Bridging Human and Machine:
Future Education with Intelligence

Shengquan Yu
Mohamed Ally
Avgoustos Tsinakos *Editors*

Emerging Technologies and Pedagogies in the Curriculum

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Foreword

This book is a set of interesting chapters, covering a wide range of topics because emerging technologies lead to emerging pedagogies, and there are so many emerging technologies these days. But all the articles reflect on the potential changes in curriculum—how learners and teachers interact with each other for a specific period of time.

I feel that to understand the implications of these articles better, it may be helpful if I relate them to my past research experience. I started my research journey in the mid-eighties. Now, I found that, when talking about the future, the future comes from what we researchers did in the past and what we are doing now. In particular, from my research as well as others', I notice that our area has evolved three orientations (Chan 2010).

The first orientation is called *dream-oriented research*, which explores the potential implications of some emerging technologies. When I did my Ph.D. in the USA, inspired by machine learning research at that time, my thesis was to simulate a virtual learning companion that could 'learn' together with the human learner under the supervision of a virtual teacher (Chan and Baskin 1988). Like intelligent tutor, this was a 'dream' of artificial intelligence in education at that time because the computing power and the overall digital environment were not mature enough to realize such dreams at that time. But, as time goes by, technologies mature and applications spread, dreams are being realized.

Some chapters in this book describe how the emerging technologies may transform the current pedagogies. These technologies include machine intelligence, holograph, virtual reality, mobile device, mechatronics, and others. These transformations happen not only in classroom settings, but also in online learning and outdoor environments; not only for self-directed or collaborative learning, but also for learning with different styles; not only for children, but also for university students and adults. Taking into consideration of the adoption of Internet of things (context-awareness) and ubiquitous learning analytics, we can foresee the formation of an intelligent seamless learning environment, depicting a picture of future scenarios of life-wide and lifelong learning.

The second orientation is *adoption-oriented research*, which intends to exert impact of our research work by spreading it out in the real world and searching for best practices. When I became a faculty member in a university in Taiwan after receiving my Ph.D. degree in 1989, my first project was to develop a networked learning system (Chan et al. 1992). Very few people knew the implication of network technology to education at that time. The system that was designed was probably the first dedicated system developed for network learning in the world, enabling students to interact in real time to support collaborative learning and competitive learning games. Thus, it was a dream-oriented research. Continuing this network learning research, in 2000, we built a large network learning community, called EduCity. One of the sub-systems in EduCity is called School-For-All. Everyone who wanted to teach could start an online course in School-For-All. With hundreds of courses offered by people from all walks of life, School-For-All was an early form of MOOCs. Nevertheless, I regard EduCity as an example of adoption-oriented research because the prevalent influence of the Internet had begun in the early 2000s.

Possibly taking hold of the global classroom, the impact of MOOCs is huge, driving the change of education at all age levels. A number of chapters in this book talk about MOOCs, indicating there are still many rooms for improvement in order to search for the best practice and advance forward. In particular, being able to collect large learner data, MOOCs will try to support adaptive learning through learning analytics. Also, as reflected in some chapters, strategies developed in flipped classroom, small-scale online learning, and blended learning are in line with adoption-oriented research, a rich research area in the forthcoming years.

Another avenue of adoption-oriented research is to rethink the architecture of how to design and develop curriculum by adopting emerging technologies. The chapter on learning cells shows that neural network, visualization tools, semantic knowledge graph, cognitive map, as well as technologies for news generation, image generation, and video generation will provide enormous potentials.

The third orientation is *humanity-oriented research*, which intends to develop learners' interest in learning, maximize every learner's capacity, and cultivate wellbeing of the globe as learners' value. We had a story in this orientation of research. In 2009, our team conducted a one-year-long experiment supported by one-to-one technology in a school. The students performed so well that we could not find satisfactory explanation. At least, we noticed that there was a big difference between our approach (interest-driven) and the school teachers' approach (examination-driven). This phenomenon is not limited to Taiwan: across Asia, education is considerably examination-driven. To change Asian education, I worked with a group of Asian researchers for ten years to develop a learning design theory, called interest-driven creator theory (Chan et al. 2018). The theory hypothesizes that, with the support of technology, learning activities can be designed as interest-driven creation processes of ideas or artifacts. Forming habits by repeating these processes as daily routines, learners will excel in learning performance, develop twenty-first-century skills, and enjoy their learning. Ultimately, they will become lifelong interest-driven creators.

Now, for this book, there are a few chapters addressing the development of twenty-first-century skills, such as communication, collaboration, critical thinking, creativity, and so forth. It is true that acquiring knowledge was the primary aim to go to school in the old days. But this is not sufficient. Today, learning should go beyond knowledge acquisition, and learners need to develop twenty-first-century skills while acquiring knowledge, or vice versa. For this to happen, new pedagogies, with the support of technology, are needed. Taking one step further, learners need to develop their personal interest (similar to hobby) of what they intend to learn, whether it is language arts, mathematics, science, and other subjects or topics.

To summarize, we used to be concerned about *what* learners learn, we now are also concerned *how* they learn and *why* they learn; we used to ask *do* they learn, we now also ask *can* they learn and *will* they learn. However, for me, the first concern is *why* they learn, and the first question to ask is *will* they learn.

Along this line, there is a chapter discussing heutagogy, a form of self-determined learning. Instead of doing what teachers assign, learners are encouraged to explore areas of their interest and choose what they want to study or find their own problems to solve. Teachers' job is to provide a safe and supportive environment for their exploration and create opportunities for them.

To retrospect, in the mid-eighties, I did my dream-oriented research for my Ph.D. work. I used a special computer for developing artificial intelligence programs that cost 50,000 USD. Now, almost every learner has one or more computing devices. In the nineties, I participated and witnessed the emergence of adoption-oriented research, which is now flourishing. Currently, humanity-oriented research is still in its infancy. Bringing the potential of enormous impact to human future life and bearing the name of an *emerging technology*, artificial intelligence is coming back strongly to our territory of research (there will be many researches on robotic learning companions together with their virtual online surrogates, for example). In future, we shall see how the three orientations of research co-evolve and change education, rapidly and effectively. I hope that, with a view of these three orientations in mind, our readers will find the chapters in this book even more stimulating and fruitful!

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Contents

Part I
Theoretical Foundations

Chapter 1
Next-Generation Digital Curricula for Future Teaching and Learning

David Parsons, Kathryn MacCallum, Lynley Schofield, Anna Johnstone and Sarah-Kay Coulter

Abstract Changes to contemporary curricula are increasingly driven by the evolution of technology. The spread of personal digital devices and pervasive communication infrastructure has led to significant changes in global society. These changes have highlighted the need for schools to ensure that all students are prepared for the contemporary digital world. The need to provide digital skills for all students means that digital technology can no longer be taught only as a specialist subject area but rather needs to be embedded in all subjects across the curriculum. This recognition of the importance of digital skills for all has meant that many countries have developed new curriculum areas focused on developing these skills. However, for many educators, there is still a disconnect between the technical skills that curricula often prescribe and the practical strategies needed to integrate these skills into their broader classroom activities. This chapter explores how a number of countries have approached the integration of digital skills into the curriculum and the commonalities between these diverse approaches. A number of examples are given of how certain technologies have provided opportunities for embedding digital skills across the curriculum. From these examples, we identify some complementary dimensions that can help us to design future curricula for the digital age.

