 3.00$, $SD = 1.41$) and 12 ($M = 3.00$, $SD = 1.41$), feeling uncertain about whether their students were mature enough to learn philosophy and

Table 17.1 Means and standard deviations of students' responses to Likert-scaled attitudinal statements

Statement[a]	*M*	*SD*
1	3.58	0.75
2	3.75	0.65
3	3.57	0.82
4	3.45	0.82
5	3.38	0.81
6	3.62	0.77
7	3.87	0.73
8	3.25	0.87
9	3.75	0.70
10	2.66	0.81
11	3.36	0.79
12	3.15	0.79
13	3.57	0.69
14	3.28	0.86
15	3.08	0.83
16	3.28	0.77
17	3.68	0.73
18	3.40	0.77
19	3.36	0.76
20	3.11	0.87

Note. The questionnaire return rate was 93% (n = 53). The scoring (Strongly Agree = 5, Agree = 4, Uncertain = 3, Disagree = 2, Strongly Disagree = 1) was reversed for the negative statements (3, 4, 8, 10) before computing the means and standard deviations
[a]The response rate for each statement was 100%

whether they had sufficient time to teach their subject using a philosophical approach, respectively. Although the teachers were negative or neutral about certain aspects of doing philosophy in the classroom, an overall mean score of 3.93 indicated that they had, in general, a positive attitude towards doing so.

17.3.2 Qualitative Data

17.3.2.1 VR

Apart from investigating the role played by PIS in developing the students' critical and creative thinking (see sections on CBC and CC), the VR of PIS classes were used to find out how the students did philosophy in English classes. Based on close

Table 17.2 Means and standard deviations of teachers' responses to Likert-scaled attitudinal statements

Statement[a]	*M*	*SD*
1	4.00	0.00
2	2.50	0.71
3	4.00	0.00
4	4.50	0.71
5	3.50	0.71
6	5.00	0.00
7	5.00	0.00
8	4.50	0.71
9	3.00	1.41
10	4.00	0.00
11	3.50	0.71
12	3.00	1.41
13	3.50	0.71
14	4.50	0.71
15	4.50	0.71
16	4.00	0.00
17	3.50	0.71
18	4.00	0.00
19	4.50	0.71
20	3.50	0.71

Note. The questionnaire return rate was 100% (n = 2). The scoring (Strongly Agree = 5, Agree = 4, Uncertain = 3, Disagree = 2, Strongly Disagree = 1) was reversed for the negative statements (2, 3, 9, 10, 14) before computing the means and standard deviations
[a]The response rate for each statement was 100%

observation of all the recorded discussions, the students were found to be able to reason and argue about philosophical problems arising from various stimuli prepared by their teachers according to the S4 English curriculum in Hong Kong. These problems included the value of passion, the conception of poverty, the nature of scams, the value of academic qualifications, the conception of sustainability, and the meaning of winning.

However, two common problems were found to persist during many of the philosophical discussions, conceivably stemming from the pedagogical practice adopted by the teachers. First, quite a lot of the students were quiet, reserved, and passive, especially in the discussions where the teacher exhibited such dominating behaviours as talking too much about their own ideas and answering their own questions. Second, quite a lot of the discussions were superficial and non-philosophical due to the following facts: that the teacher did not allow sufficient time for the students to build towards a better understanding of the relevant issues, particularly at the conceptual level; that the teacher seldom, if ever, demonstrated to the students how to frame philosophical questions or rephrase unphilosophical questions into philosophical ones, hence the predominance of content-based over concept-based questions and discussions; that the questions in the discussion plan, though well-designed, were rarely used by the teacher to acquaint the students with philosophical thinking and inquiry; that the teacher, intentionally or unintentionally, allowed the students to raise psychological questions and give psychological responses, which was unlikely to lead to a philosophical investigation; that the teacher tended to give priority to developing the students' English proficiency over their thinking competence, asking them, for example, to read aloud each of the questions they made for discussion; and that the teacher failed to model and encourage the key elements of thinking like requesting reasons to support arguments and clarifying concepts through making comparisons, allowing the students to self-manage and self-facilitate the discussion prematurely without joining, let alone leading, it.

Moreover, the VR of student and teacher interviews were used to explore the attitudes of the students and teachers towards doing philosophy in the classroom, respectively. With regard to the student interviews, 17 randomly selected students were asked to respond to 8 interview questions. The videotaped student responses were transcribed and categorized under the interview questions. On the whole, most students gave a positive response to the interview questions, indicating a positive attitude towards doing philosophy in the classroom. Specifically, many students felt good about the philosophy lessons and claimed that philosophy helped them think better, changed their learning behaviour in a positive way, helped them improve their English, and brought them real benefits. Despite various difficulties experienced during the PIS project, many students were willing and eager to offer suggestions on how to improve it.

During the teacher interviews, the two participating teachers were asked to respond to 9 interview questions. The videotaped teacher responses were transcribed and summarized under the interview questions. On the whole, the teachers gave a positive response to the interview questions, indicating a positive attitude towards doing philosophy in the classroom. Specifically, the teachers found the training and support useful, responded favourably to the philosophy lessons, gained benefits from the PIS project, and planned on applying what they learned from this project to future teaching. Despite various difficulties and constraints experienced during the project, the teachers were willing and eager to offer suggestions on how to improve it.

17.3.2.2 SQB

The participating students ($n = 53$) were asked to respond to 2 free-response questions in the SQB that examined students' attitude towards doing philosophy in the classroom. For question 1, the results demonstrated that 83% of the students thought that there *should* be philosophy in schools, indicating a distinctly positive attitude towards philosophical inquiry in the classroom. The reasons they set out are cogent, of which four typical ones are illustrated below.

1. Philosophy is interesting, important, and fun.
2. Philosophy can help us think more carefully and from different perspectives.
3. Philosophy can allow students to share and discuss their ideas about philosophical issues.
4. Philosophy can enhance students' understanding of themselves and the world around them.

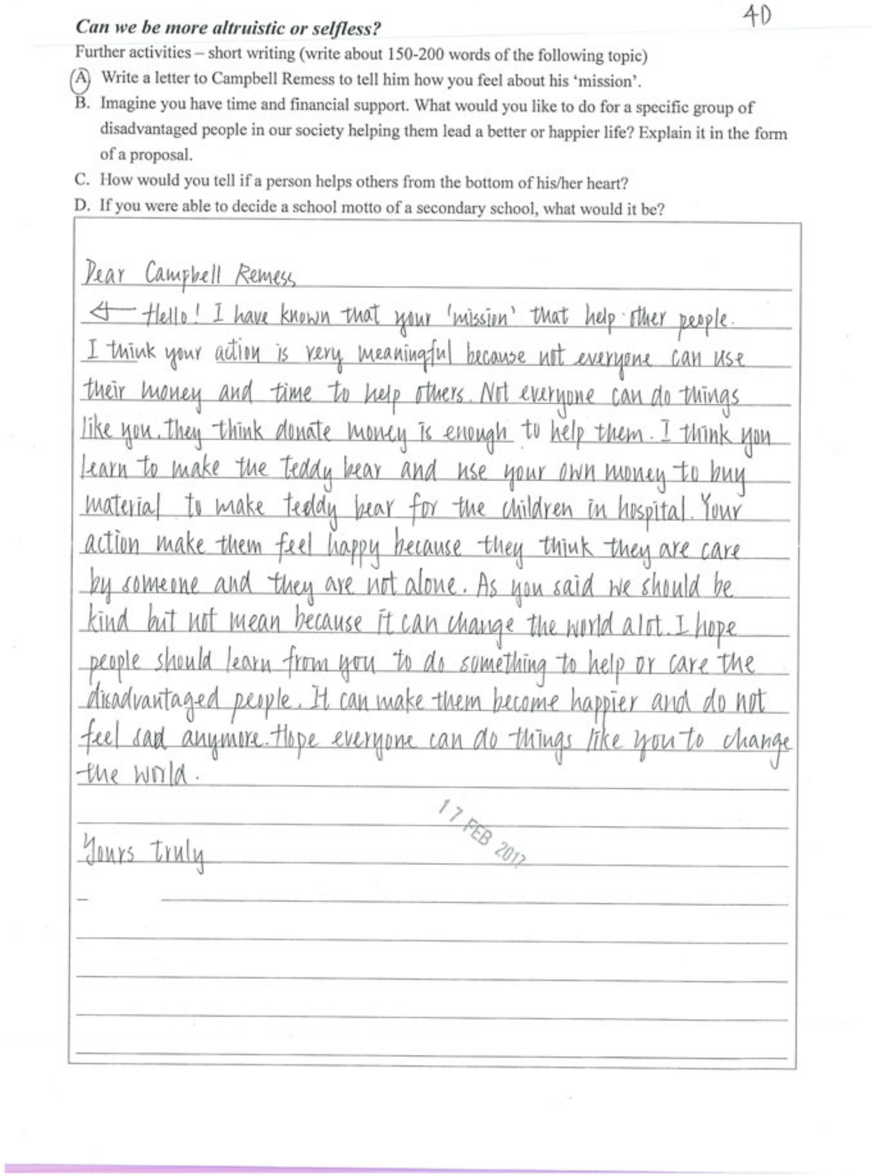
In contrast, the common reason given by those students who thought there *should not* be philosophy in schools was that philosophy is boring, not useful, and a waste of time. As for question 2 concerning the things students liked and disliked most in philosophy classes, the results demonstrated that 83% of the students could explain clearly their likes and dislikes. While most of the students liked most discussing various issues freely during philosophy classes, most of them disliked most being videotaped.

17.3.2.3 TQB

The participating teachers (n = 2) were asked to respond to 2 free-response questions in the TQB that examined teachers' attitude towards doing philosophy in the classroom. For question 1, the results demonstrated that both (100%) of the teachers thought that there *should* be philosophy in schools, indicating an entirely positive attitude towards philosophical inquiry in the classroom. The reasons cited by these two teachers are twofold: first, philosophy encourages students to become critical thinkers in all aspects of learning; and second, philosophy empowers students to think deeply about certain key concepts in philosophical inquiry even when they just listen without speaking. As for question 2 concerning the things teachers liked and disliked most in teaching philosophy, the results demonstrated that the teachers liked most guiding students to think from different perspectives and allowing them to express their views freely, while they disliked most motivating those students who were unwilling to express their ideas publicly and struggling to develop discussion plans from nothing.