Keywords Digital technologies · Curriculum · STEM · Authenticity · Mechatronics

The question of how to best integrate technology into teaching and learning has long been a concern of educators worldwide and, as technological change has intensified and digital tools have penetrated every part of society, this question has become ever more pressing. Digital curricula that consider computing a discrete subject are well-established. For example, the ACM has published computing curricula since 1968,

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with a subsequent increase in regularity and scope (Goldweber et al. 1997). However, the use of digital technologies in society is not discrete but is embedded in all aspects of work and life. It cannot be isolated from education and, more importantly, cannot be taught only to the select few. Rather, curricula that address digital skills and competencies increasingly need to be provided for every student, across the curriculum; an approach that has sometimes been called the 'entitlement curriculum' (Unwin and Yandell 2016). Thus, worldwide, there is a growing sense that use of digital technologies is a foundational competency like mathematical and language skills and therefore has the same pervasive role across the curriculum.

This chapter describes how the role of digital technologies in curricula is changing worldwide and explores how this change has impacted teaching and learning in schools by providing a series of illustrative examples that represent the cross-curricular integration of various digital technologies. From these examples, we extract some important dimensions that we believe can help to inform the development and implementation of digital technology use within the curriculum.

1.1 International Curricula and Digital Technologies

School curricula are an essential part of national or regional education systems, and many nations are reflecting on and developing their curricula in the context of addressing the increasing importance of digital technologies in society. In this section, using some indicative examples, we briefly outline how curricula in various nations have been responding to rapid global technological changes.

1.1.1 Australasia

Australia and New Zealand have both recently added specific content to their national curricula around digital technologies. From 2017, all Australian schools were required to implement the Australian Curriculum Digital Technologies, where all students to 12 years of age are taught Design and Technologies and Digital Technologies. Similarly, from the beginning of 2020, all New Zealand schools will implement changes for all students, with two new technological areas introduced to the existing curriculum—(1) Computational thinking for digital technologies, and (2) Designing and developing digital outcomes. These changes are based on the aim to grow 'digitally capable individuals' and learners being 'innovative creators of digital solutions', not just 'users and consumers of digital technologies' (Ministry of Education, n.d.). The curricula for both countries highlights a focus on providing opportunities for learners to use digital technologies with critical and creative thinking to solve authentic real-world problems. They also both acknowledge the need for a dynamic and responsive approach to technologies and developments over time.

1.1.2 China

Among the many goals of the eighth wave of reform in the Chinese curriculum in 2011 was to 'strengthen the relevance of curricula to students' lives, society, and the development of science and technology' (Yin 2013, p. 332). The overall strategy became more flexible and devolved, with a curriculum model across the three levels of nation, region and school (OECD 2016). In China, use of digital technologies has progressed at a very rapid rate, even more so than in other parts of the world (Chu 2008). As a result of this rapid growth in technology use, many of China's teenagers may now be digital natives, but they are not necessarily digitally competent. The need for ICT in the curriculum was acknowledged by several Chinese Ministry of Education publications in the early 2000s, but further curriculum development is required in the area of digital culture (Li and Ranieri 2010). A national development plan for ICT in education up to 2020 was issued in 2012 (Wu 2014) and the current five-year plan for education aims for in-depth integration between ICT and education (NCEDR 2017).

1.1.3 England

The English National Curriculum for primary schools was revised in 2014. This new curriculum replaced the previous curriculum, launched in 2000, removing the previous ICT subject area and replacing it with a stronger focus on computing (UK Department for Education (DFE) 2013). With this new emphasis, the curriculum now focuses on the principles and concepts of computer science, alongside digital literacy and IT (The Royal Society 2017). This has meant that computing is now to be taught in schools from the ages of 5 to 16, with the focus on more application and development of tools, compared to focusing on just using them. The curriculum was developed for the recognised need for computational thinking and creativity to support learners in an increasingly changing world.

1.1.4 Kenya

The Digital Learning Programme introduced in 2016 included digital devices being delivered to every primary school by the end of that year. All tablets were delivered with preloaded learning material for Maths, English, Science and Kiswahili, with ICT integrated into the existing education curriculum as a teaching and learning tool. To support this initiative ICT skills were introduced in all schools and professional development opportunities provided for primary teachers. The programme was accompanied by a strengthening of the country's internet and electricity infrastructures (Ministry of Information Communication & Technology, n.d.). The 2017

Jubilee Manifesto committed to transforming education and made ICT skills and digital literacy a priority in both primary and secondary education. The Kenyan government's current 'Vision 2030' is aimed at making Kenya a knowledge-based economy and stresses the need to prepare learners for the twenty-first century skills needed to compete globally, which includes an emphasis on the use of digital devices and digital literacy across all schools (The National Treasury, n.d.).

1.1.5 United States

There is no national curriculum in the United States, so each state decides its own. The U.S. Department of Education first released a National Education Technology Plan in 1996. This was updated every five years. In 2016 it was retitled as: Future Ready Learning: Reimagining the Role of Technology in Education (Office of Educational Technology, n.d.). In 2017, under the growing recognition that technology is changing too quickly to leave it for a five-year period, it was decided that there would be annual updates. This document outlines the vision for the use of technology in education across the U.S. and envisages equitable, ubiquitous, collaborative use of technology, moving away from passive towards active use. Twenty-first-century competencies and both cognitive and non-cognitive competencies are emphasised. Equitable access and the digital use divide are highlighted as challenges that need to be overcome. One of the key recommendations in the document is to increase the digital literacy of pre-service and in-service educators.

1.2 The Scope of Digital Technologies Curricula

As seen above, many countries have seen the growing need to redevelop and reshape how ICT and related technologies are taught in the curriculum in response to rapid technological change, particularly in China where the spread of technology in society has been exceptionally fast. Developing countries also face problems of catching up with the infrastructures and digital tools of the developed world, as the Kenyan experience makes clear. Although contexts and approaches vary, each has recognised the need for digital technologies to be embedded as a fundamental part of the curriculum.

A common theme in many new curriculum developments has been a focus on teaching digital technologies outside of the traditional ICT or computing subject areas, and to embed them across the curriculum. The Kenyan, New Zealand and English curricula, for example, have focused on including digital skills earlier in the schooling curriculum and ensuring that all students develop a good level of digital fluency. The focus is now on how the teaching of digital technologies can move beyond just teaching students about technologies to integrating technology across subject boundaries to enhance learning.

Within the English, Australasian and U.S. curricula there is a strong focus on designing creative solutions supported by the selection and use of appropriate digital tools. The role of creativity in this context is not only for design inputs focused on developing technical solutions but could equally be applied to wider aspects of digital technologies used for creative purposes.

In addition, in many of the new curriculum policies (such as in England and the U.S.) there has been a stronger focus on what we might call ‘hard’ technologies (e.g. electronics, coding, robotics, etc.). However, the ability for these technologies to be used in a cross-curricular manner is less straightforward than the use of end-user software tools and applications that might be called ‘soft’ technologies. The challenge is how we can use these hard technologies across the full spectrum of learning.

Curriculum policy in Kenya and U.S. explicitly recognises the need to upskill teachers to deliver these digital curricula. The significant shift in how computing is seen and taught throughout the curriculum and at earlier stages of students’ schooling career has meant that teachers need support to both develop their own digital skills and also to understand ways in which these technologies can be embedded in different subjects.

It is clear from these brief summaries that countries across the world are seeking to integrate digital technologies into the broader curriculum. However, the intent to do this needs to be matched by realistic ways of making it happen in the classroom. One way of approaching this is to look at some illustrative examples, as outlined in the next section.

1.3 Cross-Curricular Examples

In this section, we provide a series of illustrative examples exploring how digital technologies have been integrated across the curriculum in different ways. The most direct application for these in a cross curricular manner has been in STEM (Science, Technology, Engineering and Mathematics) education. However, the increasing focus on STEAM (Science, Technology, Engineering, Art and Mathematics) education, an approach that crosses the art/science boundary and focuses on problem-solving, has meant that a wider range of skills can be drawn on from across a range of subjects (Quigley and Herro 2016). The challenge for educators is to successfully integrate technology into subjects that go beyond even STEAM into the broader curriculum. The examples included here move from soft to hard technologies; digital storytelling, coding, makerspaces, electronics and robotics. In each example, we seek to generalise the key messages about how to effectively use digital technologies across the curriculum.

1.3.1 Digital Storytelling

One of humankind's oldest activities is storytelling and in recent years the traditional art has evolved with the advancement of digital technologies. Digital Storytelling has seen rapid adoption by educators and is a powerful opportunity for authentic student learning (Lowenthal 2009; Robin 2016). Voice, still images, video, text and the use of internet technologies can be used when developing a digital story, and there are extensive developmentally appropriate tools available for creation. Typically, digital stories are narratives and imagery shared through technology. In the past, the reading, writing and sharing of printed stories were seen as critical to literacy development. Digital stories can move beyond static, one dimensional, singular viewpoints toward engaging, personalised learning opportunities which are relevant for the students of today (Ohler 2013). There are widely documented benefits to digital storytelling—learners can consider the narratives by which they live and produce artefacts that are relevant and meaningful to them and their community (Barrett 2016; Motteram 2013).

Otto (2018) provides a pioneering example that explores digital storytelling in a collaborative, interdisciplinary way that promotes virtual mobility and intercultural understanding. The students within this example came from two distance learning universities in Germany and Tunisia. Digital storytelling was used as a means to collaborate across cultures and understand the problem of climate change from their perspectives. The three-month course was designed in a way to facilitate collaborative practice, whereby learners initially met face-to-face in a workshop, then the rest of the learning was facilitated in an online environment. The intended learning outcome was for the students to create a digital story which wove together their personal narratives to explain lived experiences of climate change. The study found that by working across cultures on digital stories the students developed a range of skills and competences. For example, technological competence was developed throughout the learning task (using digital tools to compose a story) and students were provided with an opportunity to demonstrate problem-solving and research capabilities. Similarly, it was found that as learners came together to share their unique perspectives, interdisciplinary competencies were developed. Digital storytelling is an authentic, relevant and meaningful learning experience that effectively integrates multiple soft digital technologies into cross-curricular learning.

1.3.2 Coding

Coding uses end-user software tools but can also be used to program 'hard' digital technologies such as electronics and robotics, so provides a bridge from one to the other. Learning to code has been widely recognised as a way to support problem-solving and computational thinking. Since computers were first introduced in schools in the 1970s there has been a push to teach coding. In the 1970s and 80s the Logo programming language was taught to millions of students, but the rise of personal computers and software packages changed the emphasis of curricula to using programs rather than creating them (Resnick et al. 2007). However, interest in coding in schools has been revived in recent years by block-based visual languages such as MIT's Scratch, a commonly used application that makes coding accessible to a wider range of learners and teachers. Scratch was initially designed for users from 8 to 16 years, although it is used more widely than that demographic and is currently available in more than 40 languages in over 150 countries. Scratch enables learners to create, design and invent new ways of applying their learning through the use of technology. Users are easily able to share this learning with others through public repositories.

Considerable research has focused on how to best support teachers working with coding applications like Scratch to gain the knowledge and confidence to use technology to support the learning with a constructionist approach (Brennan 2015). Generally coding and programmes like Scratch have been shown to improve mathematical thinking and problem-solving, but literacy can also be supported through coding (Hutchison et al. 2016). Bell and Bell (2018) provide several vignettes that explore the integration of music education and computational thinking. They posit that whilst on the surface these subjects seem dissimilar they do in fact have many similarities—creativity, teamwork, communication and working with notation. Both involve constructing something intended for an audience within genuine contexts. They argue that this cross-curricular approach allows collaboration between teachers from different disciplines with different passions and expertise. In general, the accessibility of visual, block-based programming tools such as Scratch has revived interest in using coding to teach across the curriculum.

1.3.3 Makerspaces

Makerspaces are collaborative workspaces that provide practical hands-on opportunities usually within a STEM/STEAM environment to work with new technologies and innovative processes to design and build projects. Such specifically designed areas are becoming increasingly common within schools (Gilbert 2017). While makerspaces provide a rich opportunity for students to be immersed in STEM project areas, there is also much potential for broader types of learning to be integrated into these creative and future-focused spaces.

Developing the storytelling idea, Bull et al. (2017) assert that joining storytelling and making together offers a natural opportunity to integrate technologies with multiliteracies and humanities subject areas within the makerspace context—a learning activity they term storymaking. While their study is small in scale, it does serve as a useful pilot for how school makerspaces can be used as settings to enable learners to integrate digital technologies in a cross-curricular manner; in this case, linking literacy with computer science and engineering. Primary age students used Scratch (introduced in the coding section above), to create animatronic dioramas. Dioramas have been a traditional strategy in school literacy programmes to enable learners to act out storytelling and play through the use of human manipulated figures or puppets. The construction of animatronic diorama incorporating the use of coding gives us insights into ways that digital technologies can be used as enablers for cross-curricular learning. The linking together of hardware and software in makerspaces to construct artefacts provides a useful model for using digital technologies across the curriculum, and may integrate electronics and robotics, outlined in the following sections.

1.3.4 Electronics

A number of different types of electronic devices have been employed to teach multiple subject areas. They range from simple microprocessor circuit boards like Makey Makey, through more complex boards like the Arduino and the micro:bit, to simple computers such as the Raspberry Pi. The relevance for real-world learning in the use of these devices comes from the prevalence of electronics in the world around us, and the increasing ubiquity of the Internet of Things. By learning about electronics, students are gaining an insight into the world around them.

Using electronics in a cross-curricular way generally requires them to be linked to other devices. This frequently means connecting them to a separate computer or perhaps connecting to additional peripherals like adding sensors that are not part of the original board or allowing a number of these devices to communicate wirelessly with each other. Further, cross-curricular electronics often means embedding an electronic device into another artifact such as a 3D printed object or a fabric garment.

A very relevant case for considering the role of cross-curricular electronics is the micro:bit, which was distributed to around 800,000 UK school children in 2016. A specific curriculum was not provided, so ways of using it were developed by a range of educators. In terms of cross-curricular use, electronics learning activities in subjects beyond STEM include embedding micro:bits into textiles to create wearables and using the accelerometer in P.E. to measure acceleration in running (Sentance et al. 2017). One social science activity from the UK included exploring the future of cities by integrating micro:bits into a simulation of driverless car management (Lavicza et al. 2018). On a broader scale, the micro:bit Global Challenge 2018 asked children aged 8–12 to address one of the 17 Sustainable Development Goals using the micro:bit. (Gabriel et al. 2018). The winners leveraged various sensors in electronics to build systems that supported personal wellbeing and environmental protection.

The most important aspect of integrating electronics into different areas of the curriculum is the ability to create an intelligent artifact that can enhance understanding of that field. Building an electronic instrument from multiple materials in music, creating interactive installations in art or building custom sensors for biological field study all enable students to develop skills and competencies that could not be developed similarly using alternative learning materials.