17.3.2.4 PDWT

The participating students were assigned various follow-up writing tasks after the discussion in order to develop in them a critical and creative response to the textbook materials used for stimulating philosophical thought. An analysis of the completed writing tasks showed that, on the whole, the students' responses to the textbook materials were relevant, reasonable, and thoughtful. As an illustration, a sample of the students' responses is shown in Fig. 17.1.



4D

Can we be more altruistic or selfless?

Further activities – short writing (write about 150-200 words of the following topic)

A. Write a letter to Campbell Remess to tell him how you feel about his 'mission'.

B. Imagine you have time and financial support. What would you like to do for a specific group of disadvantaged people in our society helping them lead a better or happier life? Explain it in the form of a proposal.

C. How would you tell if a person helps others from the bottom of his/her heart?

D. If you were able to decide a school motto of a secondary school, what would it be?

Dear Campbell Remess

Hello! I have known that your 'mission' that help other people. I think your action is very meaningful because not everyone can use their money and time to help others. Not everyone can do things like you. They think donate money is enough to help them. I think you learn to make the teddy bear and use your own money to buy material to make teddy bear for the children in hospital. Your action make them feel happy because they think they are care by someone and they are not alone. As you said we should be kind but not mean because it can change the world alot. I hope people should learn from you to do something to help or care the disadvantaged people. It can make them become happier and do not feel sad anymore. Hope everyone can do things like you to change the world.

17 FEB 2017

Yours truly

Fig. 17.1 A sample of students' responses

17.4 Discussion

17.4.1 Conclusions

The results of this study showed that the Secondary 4 students who were taught PIS were capable of reasoning and arguing about philosophical problems arising from various stimuli prepared by their teachers according to the S4 English curriculum in Hong Kong. It was also found that PIS played an important role in promoting the students' critical and creative thinking, because it could elicit from them a large quantity and variety of cognitive behaviours characteristic of critical thinking, and a large quantity and variety of cognitive and dispositional traits characteristic of creative thinking, respectively. Besides, the students were found to have a generally positive attitude towards doing philosophy in the classroom, while the teachers were found to have a distinctly positive one.

The results were consistent with research on PIS in general, and in particular with the findings of Trickey and Topping (2004) and Lam (2013) concerning the promotion of students' critical and creative thinking. Indeed, the significance of the present study lies mainly in the implications of these results for four things: the capacity of Hong Kong students to do philosophy across the curriculum; the effectiveness of the PIS programme on promoting critical and creative thinking in students within a Chinese context; the teaching of critical and creative thinking for Hong Kong secondary students; and the attitude of students and teachers towards philosophy classes.

17.4.2 Recommendations

However, this study has two main limitations. First, the results cannot be generalized to all Hong Kong students because its sample came from a girls-only Catholic secondary school with Band 1 Chinese students only. Second, there was not enough time for the teachers to prepare, teach, and consolidate the philosophy lessons as there were considerable demands on them to deliver the exam-oriented English curriculum. In response to these limitations, two specific suggestions can be made for future research. On the one hand, in order to increase the generalizability of the results, further studies should be designed to replicate the present study in other settings (e.g. co-educational schools, non-religious schools, primary schools, etc.) and with other participants (e.g. students of different band levels, students of different achievement levels, students of different class levels, etc.). On the other hand, in order to resolve the time and curriculum constraints, apart from implementing PIS through the existing curriculum rather than as a stand-alone programme unrelated to the curriculum content (O'Riordan, 2013), future researchers should explore the possibility of running the PIS programme in classes with more lesson time and a more flexible curriculum.

In a nutshell, engaging ESL students in philosophical inquiry in English classes is conducive to the development of their critical and creative thinking.

17.4.3 The Future of PIS in Hong Kong

Considering that, like many places in the world, Hong Kong has been underrating and even denigrating philosophy as an academic discipline for years, it would take more than a generation to restore the respect for it in our schools and society. Still, there are good grounds for optimism. For one thing, the inquiry-driven and dialogue-based pedagogy employed in PIS will become increasingly significant as students and people alike come to terms with the impacts of knowledge expansion and cultural diversity. Indeed, rather than accumulating knowledge of facts, PIS focuses on analyzing key concepts of various subjects so that students can make sense of the world and make connections with their world. In order to realize the dream of PIS in Hong Kong, it is necessary to develop and provide a systematic training programme for local teachers, which achieves a good balance between theory and practice, between simplicity and accuracy, and between cost and permanence. In the long run, with the growth in reputation and success of PIS in local schools, it will be important to partner with teacher educators in introducing PIS to teacher trainees, not only for ensuring greater sustainability, but also for restoring philosophy to its central position in education.

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Chapter 18
Person-Environment Fit: Implications for Vocational Students' Career in the Era of Crisis

Monica Wai Chun Choy and Alexander Seeshing Yeung

Abstract Person-environment fit theory (PE-fit) theory emphasises a match between a person's attribute (P) and the workplace environment (E). However, a differential predictions hypothesis emphasises the different contributions of personal and environmental inputs to outcomes. Higher education students in Hong Kong ($N = 380$) completed a survey on their personal interest (P) and the contemporary threatening environment (E) (fear of pandemic, social unrest, international disputes) related to tourism-related outcomes (intent to join tourism, lifelong commitment, leadership, and anxiety) during COVID-19. Structural equation modelling found that P strongly predicted Intent, Lifelong, and Leadership, whereas E strongly predicted Anxiety, supporting the differential predictions hypothesis. PE-fit (P × positive E) predicted Intent in addition to the prediction of P, supporting the PE-fit hypothesis. The findings imply the different merits of PE-fit and differential predictions hypotheses for various vocational outcomes, and the importance of reinforcing students' interest to launch their career in challenging times.

Keywords PE-fit · Differential predictions · Vocational education · Hospitality and tourism · Pandemic · Career choice · Hong Kong

18.1 Introduction

Higher education students' choice of vocational courses and their future career may be seriously impacted by unexpected and threatening events such as the recent COVID-19 pandemic, or social unrests, or international disputes and warfare. Higher education institutions, as a consequence, may need to respond to a mismatch between

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students' personal interest and the unfavourable vocational environment by adjusting their goals and strategies (Agasisti & Soncin, 2021; Eringfeld, 2021). Among various vocational disciplines, tourism and hospitality (labelled as tourism hereafter) is one of the most vulnerable. Higher education program providers in tourism have experienced immediate losses in enrolment in tourism courses (Edelheim, 2020). For students who are already enrolled in a tourism program, however, it is more about their career choice (e.g., intent to join the industry; commitment to the career), performance (e.g., leadership) and personal wellbeing issues (e.g., anxiety). An evidence-based understanding of how personal interest (P) in tourism and the vocational environment (E) may contribute to the new blood's choice, performance, and wellbeing is essential for higher education institutions to make informed decisions to maintain a healthy enrolment and a continual supply of employees in the tourism industry.

In the prediction of career choices and vocational outcomes, PE-fit theory (Lewin, 1935, 1951) has provided a strong evidence base showing that a match between one's personal attribute (P) and one's workplace environment (E) contributes to one's productivity, motivation, and personal wellbeing (also see Bowman & Denson, 2014; Rothmann et al., 2019; Suleman et al., 2018). However, another perspective is that P and E have different contributions to different outcome variables—a differential predictions hypothesis (e.g., Choy & Yeung, 2022; Parker et al., 2018; Rocconi et al., 2020). That is, P and E contributes distinctively to various vocational outcomes. Whether PE-fit adds to the discrete predictions of P and E separately has important theoretical and practical implications. During a time when E is in turmoil (such as the triple-whammy crisis in Hong Kong), one may speculate that whereas P pushes a tourism student to join the tourism industry, the threatening E pulls the student away from it. Under normal circumstances when E is positive and non-threatening, one may envisage that the joint contribution of P and E will further boost a positive vocational outcome (as would be hypothesised on the basis of PE-fit). The present study analysed survey data from students in a higher education institution in Hong Kong ($N = 380$). They were asked about their personal interest (P) and the contemporary threatening environment (E) (fear of pandemic, social unrest, international disputes) related to tourism, and a range of tourism-related vocational and career outcomes (e.g., intent to join tourism, lifelong commitment, leadership, and anxiety) during COVID-19. Using structural equation modelling, we tested whether P and E distinctly predict vocational outcomes (a differential predictions hypothesis), or P and E combined (i.e., an interaction of positive P $\times$ positive E) would add to the prediction of the vocational outcomes (a PE-fit hypothesis).

18.2 Higher Education VPET Providers

The Hong Kong Government defines VPET as "vocational and professional education and training covering programs up to degree level with a high percentage of curriculum consisting of specialised contents in vocational skills or professional knowledge" (Education Bureau, 2015). For the tourism industry and institutions running related VPET programs, the years from 2020 is not only an 'era of challenge and change' as Floyd (2021, p.1) puts it, but it is an era of crisis. COVID-19 has caused job losses in numerous industries worldwide, with tourism being one of the most devastated (Business Standard, 2021), despite continual manpower shortage prior to the pandemic outbreak (Vocational Training Council, 2018). Particularly overwhelmed is Hong Kong, which has been hit by the triple whammy of social unrest, collateral damage from the Sino-U.S. trade war, and the pandemic (Malone, 2020). Skyrocketing unemployment in tourism-related industries (10.6%) reached a 15-year high after the onslaught of SARS earlier (Census & Statistics Department, 2021). Upended employment climate and uncertain industry outlook have been disrupting school leavers' intention of pursuing further study in this discipline and joining the industry after graduation (Atitsogbe et al., 2018), sowing the seeds of manpower crisis that is envisaged to impede tourism industry revival. The current challenges call for a search for empirically tested theories that may enable informed practical considerations in VPET and the industry.

18.3 Literature Review

According to Person-Environment Fit (PE-fit) theory (Lewin, 1935, 1951), one's vocational behaviour is essentially determined by the interaction of one's personal attributes (P) and significant aspects of the work environment (E). An adequate fit between one's personal characteristics and the environment in which one works influences one's vocational choice, performance, and wellbeing. For instance, one's stress and anxiety may not be caused by separate forces (either of person or of environment), but the blend of the two. The joint forces of P and E emphasised by PE-fit theory are widely used to explain workplace outcomes. For example, a fit between tour members and the tour member-leader on a group package tour (Chang et al., 2020), or a fit between employee personality in hospitality (Doan et al., 2021) and the hotel branding as well as the applicants' customer orientation trait (Lin et al., 2018) contributes to favourable outcomes.