Electronics is certainly a hard technology in the definition we are using in this chapter and, as with other hard technologies, we have to consider whether their use in the curriculum is appropriate across multiple subjects. Looking at the examples we have highlighted we can see that the unique affordance of electronics is that they allow technology to connect out into the real world, enabling students to create artefacts that physically interact with learning contexts.

1.3.5 Robotics

Like electronic devices, the use of educational robots within the classroom has dramatically increased. This popularity has largely been driven by the affordance of robots to be constructed and developed by students themselves (Alimisis 2013). Robotics falls under the area of 'mechatronics', which combines mechanics and electronics as a way to enable students to construct their own products (robots) that enable hands-on learning. This hands-on interaction and building of artefacts draws together the principles of constructivism and constructionism so learners develop their own learning through construction (Socratous and Ioannou 2018).

According to Eguchi (2010), the use of robots in education has primarily been applied in three ways;

- Theme-Based Curriculum Approach: robots are used to facilitate the exploration of special topics typically focusing on a specific subject, such as mathematics or engineering. The learning activity is focused on students learning through inquiry and communication captured in the application and design of robots.
- Project-Based Approach: learning is focused on groups of students working together on authentic learning experiences explored through the development and experimentation of the robots. These projects are more likely focused on the integration and application of a range of subjects with cross-curriculum application.
- Goal-Oriented Approach: the applications of robots are typically used as extracurricular tournaments or competitions, where children compete in challenges held between schools, these include tournaments like RoboCup and other tournaments such as the FIRST Lego League.

In general, robotics has been typically integrated within the teaching of traditional STEM subjects. Most examples of robots in education have focused on the application of these robots for problem-solving, construction, programming and debugging designs (Alimisis 2013) within the teaching of science, engineering, technology, mathematics, and computer programming (e.g. Menegatti and Moro 2010; Goldman et al. 2004; Veselovská and Mayerová 2015). The application of robots to facilitate the teaching of these subjects has shown that it fosters high student motivation and develops learning skills such as problem-solving, collaboration, scientific inquiry and critical thinking (Socratous and Ioannou 2018).

Like electronics, robotics can be considered a hard technology from a learning perspective. However, its application within the broader context of STEAM education or integrated across the curriculum offers significant promise. Typically, the major link within STEAM has been largely focused on the application of creative problem-solving (Kim and Kim 2018). There is also a growing focus on how robotics can be used more widely, such as for the development of artwork (Kim and Kim 2018) or through artistic expression and brainstorming (Yoon and Baek 2018).

1.4 Analysis

From our initial discussion, and from the examples that we have presented, we believe that there are a number of complementary dimensions that can be considered in terms of how digital aspects can or should be integrated across the curriculum. The first is digital technology integration into the curriculum, the understanding that curricula need to consider the technology both as a discrete subject and as an integrated skill set. We see a range of applications here from technology as a subject area, through technology supporting STEM subjects, technology supporting STEAM subjects and technology integrated across the whole curriculum. From our discussion of international curricula, we have seen how this is a common focus.

Closely linked with integration is embedding digital technology in the curriculum. This relates to how broadly digital activities are integrated within and between subject areas. We have outlined a dimension that goes from technology used for a stand-alone activity within a subject, through technology used across activities in a single subject, and on to problem-based learning as a way of integrating technology-based activities across multiple subject areas. Incorporating technology successfully across the curriculum has been rare (Brush and Saye 2017). Project-Based and Problem-Based Learning (PBL) are seen as ways to authentically integrate digital technology more widely and naturally across the curriculum with the technology supporting the learning (Brennan 2015). Developed from the broader framework of constructivism, PBL provides authentic learning experiences where learners are able to build their own understandings in meaningful contexts. While it is recognised that problem- or project-based learning can be done meaningfully without the use of technology, PBL approaches provide genuine platforms to integrate technology authentically within the curriculum (Brush and Saye 2017). Many of the examples of practice described in the previous sections have links to PBL, and it may be that PBL provides an overarching concept that can be used to help embed a range of digital technologies across the curriculum.

The next dimension in our analysis is the placing of digital technology in the curriculum. This relates to whether technology use is driven by leveraging digital tools for new purposes, a 'technology-out' approach, or from a perspective of integrating digital tools into pre-existing curricular frames, a 'subject-in' approach. The 'technology-out' approach is based on ideas that technologies have intrinsic characteristics that render them relevant to disparate fields of study (Goldweber et al. 1997

p. 8). While these natural links may be asserted, it is often harder to make convincing cases for how, for example, coding, electronics and robotics provide support for learning areas beyond the purely technical. Similarly, the 'subject-in' approach may enable students to use a range of software tools that already exist to create other artefacts that relate to their learning across subjects, but may not allow full use of the potential of digital technology, because the curricular frame is substitutional—digital tools being used to do the same things as before in a slightly different, but non-transformational, way. In either approach, it is important to acknowledge that learners today should be able to utilise digital tools as designers and builders, not just as end-users. In our dimension we have suggested that an 'integration space' (such as a makerspace or a problem-based project) may help to address the potential drawbacks of both of these approaches.

The next dimension is the nature of digital technologies in the curriculum. As we have discussed, not all technologies are alike, and hard technologies (e.g. mechatronics) are qualitatively different from soft technologies (such as web-based applications). Integrating them in authentic ways across the curriculum is a greater challenge than the use of end-user software applications. A danger with hard technologies is that they may lend themselves to a technocentric approach, where the learning is focused only on how to use the tool. Papert argued against technocentrism in the mid-1980s and warned that conversations should not start and end with the technology or tools but on the learning itself (Brennan 2015; Emihovich 1990). It is important that the technology is pedagogically grounded and engages the learner in meaningful learning experiences instead of the technology being the focus (Bhattacharyya and Bhattacharya 2009). Teachers are more likely to effectively integrate technology when the focus is teaching with technology and using new approaches to traditional teaching practices rather than focusing on technology skills (Kopcha 2010). Coding may be seen as a bridge between hard and soft technologies, in that coding tools are applications, but are needed to make hard technologies perform useful tasks.

The final dimension is that of authenticity. Kafai and Burke (2014) explain authenticity as comprising of four parts. The first being how the learning in the classroom relates to how professionals use it in the real world. These authentic learning experiences should mimic how professionals would themselves be using the tools. So rather than sitting in a classroom learning abstract disciplines, they should be putting into practice real applications. The second is personal authenticity and how it relates to the learners' own lives and what they are interested in, and what is meaningful to them. The third is the need for authentic audiences, which reinforces the need for relevance, and experiences that are meaningful to each other, not just the teacher, and the fourth is designing for real-world audiences which enables genuine feedback and grounds the learning in real-world contexts. However, education is not only about preparing students for a current work context, but it is also about preparing them for the world to come. Authenticity here is harder to achieve but acknowledges that things that are unusual or challenging now may well be the norm in the near future. Our authenticity dimension, therefore, includes the future work context. Figure 1.1 summarises these dimensions of integrating digital technologies across the curriculum.

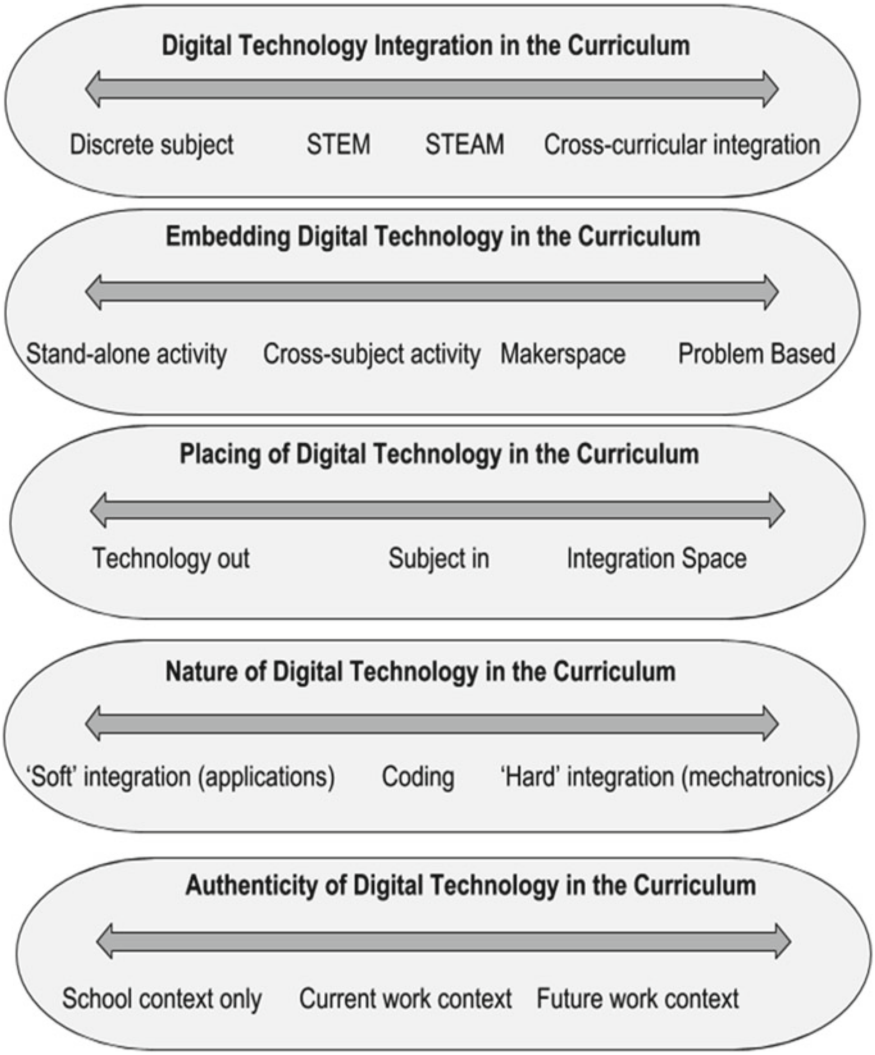

Fig. 1.1 Dimensions of integrating digital technologies across the curriculum

1.5 Summary and Future Work

In this chapter, we have highlighted the current trends towards school curricula including digital technologies, not just as a discrete subject area but as a cross-curricular skill set that is seen as essential for all students. To explore how digital technologies can effectively be used across the curriculum, we have provided some examples from various contexts that illustrate good practice and may help to inform educators who wish to contribute to or implement, curricula in the digital technologies area. We have provided an analysis that summarises some key dimensions that we believe are important considerations when using digital technologies across the curriculum. We believe that these dimensions can be useful in both developing future curricula and providing teaching and learning experiences within existing curricula. This chapter provides an initial proposal for ways that we can usefully categorise aspects of learning in digital curricula, considering how technology is integrated into the curriculum, how it is embedded into other subject areas, how technology is placed in the curriculum, the nature of technologies that may be used, and the authenticity of learning with those technologies. Further work is needed to apply these concepts to real-world contexts and promote best practice in developing digital skills in all students.

Glossary of Terms

Curricula/curriculum a set of learning goals as seen from the educator's perspective.

Cross-Curricular involving curricula in more than one educational subject.

Constructivism a learning approach where learners actively construct their own representations of the world, linking new information to prior knowledge, often in a collaborative manner.

Digital Storytelling narratives and imagery shared through technology.

Digital Technologies in an educational context, the use of Information and Communication Technologies (ICT) by both students and teachers to improve learning.

Diorama a model representing a scene with three-dimensional figures used in education to encourage learners to creatively express their learning.

Entitlement Curriculum a curriculum that all students are entitled to, in contrast to a specialist curriculum that students opt into.

Hard Technologies technologies that are hardware-based, such as electronics and robotics.

Makerspace a collaborative space used to support students' making, learning, exploring and sharing of products utilising technology and other materials such as textiles.

Makey Makey an electronic invention tool and toy that allows users to connect everyday objects to computer programs. This function allows the Makey Makey to work with any computer program or webpage that accepts keyboard or mouse click inputs. The Makey Makey was produced by research done at MIT Media Lab's Lifelong Kindergarten.

Mechatronics the application of mechanics and electronics in the design and construction of products, such as robotics.

Micro:bit The micro:bit was part of the BBC's UK-wide 2015 'Make it Digital' initiative which focused on supporting creative integration of digital technologies into the UK curriculum. The micro-bit is a pocket-sized programmable microcontroller with integrated display, buttons, sensors, and Bluetooth.

PBL Project Based Learning and Problem-Based Learning (PBL) are seen as ways to authentically integrate digital technology where learning is supported by active exploration of real-world challenges and problems.

Soft Technologies technologies that are software based such as web apps and mobile apps.

STEM an approach to learning based on the idea of educating students in four specific disciplines—science, technology, engineering and mathematics—in an interdisciplinary and applied approach.

STEAM an approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics to guide student inquiry, dialogue and critical thinking.

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Chapter 2
Designing for Context-Aware and Contextualized Learning

Christian Glahn and Marion R. Gruber

Abstract Contextualized and context-aware learning refer to active and passive approaches of utilizing contexts in educational designs. Both are at the core of many mobile learning solutions. For scaling mobile learning in educational institutions, it is important to understand that mobile learning is neither an independent nor a stand-alone educational approach, but part of a rich repertoire of tools and practices that shape complex learning processes and are embedded in increasingly smart environments. Moreover, mobile learning combines solutions for a range of different educational interventions. Educators have to choose and integrate each solution into their educational concepts in order to utilize the ubiquitously available technologies for leveraging on the learners' contexts. This requires a better conceptual understanding on the role and function of context in educational design. Seamless learning addresses this understanding by generalizing contextual influences on learning processes beyond mobile learning, which is lacking in conventional educational design models. However, seamless learning is not an educational design model that educators can use directly for deducing design principles. Seamless learning is rather a concept that best understood in relation to integrated approaches of context-awareness and contextualization that contrast of existing educational design models. Because much research on mobile learning focuses on the active role of contexts, the question comes into mind, whether context is always an explicit design element? This chapter addresses this question in two parts. First, by operationalizing the concept of seamless learning for planning and orchestrating contextual and context-aware mobile learning. Secondly by analyzing potential contextual affordances of a mobile app with minimized contextual dependencies.

Keywords Activity theory · Blended learning · Context · Contextualization · Context-awareness · Educational design · Learning design · Mobile learning · Mobile apps · Seamless learning

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2.1 Introduction

Digital natives (Prensky 2001) expect unconstrained access to information and knowledge in all parts of their lives. Mobile technologies play an important role to satisfy such expectations. These technologies are omnipresent in daily life and expand their users' abilities, open and connect different contexts, and create new perspectives. From the viewpoint of designing educational technologies, mobile learning is particularly challenging because it is often unclear how the new technologies influence and change learning processes and experiences (Traxler 2007; Sharples et al. 2009).