PE-fit theory measures individuals' self-perceptions on their own attributes. Analogously, self-concept theory features ones' self-perception in terms of cognitive and affective dimensions (Arens et al., 2011). Evidence suggests that affective self-concept (i.e., liking of the career in this case) is a stronger driver of academic and vocational choices (e.g., intent to join the industry; lifelong service in the industry) than other predictors (e.g., mastery motivation; cognitive sense of competence) (Choy & Yeung, 2022; Yeung et al., 2005). While these differential predictions seem to stand, it is unclear whether the PE-fit in a vocational education context would add value to the prediction for various vocational outcomes. It could be that while P and E predict different outcomes that are essential vocational outcomes for the individual and organisational success (Autin et al., 2020; Giousmpasoglou et al., 2021; Yeung et al., 2005), the interaction of P and E adds value to the predictions of the valuable outcomes. In this paper, we have chosen four outcome variables: Intent (i.e., an aspiration to join a tourism career), Lifelong (willingness to remain in a tourism career as a life-time career), Leadership (readiness to be a leader in the tourism industry), and Anxiety (feeling anxious when things do not work out as expected). We examined whether the combined effect of P and E factors will have additional contribution to these vocational outcomes on top of either the P or E factor as a predictor.

18.3.1 Intent to Join the Career

Career aspirations can be immediate or long-term. Immediate aspiration is the intent to join the career after training (Yeung et al., 2011; Yeung et al., 2005). Research shows that a student's career intention is influenced by both intrinsic factors (e.g., career interest and expectation) (Atitsogbe et al., 2018; Choy & Yeung, 2022) and extrinsic factors (e.g., remuneration, job nature, and career prospect) (Choy & Kamoche, 2021; Choy et al., 2021). The effect of extrinsic factors has been demonstrated in studies revealing that Filipino (Benaraba et al., 2022) and Mainland Chinese tourism students (Birtch et al., 2021) doubt career prospects, undermining their intention to join the industry. The COVID-19 pandemic has further amplified the unfavourable job nature and employment vulnerability of tourism, and demotivate students and existing tourism practitioners to join or re-join the industry (Baum et al., 2020). Despite the attempts of scholars to identify the determinants of career intention, important factors appear to vary by sociodemographic background (Akosah-Twumasi et al., 2018; Kim et al., 2016). To our knowledge, little attention has been paid to examine how individual characteristics (P) and a cumulative threatening environment (E) may influence students' career intention in Hong Kong, hence the rationale of this study.

18.3.2 Lifelong Career Choice

Continual employment of staff is crucial for sustainable individual and organisational development. Staff members' desire to stay in the job is essential. An individual considers industry prospects, occupational interest, education opportunities and societal factors to determine how much they may exert themselves to strive in tourism (Choy & Kamoche, 2021). Research shows that one's interest in a particular study or a particular job has long-term effects on engagement (Kadir et al., 2017). For some students, tourism may be considered as a stepping stone. After launching their career in tourism, only a small percentage of them may make it a lifelong career (Atef & Al Balushi, 2017). This makes the development of the industry difficult and unsustainable. Hence it is essential to understand the factors that drive students to make a lifelong commitment.

18.3.3 Leadership

Effective leadership is the anchor for crisis handling and tourism organisation success (Giousmpasoglou et al., 2021). In this regard, organisations need to make continued efforts to identify, inspire and nurture future leaders. Extant studies maintain that vocational interests positively correlate with individuals' willingness to take up a role as leader and their self-perceived leadership success (Bergner et al., 2019; Chan et al., 2000). One study suggested an aggregate power of personality traits, vocational interests and cognitive ability are the strongest predictors for leadership and workplace success (Bergner, 2020). A number of studies have recognised the importance of embracing new leadership competencies in order to swiftly respond to changes in macro business environments during turbulent times (Dirani et al., 2020; Giousmpasoglou et al., 2021).

18.3.4 Anxiety

Anxiety could be caused by many reasons including negative career shock and precarious employment conditions due to unanticipated exogenous events that are perceived to be out of control (Akkermans et al., 2020). Studies have shown that a crisis such as COVID-19 has an adverse psychological effect on hospitality employees' mental health and lowers their intention to stay with the industry (e.g., Khawaja et al., 2021). An elevation of anxiety due to the scarring effects of the COVID-19 pandemic on the labour market has reduced job satisfaction and organisational commitment among hotel industry practitioners at all levels, from frontline to management (Wong et al., 2021). A Spanish study conducted during COVID-19 showed a significantly positive correlation between hotel employees' job insecurity and anxiety (Aguiar-Quintana et al., 2021). In Hong Kong, social unrest on top of the pandemic and Sino-U.S. trade war lends uncertainty to Hong Kong economic outlook and reflects job vulnerability of the tourism industry. Hence, the fear of undesired exogenous events may trigger anxiety among tourism students in Hong Kong.

18.3.5 P (Personal Interest)

A person's intrinsic motivation in a specific domain is probably the strongest driving force for that person to engage in it and thrive. Interest in studying a specific domain constitutes the affective component of a person's self-concept, the other component being a sense of competence, which is the cognitive component (Kadir & Yeung, 2017). Vocational interest and satisfaction in a challenging job are motivators that may counter structural barriers in the industry (e.g., low pay, anti-social working hours, and vulnerability to external environments) that could prevent an individual from joining the workforce or staying within it (Choy & Kamoche, 2021; Su, 2020). Hence, we would expect that students who find interest in a VPET tourism program intend to join the industry and to stay there.

18.3.6 E (A Threatening Environment)

Negatively affecting one's career aspiration and vocational outcomes are numerous factors, some of which are out of one's control. While the current pandemic situation is one of these factors, other barriers include social unrest, violence, war, international disputes, political instability, economic crisis and natural disaster, etc. In Hong Kong, the social unrest that started from 2019 (Shek, 2020), followed by COVID-19 in 2020, has left Hong Kong 'living in uncertainty' (Jung et al., 2021, p. 107). COVID-19 has affected all aspects of Hong Kong society, including the higher education sector. For Hong Kong, any international affair may have an impact on the city. The South China Sea dispute (Regilme, 2018), and the ongoing trade war between the USA and China which has impacted global economy (Boylan et al., 2021), are inevitably affecting Hong Kong as part of China. While the pandemic has led to drastic changes around the globe in terms of employment, career development, and workers' mental health (Autin et al., 2020), studies have reported mixed views and attitudes of career intention in tourism industry. For example, career intention among Indian and Ecuadorian tourism students remained positive in face of COVID-19 (Shad et al., 2020; Zurita & Soler, 2021) while New Zealanders have temporary halted their career plans for the long run (Reichenberger & Raymond, 2021). Conversely, a Mainland China study about the implication of COVID-19 maintained that hospitality students' future career intention was significantly linked to negative emotions but moderated by self-efficacy, intrinsic/extrinsic factors and the individual's passion for the industry (Birtch et al., 2021). To our knowledge, no study has scrutinised the impact of a threatening environment on the career choice among tourism students in Hong Kong. We therefore investigate whether tourism students in Hong Kong have a similar sense of pessimism as their counterparts in Mainland China.

18.4 The Present Investigation

The main goal of the current study is to examine the relationship between person-environment fit (PE-fit) and four selected vocational behaviours (i.e., intent to join tourism industry, lifelong commitment, leadership, and anxiety) among tourism students. In this study, we seek to determine whether P and E distinctly, or jointly, predict the four vocational outcomes. Specifically, the present study attempts to answer two research questions (RQs):

RQ1: Do Person (P) and Environment (negative E) factors distinctly predict four vocational outcomes (Intent, Lifelong, Leadership, and Anxiety)?

Rationale: Distinct predictions will support a differential predictions hypothesis.

RQ2: Does PE-fit (i.e., positive P $\times$ positive E) add value to the predictions in addition to the discrete predictions of P and E on the four vocational outcomes?

Rationale: A significant predictive path from PE-fit to an outcome will support a PE-fit prediction of that specific vocational outcome.

18.5 Research Design and Measures

The student population for tourism-related programs in Hong Kong is around 7,700 (CSPE, 2020). Students who were studying tourism-related local full-time undergraduate and sub-degree programs in VPET institutions in Hong Kong were invited to complete an online bilingual (English-Chinese) survey (paper copies were provided instead if requested) between January and September, 2021 when the triple whammy affecting Hong Kong's economy was prevalent owing to COVID-19 following months of social unrest and continuing Sino-U.S. tensions. Purposive sampling was used to select participants who possessed relevant knowledge and experience to achieve the objectives of the research (Jennings, 2010). A self-administered survey was developed after reviewing relevant measurement scales from the existing literature. Subsequently, we consulted two professors to ensure content validity and modified the survey questions to suit the purpose of the study. The survey was pilot tested before the actual study to assess validity and reliability of the survey questions, followed by improvement of the survey to address identified problems.

In this paper, we conceptualise vocational education students' interest in a tourism-related career as the P factor. During the recent consecutive occurrences of multiple crises in Hong Kong, for the sample of Hong Kong vocational education students, we considered a construct of threatening extraneous events as a negative workplace E. The survey comprised of 18 items and focused on seven constructs: P (personal interest), E (a threatening vocational environment related to tourism—fear of pandemic, social unrest, international disputes), and short- and long-term outcomes (Career intention; Lifelong career choice; Leadership, and Anxiety). All survey items were measured by a 6-point Likert type scale ranging from 1 (Disagree strongly) to 6 (Agree strongly). Person (P) was adopted from Yeung et al. (2012) to measure students' interest on tourism discipline using three items. Measurement items of Environment (E) were developed by the authors to assess the extent to which tourism students fear about unanticipated challenges to the industry. Three items were designed to include infectious diseases, international disputes, social unrest and violence, and any global issues that can damage the economy. Three items to measure career intention were adapted from Yeung et al. (2005) and Yeung et al. (2011) with two adjustments: (1) the items were directly relevant to tourism, and (2) the items referred to choosing to enter the workforce as a fresh staff member. The scale to measure students' propensity of choosing the industry as a lifelong career preference was also adapted from Yeung et al. (2005) and Yeung et al. (2011). Three items were used to refer to remaining in the industry as long as possible. Items to measure students' leadership was adapted from Tsai et al. (2006). Three items were used to measure students' readiness to be a leader in the tourism industry. The scale to access students' anxiety was adapted from Martin (2001, 2009) with modification to align with the context of the study. Three items were used to measure students' feelings of tension and apprehension over undesired event(s) and situation(s) that could happen in the future. The survey also collected respondents' demographic data (i.e., gender, age, program level, and major program) (See Appendix).