One barrier for mobile learning is that it challenges the educational design repertoire of educators and instructional designers. This creates uncertainties among educational practitioners because learning experiences are often designed in ways that do not integrate well new functions of mobile technologies: Mobile learning breaks the dichotomy of analog and digital learning experiences that is underpinning concepts such as blended learning (Rovai and Jordan 2004; Garrison and Vaughan 2008). Newer developments such as ubiquitous learning (Hwang et al. 2015) and seamless learning (Wong and Looi 2011) address this limitation and emphasize the capability of networked mobile technologies to bridge between learning settings and contexts. These developments include technological support for in-class and out-of-class experiences (So et al. 2015) that go beyond the conventional separation of non-technologically-enhanced face-to-face and technologically-enhanced self-study experiences. Such approaches depend on tools that rely on new forms of human-computer interactions as well as mediated interactions between humans.

Our journey started with promoting mobile technologies into existing higher education courses (Glahn et al. 2015). Lecturers found it hard to integrate mobile modes into their educational approaches. This was not due to the technological novelty, but because in their perception the new technology targets learning practices and settings that were already well supported by other technologies. In the course of more fundamental educational transformation projects, we found similar perceptions hindering the adoption of new pedagogical approaches, such as video lectures for the inverted classroom (Lage et al. 2000). The perceived invariability of educational modes and sequences as well as the apparent lack of contextual factors in educational designs appeared as a common theme in these developments. Consequently, we recognized seamless learning as an educational design concept for planning and orchestrating contextual and context-aware learning. This operationalization is particularly relevant for integrating new interactive technologies for learning as well as for combining such solutions into complex learning experiences.

This chapter explores the role of context as a design element and provides a brief overview on it in educational design models, as well as by isolating and integrating contextual factors into an extended activity theoretical perspective. On this foundation, we analyze the question, whether context must be actively considered in educational design or can educational design draw on context-related affordances of learning resources? We answer this question on the grounds of the findings of a multi-year implementation of a mobile app that minimizes contextual dependencies that allow learners to expand their learning environment into new or alternative contexts independently from explicit educational interventions.

2.2 What Is Context?

Context is a complex concept in education. It covers many different aspects that influence learning experiences and educational interventions. The aspects include learning modes, educational settings, social relations, environmental identifiers, accessibility, media and device modality, procedural and system dynamics, as well as cognitive framing (Luckin 2010; Wong and Looi 2011). Learning experiences can be perceived as transitions between settings that are defined by these aspects. It has been noted, that the effectiveness of complex learning depends on the educational capability to moderate and integrate the different contextual learning experiences, which leads to *seamless learning* (Kuh et al. 1994). Mobile seamless learning centers on context as a key educational design principle for mobile learning experiences (Wong and Looi 2011).

The role of context has been identified as an important functional driver for interactive technical systems. Systems that can identify and respond to the contexts, in which they are embedded, are called "*context-aware systems*". For such systems, Dey (2001) defines context as "*any information that can be used to characterize the situation of an entity*", where this definition refers both, *people* as well as *objects* as entities. Such situations are separate of an entity and of activities and processes that are performed by an entity. However, context is not independent from the entity, because presence, performances, and artefacts may influence the context. The influencing information can be grouped into the categories: "individuality", "activity", "location", "time", and "relations" (Zimmermann et al. 2007).

- Individuality refers to the characteristics of an entity, such as a person or an object. Information related to this category helps identifying presence of persons or objects in a given setting.
- Activity refers to the dynamics of and within a setting. The related data allows determining action disturbances, e.g., through noise levels or amount of movements.
- Location refers to the position in a setting and time is its temporal counterpart. Data of both categories support to locate or trace actors or objects.
- Relations point to social relations, such as organizations, communities or hierarchies, relations between physical and social entities, such as ownership or access, as well as relations between objects, such as structures or systems.

The contextual categories help the design of sensor networks that provide data about an entity's situation (Zimmermann et al. 2007).

The viewpoint of context-aware systems highlights that context is situational for an entity: While different entities can share some situational characteristics, each entity may have other unique characteristics. Therefore, context is not objectively identifiable and static, but dynamic and subjective, which is relevant for educational settings and learning experiences: Context "is complex and local to the learner [and educator]. It defines a person's subjective and objective experience of the world in a spatially and historically contingent manner. Context is dynamic and associated with connections between people, things, locations and events [...]. Technology can help to make these connections in an operational sense. People can help to make these connections have meaning for a learner." (Luckin 2010: 18).

2.3 Context in Educational Design

Educational design describes approaches for creating educational arrangements that ground on educational theories, while not a theory of learning itself (Laurillard 2012). The challenges of designing for new pedagogies and/or technologies become apparent in contrast to the various educational design models and embedded concepts of context. The following analysis excludes instructional production and life-cycle models, such as ADDIE (Gagné et al. 2004) or RASE (Churchill et al. 2016), because these models do not focus on educational rationale but on the production processes for learning experiences.

Luckin (2010) provides an overview on the perceptions of context in education, philosophy, culture and technology. The overview indicates a range of interpretations of context and its influence on learning. These interpretations are also present in experience-centric educational design approaches, which can be grouped into four categories:

- Context agnostic;
- Context as delivery modes;
- Context as a passive environment;
- Socio-centric context.

The following review focuses on prominent educational design models with relevance to technology-enhanced learning. These models are used as examples for the related category.

2.3.1 *Context Agnostic Models*

Context agnostic educational design models lack an explicit representation of context. Educational designers that rely only on context agnostic models can address context only implicitly. One example for context agnostic educational design models is the "four-component model for instructional design" (4C/ID-model). The 4C/ID-model structures design elements of learning processes and their quality indicators (Merriënboer and Kirschner 2013). The model isolates characteristic elements of educational processes that are relevant for educational designs: "learning tasks", "supportive information", "procedural information", and "part-task practices". The interplay of these elements leads to learning outcomes. The important aspect of the 4C/ID-model is the connection of learner performance in the learning tasks and educational interventions in the form of supportive and procedural information. Besides the roles of the actors, the model is context free, which means that it has no explicit notion of context or a learning environment.

2.3.2 Context as Delivery Modes

The second group of educational design models consider context as delivery or interaction modes. Such models do not typically mention context or the learning environment explicitly but differentiate interaction modes that are implicitly connected to an environment or setting.

The delivery modes imply contextual framing in which learners perform an activity. Gagné et al. (2004) suggest a sequential model for educational design. This model takes a primarily resource-centric approach to learning activities that guide learners through a learning process. Each learning activity contributes to learning outcomes that are used for assessment. Instructional designer structure and arrange learning resources for the various activities according to subject matter needs. Context is only acknowledged in the form of different delivery modes, such as computer-supported and online learning, and face-to-face activities. Many blended learning concepts rely on shifting between analog and digital delivery modes, as it is found for example in the inverted classroom approach (Lage et al. 2000).

A similar viewpoint is taken by UCL's Arena Blended Connected (ABC) curriculum design method (Evers 2018; Young and Perovic 2016). The ABC method builds on the six activity types associated to Laurillard's conversational model (Laurillard 2012). The ABC method arranges learning activities along a term-centric week-schedule. Each activity is associated to an activity type, to which the interaction modes of conventional teaching methods and digital technologies are associated. An educational design may use either mode or mix them.

2.3.3 Context as a Passive Environment

The third type of educational design models consider context as environments that frame or constrain learning activities. Models of this type have a notion of context as framing, mode of interactions, or container.

Romiszowski's instructional systems (1981) take a system-theoretical approach to instructional design. Central to this model is the relation between educational objectives and learner performance. In this model, learning activities are design elements that help to indicate the achievements of an objective through the learner performance.

Different to Skinner's concept of programmed instruction (Skinner 1958), the educational scripts in Romiszowski's model are not stimulus-response interactions but for dynamic system with feedback loops. Four main "quadrants" influence the design of each learning activity. The quadrants include "prior knowledge", "task frequency", "performance consequences", and "task organization". The latter two quadrants refer to environmental or contextual factors. Romiszowski distinguishes between a system's *internal* environment that educational design decisions can influence, and a system's *external* environment that cannot.

Reigeluth's educational design model (Reigeluth 1983; Reigeluth and Keller 2009) defines educational processes as the integration of organizational strategies, content strategies, instructional strategies, and assessment strategies. In this model, learning environments are part of the organizational strategies. A learning environment defines the framing constraints for learning activities and thereby structures the learning experience. This model explicitly emphasizes the learning environments' role as an educational design element that arranges different resources (Reigeluth and Keller 2009) or allows to integrate digital tools and online services into the learning process (Koper 2003). However, the model only considers the learning environment for locating learning activities (Reigeluth and Carr-Chellman 2009). This assigns a passive-structuring role to the environment. The model suggests that social roles and social relations are part of the instructional strategies. This model provides the theoretical foundation for IMS Learning Design that limits the learning "environment" to a collector for bundling learning resources and tools without any influence on the learning process or notion of variability (Koper et al. 2003).

Laurillard (2012) introduced the conversational model for abstracting design principles for complex learning. While Romiszowski's model focuses on the systemic relations of different educational design practices and Reigeluth's concept of educational design addresses the procedural nature of educational processes, the conversational model provides a meta pattern for designing educational experiences. The conversational model distinguishes between the teacher and the learner role, who interact either directly on the conceptual level or through the "environment" on the performance level. The model suggests that activity at the conceptual level generates performances in the environment. In response, such performances refine the mental concepts at the conceptual level. This dynamic is present and observable for both, the learners and the teachers, and is the core of educational "conversations": The model attributes the teachers' performance to the environment as "model performance" as well as a source for feedback. The basic principles are extended to collaboration, where peer "communication" takes place on the conceptual level and "peer modeling" is attributed to performances in the "environment". The environment itself has no other function than serving as the framing in which performances manifest and teachers as well as learners can observe these performances and their outcomes.

2.3.4 Socio-Centric Context

The fourth group of educational design models include socio-centric contexts. Socio-centric refers to contexts that are determined only by social relations, such as networks or hierarchies of people. The socio-centric perspective differentiates social contexts from social interactions for determining different aspects of a learning experience.

A prominent model that includes socio-centric contexts is Engeström's activity theory (Engeström 2015). Similar to the 4C/ID-model it focuses on the characteristics of (learning) activities. The model attributes six components to activities that jointly lead to an activity's outcomes: "Subjects", "tools", "objects", "rules", "community", and "division of labor". According to the model, these components structure the productive part and the framing of an activity, where "subjects", "tools", and "objects" are considered as productive, and "rules", "community", and "division of labor" as framing. Community refers to the social context of an activity, that sets demands, regulates and embeds the performances of the active subjects, and consumes the activities' outcomes. The social context of activity theory is not a passive framing for an activity, but actively influences the possible performances.

Before educational designs can draw on Engeström's model, the models' components need to be adapted to the educational application (Fig. 2.1). This change allows to relate this model to other educational design models: The "subject" refers to the *actors* in a learning activity and the "object" to the *topic* and *learning objectives*. "Tools" refer to the technologies that support the actors' interactions with a topic, which includes *learning resources*, such as text material or infographics, and *interactive tools*, such as educational apps or working sheets. While rules and contexts remain unaltered, "division of labor" is uncommon in educational settings. It refers to the different *tasks* performed by the actors according to their *roles* in an activity.

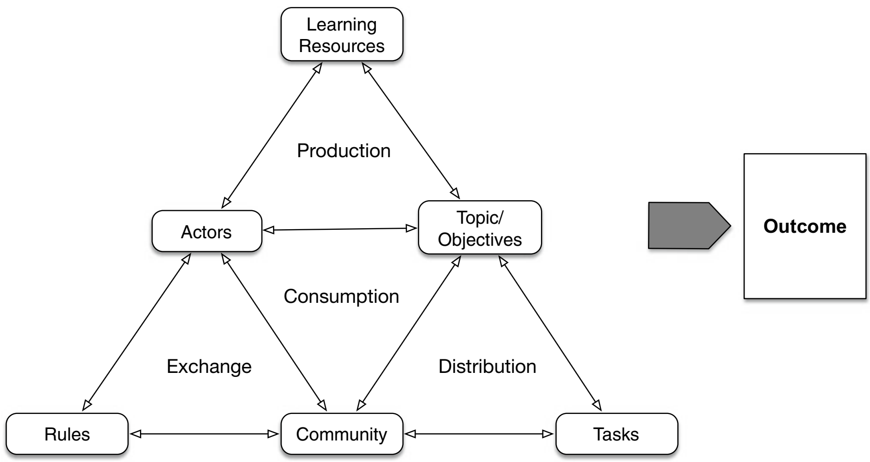

Fig. 2.1 Engeström's activity theory model with adaptations of educational design

The socio-centric perspective on contexts can be also found in Dillenbourg's orchestration graphs (Dillenbourg 2015). The orchestration graph model focuses on operationalizing social interactions in learning experiences. The model consists of "activities" that are connected by "operators" and the activities' outcomes. Activities can take place at different social planes, such as "individual", "group", "class", "cohort", "friends" or "school". The transition between social planes is coupled to special operators. The operators consume the learning outcomes of preceding activities for triggering the following activities. The arrangement of activities and operators across social planes is based on the design decisions of the educator. Different to Engeström's activity theory, the social context is not external to the activity, but characterizes the possible performances and data sources for an activity.

2.4 Contextual Factors of Learning

The limited recognition of context in educational design does not imply that context is new to the domain of education and learning on a broader perspective: Lave and Wenger (1991) introduce context as a driver of situated learning in communities of practice. The authors highlight that learning is always situated in contexts, which are not naturally given, but the result of a communal process that sets rules and responsibilities for communication and collaboration. Situated learning must not get confused with episodic and spaced learning (Melton 1970). Instead, situated learning refers to the set of socio-environmental practices into which learning is embedded. This implies that educational designs can be context agnostic but never context independent (Lave 2009). An integral part of situated learning processes is related to resolving conflicts between situated practices and the underpinning models along with six contextualizing dimensions: processes, peers, events, participation, concepts, and environment (Lave 1993).

Wenger (1998) independently focused on the contextual influences on communal learning processes. In the author's view, temporal, location-related, and social aspects as well as boundaries for differentiating contexts characterize contexts and the learning within. Wenger identifies 12 contextual factors that influence learning processes. The combination of the factors influences the selection and impact of supportive technologies for learning and socializing processes (Wenger et al. 2005, 2014). In return the selection of tools pre-structures contexts and their application contextualizes the activities in a community.

The relation between Lave's context dimensions to Wenger's contextual factors allows to move between different granularity levels (Glahn 2009). The relation also shows a strong emphasis of Wenger's concepts on social dimensions of peers and participation similar to the notion of context in Dillenbourg's and Engeström's models (Table 2.1).