To enable easy interpretation of PE-fit and its impact on vocational outcomes, we generated a PE-fit measure by juxtaposing P and E and created a positive PE-fit construct. Because E in the survey was a negative construct representation unfavourable circumstances in the industry, we first reverse coded the scores for E to make it a positive measure representing favourable workplace circumstances. The PE-fit construct was an interaction term ($P \times E$) which represents a combination of positive P and positive E (i.e., favourable personal attribute coupled with positive vocational environment). However, because the PE-fit construct is dependent upon the P and E constructs, SEM models using the P, E, and PE-fit measures are unlikely to be properly identified, we used standardised scores of P and E to generate the PE-fit measure (i.e., PE-fit $= zP \times zE$).

18.6 Data Analysis

Data analysis started with preliminary analysis including descriptive statistics and reliability analysis (Cronbach's alpha). A series of confirmatory factor analyses (CFA) and structural equation modelling (SEM) were conducted using the statistical package of Mplus (Version 7.11) (Muthén & Muthén, 2013). We first tested the factor structure of the hypothesised three predictors (P, E, and PE-fit) and each of the four vocational outcomes (Intent, Lifelong, Leadership, and Anxiety) respectively in four CFA models (Models 1 to 4 each with three predictors predicting one outcome variable). When each of the four models provided a reasonable model fit, we examined the paths from the three predictors to each vocational outcome in respective SEM models. As the model fit would be identical to each respective CFA model, we report only the model fit for CFA models to avoid redundancy.

Model fit was accessed by multiple indices: Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and comparative fit index (CFI). The chi-square test statistics are also reported. In general, for TLI and CFI, values equal to or larger than 0.90 are considered acceptable (Byrne, 2012). For RMSEA, values ranging between 0.05 and 0.08 are generally accepted as a close fit to a fair fit (Bowen & Guo, 2012). Factor loadings and latent factor correlations were than examined to provide further support for the structural validity of the tested model. Factor loadings show the relations of each underlying construct with each of the observed variables (i.e., the survey items). The latent factor correlations show the associations of the latent constructs, which should be clearly smaller than 1 so as to be distinguishable from each other.

The models would enable us to answer the RQs. By examining the paths from P and E to each outcome variable, we would be able to answer RQ1: 'Do P and E distinctly predict the vocational outcomes?' By examining the path from P × E to each outcome, we would be able to answer RQ2: 'Does PE-fit add value to the predictions?'.

18.7 Results

18.7.1 Descriptive Statistics and Reliabilities

A total of 380 completed surveys were analysed. The sample was made up of 72% females and 28% male. While students' age was from under 20 to over 50, the majority of respondents were aged between 20 and 29 (52%), followed by those who were under 20 (47%). Of the respondents, 70% were undertaking hospitality-orientated programs (i.e., Hotel, Food and Beverages) and the rest were from tourism-oriented program (e.g., Theme park, MICE, Cruise and Aviation). Students from sub-degree levels have the highest number of respondents (41%), followed by undergraduate degree (38%) and certificate (21%).

Table 18.1 summarises the means, standard deviations, and reliabilities of the constructs. The Cronbach's alphas (ranging between 0.61 and 0.90 across seven constructs) suggest a reasonable internal consistency for each factor. Most of the convergent validity requirements were satisfied, except that Cronbach's alpha of Anxiety was below 0.70. Extant studies measuring affective constructs (e.g., attitude and anxiety) accepted a wider range of alpha values from 0.45 to 0.98 to demonstrate the constructed tests and scales are fit for the purpose (Taber, 2018). The highest means were observed in the Environment ($M = 4.31$) and Person ($M = 4.24$) constructs, well above the mid-point of a 1–6 scale. The high mean scores imply that the current sample of students had high personal interest (P) but also perceived high fear of extraneous barriers due to unexpected and uncontrollable events in the vocational environment (E).

Table 18.1 Descriptive statistics and alpha reliabilities

	Person(P)	Enviro(E)	PE-fit	Intent	Lifelong	Leader	Anxiety
Alpha	0.90	0.80	0.77	0.86	0.88	0.83	0.61
Mean	4.24	4.31	−0.13	3.88	3.17	3.95	4.00
SD	(0.98)	(1.11)	(0.85)	(1.02)	(1.12)	(0.99)	(0.85)

Table 18.2 Models

N = 380, Person(P), Environment(E), P × E with Dependent Variable	χ^2	*df*	CFI	TLI	RMSEA
Model 1. Intent	130.957	48	0.962	0.947	0.067
Model 2. Lifelong	113.338	48	0.969	0.957	0.060
Model 3. Leadership	94.503	48	0.975	0.966	0.050
Model 4. Anxiety	110.543	48	0.962	0.948	0.059

Table 18.3 Factors loadings

	Person(P)	Enviro(E)	PE-fit	Intent	Lifelong	Leader	Anxiety
Item 1	0.82**	0.70**	0.69**	0.91**	0.85**	0.76**	0.56**
Item 2	0.88**	0.80**	0.78**	0.66**	0.82**	0.75**	0.66**
Item 3	0.88**	0.76**	0.72**	0.92**	0.87**	0.85**	0.52**

N = 380. *$p < 0.05$. **$p < 0.001$. r between P and E = 0.22; r between P and PE-fit = –0.14; r between E and PE-fit = 0.10

18.7.2 CFA

A series of CFA models were tested (see Table 18.2). Model 1 to Model 4, testing a 4-factor model (3 predictors and 1 outcome), each showed an acceptable fit supporting the hypothesised predictors and outcome structure (weakest CFI = 0.962, weakest TLI = 0.962, weakest RMSEA = 0.067; all acceptable).

The factor loadings for each of the seven variables are summarised in Table 18.3. All the factor loadings were statistically significant (all > 0.50), ranging from 0.52 to 0.92. The latent factor correlations were all clearly smaller than 1, indicating that they were clearly differentiable from each other ($r < 1$). The PE-fit measure, operationalised as the standardised interaction between P and a positively coded E, had small correlations with P ($r = -0.14$) and E ($r = 0.10$), respectively (Table 18.3). These low correlations among the predictors have avoided difficulties in interpreting the effects of PE-fit. Interestingly, between P and E, the correlation was significantly positive ($r = 0.22$), showing that E, which is presumably a negative and devastating force, did not seem to be in direct conflict with personal interest.

18.7.3 SEM

The SEM fit indices were identical to the CFA solutions (Table 18.2) and are therefore not replicated in the report on SEM results. The paths from the three predictors to each tested vocational outcome are presented in Fig. 18.1. Model 1, an SEM with paths from three predictors to Intent, found that the path from P was significantly positive ($\beta = 0.61$) whereas the path from E was small and not statistically significant

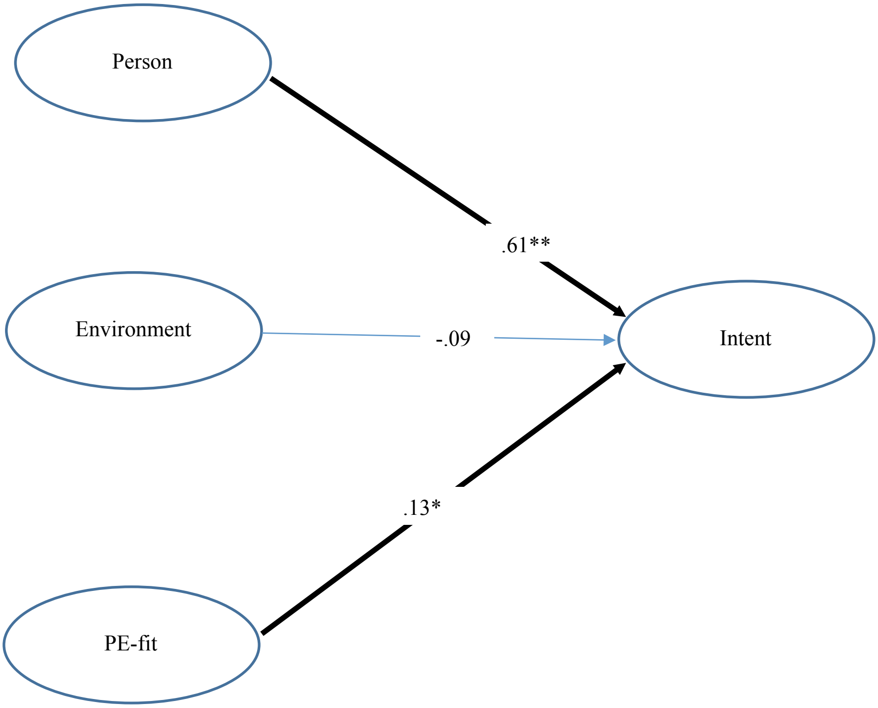

Fig. 18.1 Model 1 Paths to Intent (* $p < 0.05$. ** $p < 0.001$)

(β = −0.09). The path from PE-fit to Intent was significantly positive (β = −0.13), indicating that a match between P and E would have a significant impact on the intent to join the tourism industry (Fig. 18.1: Intent).

Model 2, an SEM with paths from three predictors to Lifelong, found that the path from P was significantly positive (β = 0.52) and the positive path from E was also statistically significant (β = 0.17). The path from PE-fit to Lifelong was small and not statistically significant (β = 0.06), indicating that a match between P and E would have almost no impact on the lifelong commitment to tourism (Fig. 18.2: Lifelong).

Model 3, with paths from three predictors to Leadership, found the path from P significantly positive (β = 0.61) but the path from E (β = 0.01) and from PE-fit (β = −0.03) to Lifelong was small and not statistically significant, indicating that P was the only prevalent predictor whereas PE-fit had no additional impact (Fig. 18.3: Leadership).

Model 4 with paths from three predictors to Anxiety found that the path from P was not statistically significant (β = −0.05). The path from E (β = 0.82) was positive and statistically significant. The path from PE-fit (β = 0.09) to Anxiety was not statistically significant, indicating that E was the only prevalent predictor whereas PE-fit had no impact (Fig. 18.4: Anxiety).

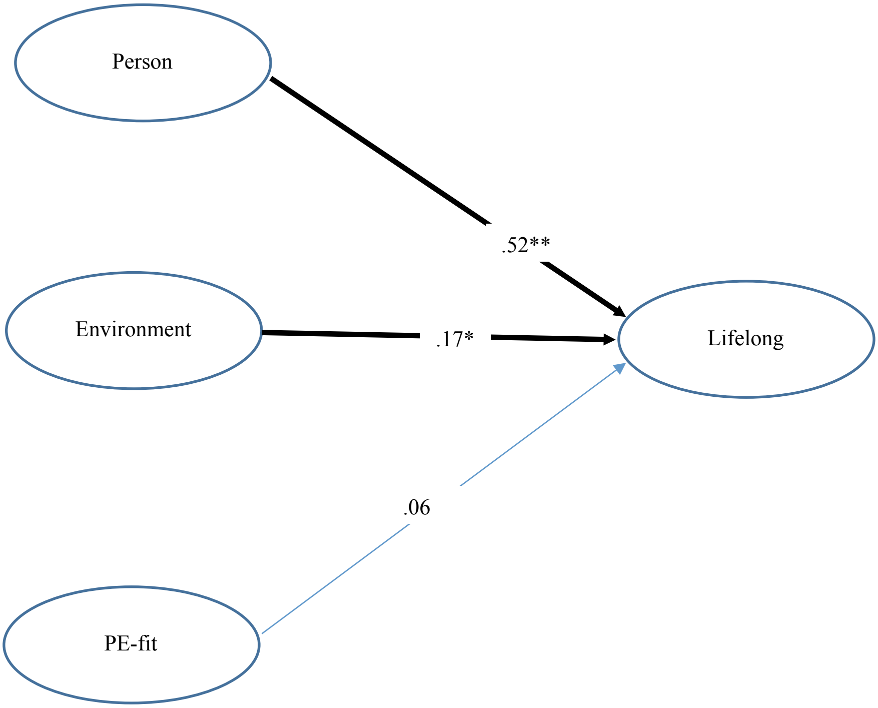

Fig. 18.2 Model 2 Paths to Lifelong (* $p < 0.05$. ** $p < 0.001$)

As the key issue to investigate was the effect of PE-fit on vocational outcomes, an inspection of the paths from PE-fit to outcomes would be essential. As found in the models above, PE-fit had a significantly positive path to Intent ($\beta = 0.13$), indicating that a match between one's personal interest and an unthreatening work environment would facilitate one's intent to join the industry after graduating from the tourism program in higher education. However, this was the only significant prediction of any of the vocational outcomes. The other paths were not statistically significant (βs = 0.05, −0.01, 0.04, and 0.09 respectively for Lifelong, Leadership, Resilience, and Anxiety).

18.8 Discussion

This study attempts to provide empirical evidence for PE-fit theory to make connection between personal characteristics (P), Environment (E) and the selected vocational behavioural outcomes (i.e., intent to join tourism industry, lifelong commitment, leadership, and anxiety) among tourism students in Hong Kong.

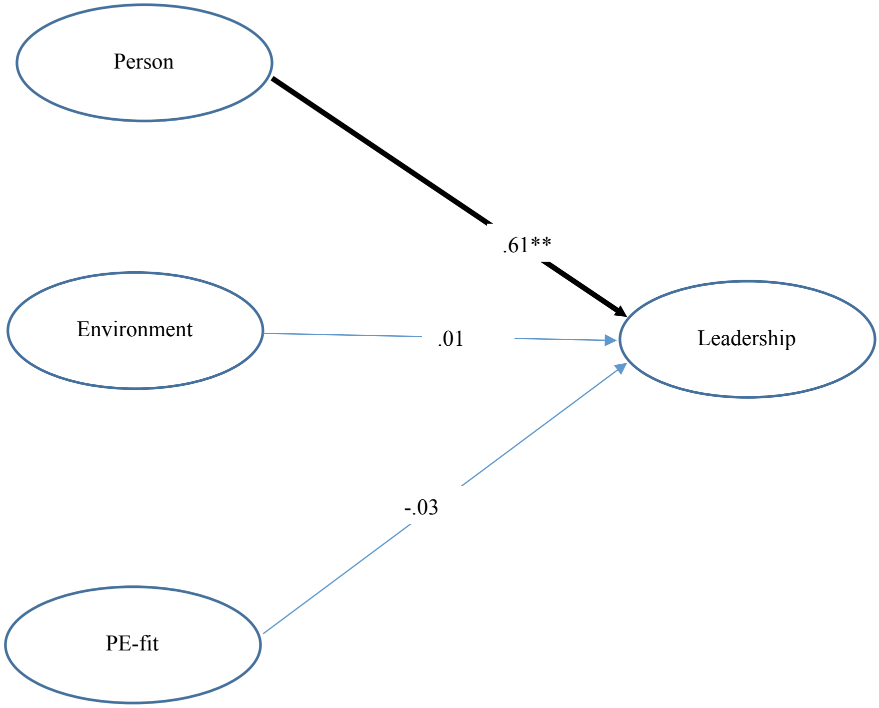

Fig. 18.3 Model 3 Paths to Leadership (* $p < 0.05$. ** $p < 0.001$)

Personal interest and a threatening environment were operationalised as personal characteristics (P) and exogenous environmental impacts (E) respectively.

Answering the RQs

***RQ1.* Do P and E factors distinctly predict vocational outcomes?**

The analysis found that the distinct predictions of P and E on the various outcomes supported the differential predictions hypothesis (Models 1 to 4). Hence P and E each tends to have a distinct contribution to each career outcome.

RQ2. Does PE-fit (i.e., positive P × positive E) add value to the predictions?

The answer is 'yes' for the intent to join the industry. The significant predictive path from PE-fit to Intent (Model 1) supported the PE-fit prediction of that specific vocational outcome.

Overall, our analysis attempted to distinguish the difference between P and E in predicting vocational and career outcomes while testing the combined effects of a positive match between P and E. Our findings revealed that personal interest had the strongest prediction on three of the four outcome variables (i.e., intent to join tourism industry, lifelong commitment, and leadership). Hence personal interest in the career tends to be the strongest driver of a person's intent to join tourism, willingness to

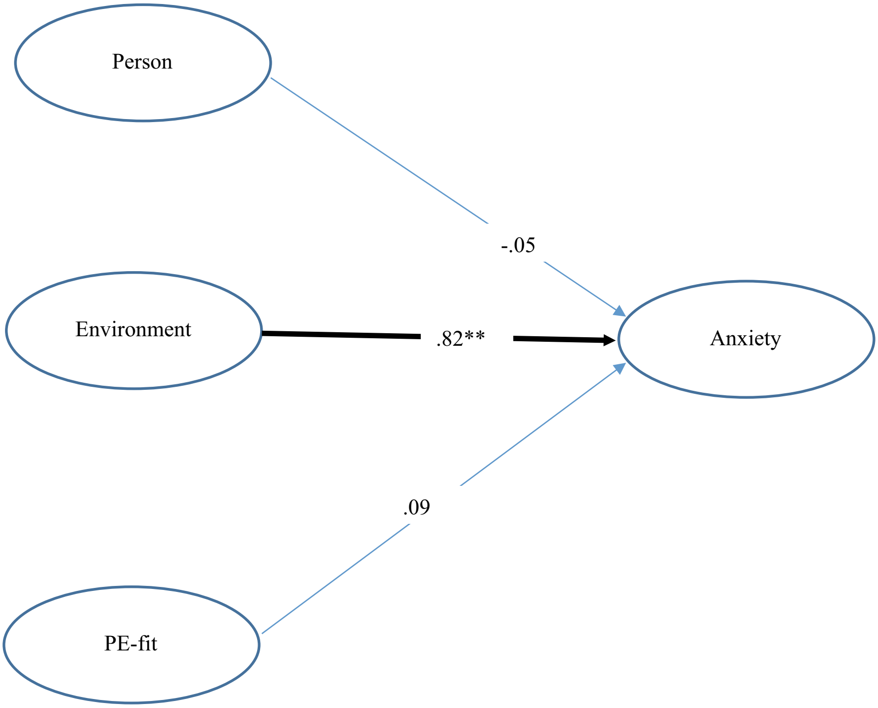

Fig. 18.4 Model 4 Paths to Anxiety (* $p < 0.05$. ** $p < 0.001$)

choose tourism as a lifelong career, and readiness to be a leader in the industry. These results appear to be in line with the findings of Choy and Yeung (2022), Su (2020); Atitsogbe et al. (2018); and Kadir et al. (2017) who suggested that career interest is a powerful motivator of career choice that can counter unfavourable job natures. Our findings also support the findings of Yeung et al. (2012) and Choy and Kamoche (2021), showing that positive affect leads to long-term career engagement. Nevertheless, the results contradicted the findings of Atef and Al Balushi (2017) who indicated that a tourism job only serves as a stepping stone into another industry. Our results tie well with previous studies wherein vocational interests positively correlate with individuals' eagerness and confidence to take up the leadership role (Bergner et al., 2019; Chan et al., 2000).

In line with previous studies (e.g., Aguiar-Quintana et al., 2021; Khawaja et al., 2021), the threatening extraneous events were found to be a strong driver of anxiety. Hence a negative, threatening environment can be detrimental to one's wellbeing. Despite the presumably negative effect of a threatening environment on vocational outcomes, the effect was negligible for most of the outcome variables. Also, surprisingly, the effect of a negative Environment on Lifelong was significant positive, reflected that tourism students are optimistic about their career prospects in the industry in the long run. A similar finding was reported in a New Zealand study

(Reichenberger & Raymond, 2021) but our result goes beyond pervious reports in the Philippines (Benaraba et al., 2022), Mainland China (Birtch et al., 2021), United States (Wong et al., 2021) and Pakistan (Khawaja et al., 2021), which suggest that challenges and uncertainties caused by COVID-19 are a destabilising factor of career intention and job change. Inconsistent findings imply that tourism students' attitude towards career choice are probably culture specific (Akosah-Twumasi et al., 2018; Kim et al., 2016). Further research is required to examine driving forces and barriers for making initial career decisions in different countries.

As for the joint effect of P and E, it was only for the outcome of Intent that the PE-fit construct had a significantly positive contribution, out of all predictors. That is, whereas P had a significantly positive drive to facilitate career intention, and a negative E (threatening crises) had a weak and nonsignificant effect, PE-fit (i.e., a positive personal interest together with a nonthreatening work prospect) had a significantly positive contribution to Intent on top of the Person and Environment effects. Hence for this sample and within this context, PE-fit seems to have specific but little contribution to the other desirable outcomes overall. However, given the practical significance of the contribution to new recruits' intent to join the tourism industry, the merit of PE-fit should not be undermined, theoretically and practically.

18.9 Practical Implications

One of the key pillars of Hong Kong's economy that creates enormous job opportunities is tourism, which has been hit by the triple whammy of social unrest, collateral damage from Sino-U.S. trade war and the pandemic. Our findings highlight the importance of enhancing students' personal career interest (P) for making a career choice and enhancing leadership development. Educators may need to revisit their curriculum and pedagogies to focus on enhancing students' occupational interests and competencies at an early stage of year 1 in higher education. Once a student has developed a strong passion for the occupation, the intrinsic motivation may outweigh the fear for extraneous events (E) that cause hardship and anxiety. Ongoing engagement with students is expected to boost their interest, hope and decisiveness of study and career aspiration in tourism (Zhong et al., 2021). To boost a positive workplace environment, for VPET, voices from industry practitioners may have paramount contributions as they carry equal, or sometimes stronger, credibility than those from academia (Van Hoek et al., 2011). Guest speakers from the industry are more able to share their real-world experience and insight about industry prospects in current situations. Policy makers will also need to consider ways to reduce the concerns of tourism workers about extraneous factors. In essence, with Government support, tourism educators and industry practitioners may need to modify their approaches to rebuild students' confidence and interest to launch their career after graduation.

18.10 Strengths, Limitations, and Future Research

The present study extends our knowledge of applying PE-fit theory of a differential predictions approach to achieve relevant career outcomes. By examining the predictive power of a single dimension (P or E), or PE-fit emphasising the strength of the combined effects of P and E on a range of vocational outcome variables, we will be able to target vital productivity, motivation, and wellbeing outcomes to facilitate tourism students' future career and the industry's revival and success. The contribution of this study has been to support the notion of PE-fit yheory for career choice and the notion of differential predictions for other vocational outcomes. This research lays the groundwork for further research on other tourism-related industries and elsewhere. Our finding showing the strengthen of affective self-concept in driving vocational choices (Choy & Yeung, 2022; Yeung et al., 2005) is of particular importance as it highlights the need for education providers and tourism organisation management to promote personal interest (P) as a strong motivating factor to counter any fear of extraneous factors (E) to outweigh any perceived extraneous threats to a tourism career in future.

Despite the strengths, due to the cross-sectional nature of the study design, this study cannot determine causal inferences. A longitudinal study will be useful to test causal relations of identified variables. Also, because the study was conducted in Hong Kong, the findings may not be generalised to other cultures or tourism markets. Given tourism in Mainland China is recovering swiftly from COVID-19 with its domestic demand, researchers may consider to replicate the present study in Mainland China or conduct a comparative study in other industries and socio-geographic settings. Further investigation using a broader range of motivational and behavioural constructs could shed more light on the application of PE-fit theory and differential predictions to test their theoretical and practical implications.

18.11 Geolocation Information

The research was conducted in Hong Kong.

Funding The research was fully supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (UGC/FDS25/H02/20).

Appendix: Variables and Sample Items

Construct		Sample Items
Person	P1	I am liking my preferred hospitality discipline
	P2	Interested in my preferred hospitality discipline
	P3	I am enjoying my preferred hospitality discipline
Environment	E1	I fear that any infectious disease can suddenly destroy the economy
	E2	I fear that people may suddenly lose their jobs when international disputes occur (e.g., political fights, trade war)
	E3	I fear that social unrest and violence may happen any time causing economic crisis (e.g., anti-government protests)
PE-fit	P1 x E1r	zscore of P1 × zscore of reverse-scored E1
	P2 x E2r	zscore of P2 × zscore of reverse-scored E2
	P3 x E3r	zscore of P3 × zscore of reverse-scored E3
Intent		I will join the hospitality workforce after graduation
		I am ready to become a staff member in the hospitality industry
Lifelong		I am willing to be in the hospitality industry till I retire from work
		I will not leave the hospitality profession if I don't need to
Leadership		I am a good leader in the hospitality and tourism sector
		I am confident to lead a team
Anxiety		I worry about my career prospect in hospitality industry
		I tend to get anxious about my duties serving my customers

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Chapter 19
Reimaging Academics' Participation in Quality Enhancement in the Era of Technological Change

K. Y. Ho, S. T. Kwok, Aileen P. Y. Chan, and C. F. Yuen

Abstract This paper evaluates experiences of quality enhancement as actualised by academic and teaching staff. Based on the experience of some major Vocational and Professional Education and Training (VPET) institutions in Hong Kong, the purpose of this article is to shed light on critical insight gained from the good practices and suggest areas for improvement for supporting quality enhancement (QE) in higher education sector with due consideration of the emerging technological environment. This article innovatively translates the key themes and elements with regards to QE into a theoretical framework to show the processes through which institutions can further develop its internal QE culture via the use of existing and emerging technologies. Through these technologies, learning and teaching will also be guided, thereby contributing to maximising students' benefits.

Keywords Vocational and professional education and training · Quality enhancement · Digitalisation · Collaboration · Best practices

19.1 From Quality Assurance to Quality Enhancement

In higher education, quality assurance (QA) has been adopted and promoted to ensure accountability for the use of funds, learning and teaching, and for students to make informed decision for admission. QA has also been used to represent external quality

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monitoring and accreditation through fit-for-purpose QA systems and processes as a way to assure high quality and academic standards. QA ensures that quality learning experience and environment are always provided to students. Other scholars also defined QA in higher education as a process of fulfilling the expectations of stakeholders, ensuring accountability or using check list to measure fulfilment of external standards to threshold minimum requirements (Biggs, 2001; Cheng, 2003; Green, 1994; Harvey & Green, 1993). It is believed that a transparent QA system together with external assurance and accountability could ensure the effectiveness of teaching and learning and functional administrative structure (Gvaramadze, 2008).

While ensuring the foundational QA mechanisms continues, some higher education, including VPET institutions, has already advanced to the arena of quality enhancement (QE), as a result of organisational maturity and a continuum of QA (Elassy, 2015). QE, which embraces student interest as the core value, allows VPET institutions to systematically promote and continuously improve the quality of the institutions, in addition to programme provision and the ways in which students' learning is supported. A number of literatures is available to associate and differentiate QA and QE in the context of higher education. It is thought that unlike QA, which was deemed as a summative diagnostic process that focuses on the past actions taken, QE can be regarded as a formative treatment process that focuses on the present and future outcomes (Biggs, 2001; Brink, 2010; Fillippakou & Tapper, 2008; Lomas, 2004; Gibbs, 2011). QE tends to continue improve learning, teaching and enables a more complex discourse and interpretive space, thereby enhancing the overall learning experience of students in higher education.

19.2 Quality Enhancement in VPET of Hong Kong: An Overview

QA and school monitoring have long been a trend in the Asia Pacific Region (Mok et al. 2003). In fact, Hong Kong has not been aloof from placing emphasis on quality in education, including the VPET. With the development of Hong Kong Qualifications Framework (HKQF) and the establishment of the Hong Kong Council for Accreditation of Academic and Vocational Qualifications (HKCAAVQ), higher education institutions have given prominence to their accountability and transparency on QA process. Although each institution has its own framework for QA, approach and guiding principles, governance and administration, they all share a similar process of approval, monitoring, review and continuous enhancement. Furthermore, making reference to the Manual for the Four-stage Quality Assurance Process under the HKQF (HKCAAVQ, 2020), quality of a programme is characterised by meeting the competence requirements to demonstrate that its objectives and expected programme learning outcomes are achieved. The domains of competence for learning programme cover different aspects include programme structure and content, learning, teaching and assessment, programme leadership and staffing, learning, teaching and enabling resources/services and QA (HKCAAVQ, 2020).

Nevertheless, institutions are not purely meeting the authoritative advice from statutory QA bodies but endeavour to develop more structured enhancement measures for the improvement of quality within the institutions. Taking one of the notable VPET institutions, the Vocational Training Council (VTC), as an example, it enhances connectivity among academics and QE by deriving a student-centred VTC Quality Enhancement Gold Standards Model (VTC, 2021). Developed based on over thirty years of experiences passing through innumerable external accreditations, the Model adopts an evidence-based systematic approach summarising best practice through continuously improving the development, offering and review of vocational and professional learning programmes. The Model emphasizes eight facets pertaining to (i) programme structure and content; (ii) recognition/accreditations; (iii) student admission; (iv) availability of information to students and the general public; (v) student support and enabling resources; (vi) engagement of teachers; (vii) qualifications and quality of teachers; and (viii) external views—industry and market needs (Cheuk, 2022). In spite of the Model now being mainstreamed and advocated as one of the best practices in QE, especially in the context of VPET provision, the success of QE still heavily relies on the implementation driven by academics and teaching staff.

19.3 The Use of Digital Tools to Facilitate Quality Enhancement

Along the rapid progress of emerging technological development, a wide range of information and data have been continuously and increasingly converted in a digital format which impact every facet of our lives. Entering an era of digitalisation, the education sector has been transformed in several aspects. VPET is no exception. Various tools are now being employed to facilitate learning and teaching. For example, in many VPET institutions, online learning management systems enable educators to create dynamic courses/modules with teaching and learning materials in additional to the assessment tasks due. These online learning management systems also allow students to have a real-time synchronous discussion and work collaboratively such as in forums and database. In the context of VTC, workplace learning and assessment (WLA) is conducted via a tailor-made electronic platform. Students' academic performance in various subjects are being recorded and tracked digitally using performance tracking tools available on the learning management platforms, such as Moodle. While a variety of technology has been extensively used in learning, teaching and assessment, attention on its application to facilitate QE is minimal.

19.4 Academic Ownership to Quality Enhancement

Participatory bottom-up approach has long been proven as the most effective way to QE (Becher, 1992; Gordon, 2002; Zaar & Andersson, 2020). For instance, evidence suggested that quality of students' learning experience can be effectively enhanced if students' suggestions are closely interrelated by educators with clear and tangible improvement actions (e.g. the actual teaching practices, updates in learning and teaching materials) (Williams & Kane, 2009). Other scholars also reviewed that with active engagement of academics, the orientation of quality could be deliberated and converged towards maximising students' benefits without focusing on the process of summative checking or evaluative audit (Gunn & Cheng, 2015). More recently, Elken and Stensaker (2018) emphasized that successful QE relies on practice-oriented approach in which academics shall take up one of the key responsibilities to continuously shape the daily practice to enhance quality in higher education. Other researchers also explicitly stressed that frontline academics' ownership is positively related to QE practices (Anderson, 2006; Bendermacher et al., 2019). Coupled with the application of emerging technologies, academics who consider QE to be their own responsibility and commitment are expected to demonstrate higher degree of participation in quality activities as being previously reported in another research conducted in the Netherlands (Bendermacher et al., 2019) and a systematic review covering 111 studies to improve teaching effectiveness (Steinert et al., 2016).

19.5 Objectives

Consolidating literatures and experience gained from enhancing the quality of vocationally oriented applied degree programmes, this article sheds light on the critical insight gained from the good practices and suggest practical tactics to cultivate academics' positive attitude towards QE and active participation. With the inspiration of a theoretical framework detailed in the following section, this research was the first of its kind to innovatively consider the complex interplay between individual, interpersonal, institutional, community and public policy and to examine how digitalisation may facilitate academic's participation in QE from all-rounded aspects and multiple perspectives. This research facilitates the understanding on the range of factors that affect academic's participation in QE and illustrates how factors at one level influence factors at another level.

19.6 Theoretical Framework to Support Academics Participation

As academics' participation is vital to the success of continuous QE, it is important to apply a theoretical framework to understand the complex challenges academics face and to guide supportive measures. The social-ecological approach is adopted as the theoretical framework to guide the current study. Introduced in the 1970s, the social-ecological model is a broad-based conceptual model depicting basic ecological principles of human behaviour (Brofenbreener, 1979).

Despite literatures suggest that this approach has never been adopted in the context QE, it has long been used as a theoretical framework to analyse and promote behavioural changes in a variety of subject matters (Veer et al., 2019). For example, some researchers adopted this model as a holistic approach to investigate how human mind and belief can be shaped (McNamara & Purzycki, 2020), to examine individual's belonging in an organisation (Allen et al., 2016), to analyse health behaviour and barriers to behavioural changes (Kwok et al., 2020), to derive code of ethics at workplace (Shapira-Lishchinsky & Ben-Amram, 2020), to develop effective empowerment programmes and change strategies (Berkes et al., 2008). Since the social-ecological approach has been widely used in many different contexts to shape the mindset and drive behaviour change, it is reasonable to adopt this approach to inculcate a greater sense of academic responsibility for QE.

According to the social-ecological model presented in Table 19.1, there are multiple influences on individual behaviours and these influences are categorised in different levels. These levels of influence include intrapersonal (i.e. individual), interpersonal, institutional and community factors, and public policies (Brofenbreener, 1979).

The social-ecological framework offers a boarder and more comprehensive perspective that impact individual behaviours. Based on this approach, a variety of multiple level focused strategies and activities that utilise digital tools can be derived to support academics' participation in QE (Table 19.1). Such theoretical framework also builds a mutual understanding of strategies and expectations, enhances collaboration and promotes clear communications among stakeholders. Although each level of influence could be unique, these influences also interact across levels to affect academics' behaviour in QE.

Table 19.1 The socio-ecological framework: levels of influence in the context of quality enhancement

Level of influence	Description	Key factors influencing academics' participation in QE	Examples of technologies/digital tools to facilitate academics' participation in QE
Intrapersonal	Individual characteristics that influence behaviour	Knowledge	Online capability building training; AI chatbots
		Motivation and engagement	Machine learning; online assessment; big data and predictive analytics
Interpersonal	Interpersonal processes and primary groups	Roles and responsibility	Monitoring management system/application
		Sharing of good practice	Digital communication technology; knowledge management system; content management systems
		Collegiality	Cloud storage; collaborative real-time editor; monitoring and management system
Institutional	Regulations, policies and structures which may constrain or prompt certain behaviours	Infrastructure support	Hybrid clouds; common management system; blockchain
		Bottom-up initiatives	Internal communication tools; online staff engagement platform
Community	Networks outside the institution, which exist as individuals, formal and informal groups and organisations	Stakeholder engagement	Cloud/In-house client database management system; integrated stakeholder engagement system
		External accreditation body	Blockchain
Public policy	Policies and climate that support QE actions	Dissemination of information and support scheme	Web2.0; digital video production

19.7 Technologies to Facilitate Academics Participation in QE

19.7.1 Intrapersonal Factors

19.7.1.1 Academic Ownership

Key factors affecting academic ownership include (i) academics' knowledge on QE; and (ii) individual perspective, interpretation, perceptions and engagement in QE, i.e. motivation and engagement.

(i) *Knowledge on QE*

All academics and front-line teaching staff need to first develop a clear understanding before they can fully engage in and devote time and effort to contribute to QE. Quality culture should be designed with multiple dimensions and contextualised in every institutional setting to become specific so that different understandings of quality can be embedded within a specific context (Gvaramadze, 2008). For instance, many higher education institutions worldwide have now regularly organised an induction programme for new academic staff so as to facilitate new academics' understanding on the respective graduate attributes, learning and teaching practices, funding and support for teaching, not least QA/QE. These induction programmes also serve as part of the capability building professional development for academics to expose and advice to advance knowledge and skills. Nowadays, many of these induction programmes are conducted face-to-face with a series of forums and workshops, supplemented with manuals and handbooks, though online real-time delivery had been increasingly adopted by some institutions.

Technology can offer academics the opportunity to benefit from bite-size online professional development, especially in the arena of QE, which consists of numerous facets involving a wide range of internal and external stakeholders, procedures and approval authorities. Compared with one-time workshops and face-to-face sessions, bite-size online programmes can be customised and tailored to meet varying needs of academics who have different academic expertise, roles and responsibilities in the QE process, prior knowledge and previous experiences, individual preferences, learning styles and paces. While online professional development programmes in QE have concomitant advantages of being convenient, flexible and versatile, academics may still have questions from time-to-time during day-to-day programme management and teaching.

There are several ways to help academics better navigate through QE. Traditional ways may include a dedicated enquiry hotline or mailbox, regular communication or meeting between the academics and the administrative staff responsible to facilitate institutional/programme specific QE. To facilitate academics' self-service, streamline interactions between staff and services, and facilitate the carrying out of designed QA procedures, chatbots can be used. Chatbots are programmes that mimic human conversation using Artificial Intelligence (AI). Chatbots offer instant responses, are

24/7 available and can manage multiple users at the same time. Because chatbots use a predetermined list of inputs while answering inquiries, they also provide consistency in answering questions of the same kind and avoid confusion amongst the academics. In addition to serving as an automated FAQ answering machine, chatbot can empower academics as a knowledgeable and personalised assistant that is always readily available. By having academics interact with chatbots periodically for an extended period for training, they can also improve the retention and application of knowledge and skills pertaining to QE.

(ii) *Motivation and Engagement*

To some academics, quality processes were still mistakenly perceived as burdensome, time-consuming and resource-intensive, mainly serving bureaucratic purposes with little relevance to learning and teaching (Seyfried & Reith, 2019). This belief was often expressed more prominently by staff with a strong academic background as opposed to administrative staff as they often place higher priority to daily teaching and research activities (Newton, 2002; Cardoso et al., 2018). Since QE is indeed embedded in routine learning and teaching activities, motivation and engagement of academics is key in nurturing and driving sustainable efforts.

Researchers previously suggested that academics were more likely to be intrinsically motivated to and engage in QE if they understood the proposes of doing so (Cheng, 2017). Such purposes include meeting the needs of students and employers, not least making the respective institutions more competitive. Most importantly, institutions shall not over-emphasis compliance, which forces academics to concentrate upon satisfying rules of quality evaluation, treating it as a box-ticking exercise at the expense of making real contribution and proactively striving to find new ways to constantly improve. It is therefore important to emphasize the role of QE in day-to-day learning and teaching activities while providing academics with appropriate technological tools and resources so that they are able to devote the time to critical QE activities.

For example, the VTC and some other higher education institutions had used machine learning to monitor students' progress and alert course leaders when an individual was likely to fail the semester so that they could timely intervene and support students (Xu et al., 2017). Online assessment could also free up time for academics to concentrate on student well-being, review and improve pedagogies and enhance students' academic performance with personalised feedbacks and support (Weleschuk et al., 2019). Some institutions are also beginning to use big data techniques to predict student dropout so that academics could help students who were at risk (Sorensen, 2019).

19.7.2 *Intrapersonal Factors*

19.7.2.1 Roles and Responsibility

The participation of different parties in the QE process is indispensable particularly when the roles of teaching staff and students keep evolving in the virtual domain where classes are conducted online. Accelerated by the COVID-19 pandemic, technology is advancing rapidly and increasingly adopted in the education sector which causes the change of the role of teaching staff from a more traditional face-to-face one to a more remote one in a virtual domain supported by technological tools. Students would also need to be technically and psychologically ready for the classes conducted with advancing technologies while collaborating actively with teaching staff. As the key stakeholders, it is preferable that both teaching staff and students could be prepared to reflect and give new ideas and feedback where appropriate to improve teaching and learning. In this regard, it is considered necessary to disseminate a quality culture in the institutions to ensure and enhance the standards in the changing education environment.

Instead of relying on discrete individual effort, each and every academics contribute to ensuring academic standards and QE within a programme team, and across department, faculty and institution. For instance, while some academics may be mainly responsible to ensure there is a regular cycle of feedbacks from student, staff and industry experts, others may engage in QA functions such as course approval, monitoring and review.

To give priority to continuous enhancement, higher education institutions shall therefore not only promote distributed empowerment but also share ownership among academics (Greere, 2022; Greere & Riley, 2014). Feasible ways include orchestration to avoid overlapping roles and responsibilities, and the establishment of a transparent electronic real-time monitoring management system for all academics, and other key stakeholders concerned, to visualise the quality process and respective degree of involvement coupled with an online forum to prompt constructive discussion and reflection. This allows institutions to build capability and exhibit autonomy through defining, designing, developing and monitoring the respective fit-for-purpose internal systems that are most beneficial to students.

19.7.2.2 Sharing of Good Practice Among Programme Teams

Sharing of good practices allows academics across the institution to learn from the successes of others. When regularised, a community of practice can be formed for academics to share experiences, challenges and innovative solutions that can enhance the efficiency and effectiveness of processes while offering mutual support. Sharing of good practices also helps institutions to recognise existing knowledge gaps and malpractice so that better strategies can be developed. Ultimately, it contributes to create and sustain the quality culture without the loss of know-how.

Other than meeting face-to-face, or communicating online on a regular basis, a variety of knowledge sharing platforms can be utilised for academics to share best practices and real cases on QE. Such knowledge sharing platforms allow academics to access the information needed anytime and anywhere, quickly search relevant information, chat with team members or other academics, build trust and teamwork, and create synergy. For example, an IT platform named as ‘Knowledge Collaboration Space’ has been established at the VTC to facilitate the sharing of best practices in various aspects including the VTC’s initiatives and related QE issues which require staff’s awareness, support and participation. Such best practices include planning, development and implementation of new initiatives concerned. With the relevant information uploaded to this ‘Knowledge Collaboration Space’ regularly, staff are kept abreast of its latest development and are more likely to excel at it. It is of paramount importance to keep the platform updated with topics and best practices that are of stakeholders’ interest and needs so as to benefit the teaching and learning.

19.7.2.3 Collegiality Among Academic and Quality Administrative Teams

Effective QE requires a spirit of collegiality that fosters mutual respect and cross-functional collaboration among all staff with an institution. It is considered that collegiality is one of the most important factors in determining the quality of an institution (Shah, 2012). Collegiality consists of shared commitments, decision-making process and a set of attitudes that cause individuals to regard the members of the various academic and the quality administrative teams as responsible for the success of QE. It also allows all members of the institution to participate in QE appropriate to their knowledge and responsibility. Formal and regular communication channels shall therefore be established to bridge links between faculty and administration, facilitate members to work hands in gloves, contribute at their strengths, be sensitive to the concerns of others and avoid acting unilaterally.

In an era of continuous change and improvement, teacher collegiality is necessary to solve the complex education problems of modern times, enhance staff professional growth and organisational effectiveness (Shah, 2012). Ideally, each programme team, which consists of several teachers in an institution, is supported by a dedicated quality administrative team for continuous connectedness and professional collaboration. With digitalised communication, without the needs to travel across different geographic locations (e.g. between campuses), regular meeting among academic and the respective quality administrative team can be conducted easily via a variety of online tools (e.g. Zoom, MS Teams). File sharing applications and real-time co-editing, which can be easily done using cloud technology (e.g. Google Drive and OneDrive), further facilitate communication, streamline review, enhance team collaboration, productivity, knowledge sharing and professional development.

19.7.3 *Institutional Factors*

19.7.3.1 Infrastructure Support

Many education institutions, such as the VTC, have prioritised QE instead of checklist basis single event accreditation exercise that sometimes promotes tactical quick-fixes. This is often coupled with well-articulated long-term plans that align with and strategically support quality expectation of the institutes. For example, in the case of a Sino-Foreign higher education institution, online learning is supported by digital infrastructure including an university website which is regularly updated with the latest information for students and staff, a web conference system named as Big Blue Button for online learning and a software product named as Sonic Foundry's Mediasite for recording live lectures (Perrin & Wang, 2021). In addition to the above-mentioned technologies that can be used at different contexts, institutions can create conducive infrastructure to further shaping and anchoring QE.

With the adoption of more cloud applications, institutions may develop a flexible and secure hybrid cloud architecture with blockchain applications. Hybrid integration represents an array of a la carte services. It can blend in-house resources and a variety of cloud service providers to provide centralised management and make QE processes more integrated. Blockchain application, on the other hand, reduces overhead costs associate with storing academic records whilst streamlines the verification process on students' credentials within member institutions in the form of digital transcript. Another way to facilitate the various processes of QE is the establishment of a common management system, with role-based access, that serves as a one-stop operation hub for students (e.g. academic performance and feedback survey), academics (e.g. predictive analytics on student performance and programme management) and administrators (e.g. quality administration and dissemination of regulations and policies).

19.7.3.2 Bottom-Up Initiatives

QE requires higher education institutions to provide top-down prescriptive direction that defines goals and accountabilities, offers the required resources and drives timely continuous improvements. Though strong leadership is required for initiating a change process towards quality culture, the implementation of quality strategy can only be sustainable through the participation of all organisational members and the cultivation of a quality culture (Gvaramadze, 2008). As such, even when QE is initiated as top-down, successful implementation still relies on collaborative bottom-up engagement and initiatives where academics take ownership, help tackle root causes and provide practical insight into actions needed for improvement.

Engagement and sentiment of academics are the best ways to drive bottom-up quality initiatives. To achieve that, the need for internal bottom-up communication tools is apparent. For example, intranet is widely used by higher education institutions to connect all staff. Leadership blog allows institutes to share top-down messages while stimulating bottom-up feedback directly from staff. Online staff engagement platform can also be used to solicit academics feedback (i.e. via regular survey), crowdsource quality initiatives from the ground up (e.g. in form of a staff suggestion scheme that has long been launched by the VTC), provide responses, recognise staff and track improvement over time. Most importantly, such platform can be integrated with other features mentioned above to create a synergy for successful QE, *inter alia*, defining and visualising individual roles and responsibilities, establishing spaces for collaborative and knowledge sharing, forming community of practices.

19.7.4 Community Factors

19.7.4.1 Stakeholders Engagement

Structured engagement of external stakeholders is required for effective QE. In the context of VPET, among other stakeholders, employers and industries, professional bodies and graduates are of paramount importance. These external stakeholders help continuously enhancing the quality of programmes provided so that work-ready graduates are always nurtured to meet the evolving needs of economies and labour markets (Kwok & Yuen, 2021). Particularly, these external stakeholders often take up formal roles in the QE process such as serving as external examiners and members of an advisory committee/board. In many higher education institutions, relationship with these external stakeholders is often established and maintained by academics as they have the most updated and direct knowledge of the programmes and the associated students. Because of the variety and number of stakeholders involved, and that their involvement in QE is indispensable, academics had expressed challenges in managing these relationships (Alves et al., 2010; Van Buren & Greenwood, 2009).

By importing data from different existing sources, a diversity of client database management systems is now available for institutions to centralise all contact information of external stakeholders and assign proper access rights for instant accessibility. Traditionally and widely used to maintaining customer relationships, the client database management system allows academics to record and track all engagement and commitments of a specific stakeholder, not least preventing the same stakeholders being contacted by different academics or administrative staff on the same QE matter. By including additional modules/features to the client database management system, the client database management system can be modified to an integrated stakeholder engagement system to reduce time required for academics to communicate with external stakeholders. This includes enabling automated interactions such as sending meeting invites and notifications. The integrated stakeholder engagement system can also be enhanced with a compliance module to capture all QE requirements and streamline workflows. For example, it can register all reports that must be submitted by an external examiner, along with the target time frames and specific criteria to minimise risks of non-compliance. Ultimately, this system will help academics to easily collect evidence of QE and demonstrate to the various internal and external stakeholders (including accreditation bodies) that obligations are met within the target time frame.

19.7.4.2 Accreditation Bodies

Though QE emphasizes continuous improvement, accreditation by external authorities/bodies is still indispensable in higher education of many jurisdictions to achieve accountability and safeguard the credibility of qualifications. The accreditation can be a complex and time-consuming exercise involving a number of internal and external stakeholders, a variety of confidential data, records, documentations and evidence.

Recently, a number of scholars pointed out that blockchain can serve as a practical solution to facilitate the programme accreditation process conducted by external agencies (Fedorova & Skobleva, 2020; Sharma & Batth, 2020). Through blockchain, institutions can easily trace data, and share confidential records only with accreditation agencies that have been specifically granted access. Since consensus on data accuracy is required for all blockchain network members and that all information will be recorded permanently, no records can be deleted to safeguard security. In other words, the burden for institutions to prove the completion of certain QA procedures and the need for accreditation body to manually collect and verify evidence can be eliminated.

19.7.5 Public Policy Factor

19.7.5.1 Dissemination of Information and Support Schemes Conducive to QE

To promote QE, some jurisdictions have launched promotion and incentive schemes to support higher education institutions and academics to conduct initiatives, particularly those that enhance the quality of teaching and learning. For example in Hong Kong, the Quality Enhancement Support Scheme is established to support QE projects of self-financing post-secondary sector. The Enhancement and Set-up Grant Scheme is also available for eligible self-financing post-secondary education institutions to develop and enhance higher education programmes that meet market needs. Nevertheless, establishing effective communication links between policy makers and institutions/academics to make visibility of these information so that institutions/academics can increase the chance of getting funding can be complex.

Currently, dissemination of such information and promotion efforts relies on organisation of briefing sessions, publishing on official website and electronic direct mail marketing, which are mainly one-way communication. The use of Web 2.0 technologies, such as social media and academic social networking sites, shall allow policy makers to enhance online dissemination, enable interdisciplinary and interinstitutional collaboration. Omnichannel marketing with the use of digital video production and social media stories shall also be considered to republish existing content and drive higher engagement in initiating new QE initiatives.

19.8 Conclusion

In spite of the paramount focuses on academics and teaching staff, it is much more likely for QE to be effective and sustainable when being prioritised at all levels of the higher education institutions involving both internal and external stakeholders. Guided by a theoretical framework, this article novelly suggests how the use of innovative technologies, in view of their increasing importance in the digitalisation era, can be expanded to facilitate academics' participation in QE given specific contexts and needs. To meet the needs of academics, decision-makers who are vital in the shaping of institutional quality culture should be sensitive to their characteristics, not least the needs of students, while systematically plan for and focus on holistic use of advanced technologies and their integration to continuously enhance the quality of teaching and learning. It is necessary to strategically act across multiple levels of the model at the same time for sustaining QE efforts over time and achieve institutional-level impact.

How technology has been used and its effectiveness will determine how effective academic performance is, and how it is perceived by academics, teaching staff, students and other stakeholders (Perrin & Wang, 2021). Therefore, for future research, the actual effectiveness of the digital tools mentioned in this article shall be empirically evaluated given they are comparatively new in the existing QA field. For instance, the collection of large-scale longitudinal data may be useful for a comprehensive evaluation on the use of new technologies to facilitate academics' participation. Nonetheless, academics and teaching staff shall as well exploit new technological tools to improve higher education and be reflective of their evolving roles in the enhancement of quality in the era of technological change.

Due to the highly transferable principles of driving QE, the strategies derived from this article can be equally valid in and scaled for other education settings. Nonetheless, both the guiding principles and the corresponding strategies promoting QE will need to be reviewed constantly to ensure that they are responsive to stakeholders' needs as well as changes that may arise under foreseeable or even unforeseeable circumstances. When institutions carefully, effectively and appropriately use technologies, the work of academics and teaching staff will be enhanced, thereby improving the quality of education and enabling learners to thrive.

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