The concept of "ambient information channels" (Specht 2009, 2015) addresses the forms of adaptation for different technologies in order to support learning of mobile actors through information technologies that are available in a setting. Information

Table 2.1 Context dimensions and context factors

Lave (1993) → Wenger (1998) ↓	Process	Peers	Event	Participation	Concept	World
Presence		×	×	×		
Rhythm	×		×			
Interaction		×		×		
Participation				×		
Values		×			×	×
Connections		×			×	×
Personal Identity				×		
Communal Identity		×		×		
Relations		×				
Boundaries		×		×		×
Integration	×	×				
Community building	×	×		×		

channels are learning resources with contextual meta-data. The underpinning model relies on interactive learning environments, that can draw on *sensor* networks as well as mobile-, personal-, room- social-based, as well as Internet of Things technologies as *actuators*. The learning experience is tailored to the learners' context by matching their contextual dimensions with those of an information channel and the conditions of the present setting. This matching is different from activity rules because it is not part of the educational design but inherent to the learning resources and the learners' context.

The ambient information channels provide a framework for operationalizing learning contexts and transitions between them. The framework presumes that contexts are defined by interactions of actors with their environment that are measurable through sensors. It connects the technical level of sensors in mobile technologies with Lave's abstract context dimensions. This makes context accessible as a technical and educational design element and allows to operationalize seamless learning concepts for designing learning experiences. By mapping the contextual categories suggested by Zimmermann et al. (2007) to Lave's (1993) educational dimensions, we can link sensor-level context types to the educational framing (Table 2.2). The mapping shows that not all educational context dimensions are directly mapped to specific sensor types. Instead, it shows that some contextual dimensions of educational approaches depend on more than one sensor-level dimension. The mapping supports the design of data collection and processing for orchestrating contextual learning activities and interactions.

Sharples et al. (2009) indicate that Engeström's "community" element can be generalized as "context" so the model becomes suitable for designing mobile learning experiences. This broadens the perception of activity theory's elements towards activities that consider contextual dimensions beyond social relations. The authors

Table 2.2 Relation between Lave's context dimensions and Zimmermann's context awareness dimensions

Lave (1993) → Zimmermann et al. (2007) ↓	Process	Peers	Event	Participation	Concept	World
Activity	×			×		
Relations		×		×	×	×
Time			×			
Identity		×			×	
Location						×

illustrate this wider context definition for the "location" context in location-based learning scenarios. However, broadening the model's scope of context adds little to guide the design of situated and contextualized learning experiences and the related tools (Fig. 2.2).

The extended function of the context element becomes more apparent when Engeström's activity model is inverted as depicted in Fig. 2.3. By re-aligning the

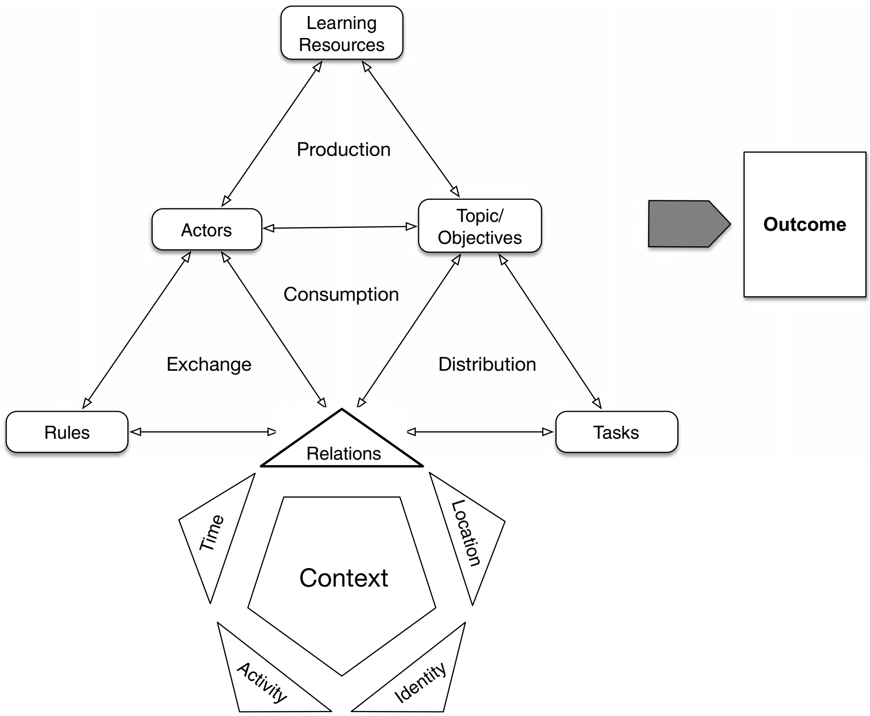

Fig. 2.2 Integration of context with Engeström's activity theory model

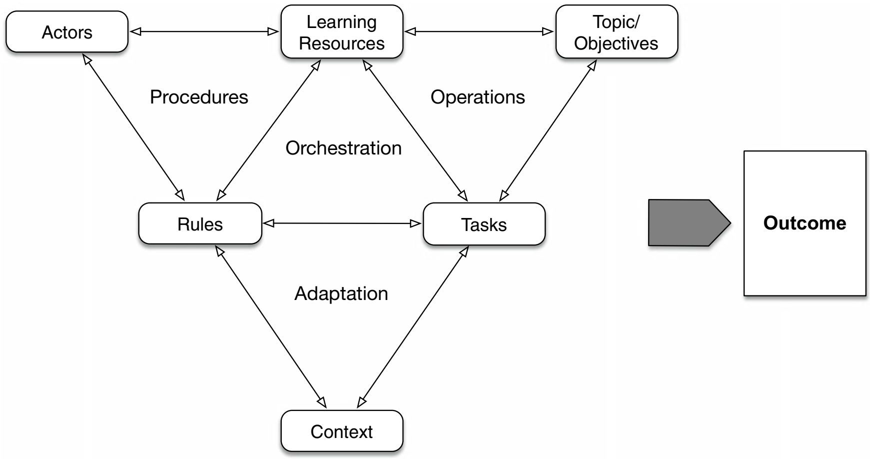

Fig. 2.3 Inverted activity theory model

productive triangle of the original model, we identified new relations between the components in technology-enhanced activities: Our changed perspective emphasizes the impact of technologies and context on learning activities that were previously hidden behind to the dominant emphasis on the interaction of actors with a topic. It also shows four tension areas for educational designs that were hidden in the original presentation:

- "Procedures" define when and how actors can, should or must use learning resources;
- "Operations" refer to the alignment of learning resources, tasks and learning objectives;
- "Orchestration" focuses on tasks, resources, and rules that influence the flow of learning processes;
- "Adaptation" targets the interplay between rules and tasks in and across contexts.

The tension area of "adaptation" includes adaptive variants such as *personalization*, *recommendation*, *localization*, and *synchronization*:

- Personalization refers to adaptation along the *identity* dimension.
- Recommendation refers to adaptation along the *activity* dimension.
- Localization refers to adaptation along the *location* dimension.
- Synchronization refers to adaptation along the *temporal* dimension.

The inversion of the model highlights the functional design elements of seamless learning with context as the focal point for design decisions. It visualizes that contextual designs depend more on learning tasks and rules in order to situate activities in contexts or bridge between contexts.

2.5 Contextualization Beyond Context-Awareness

The recent research on seamless learning indicates an active role of context in learning experiences. Interactive learning environments can source contextual information by aggregating data from sensor networks in the learning environment. From the perspective of designing seamless learning experiences this raises the following question.

Is contextualization the result of explicit educational arrangements or exist contextualizing aspects that are inherent to tools, rules, or tasks?

This question is of particular interest for designing interactive learning environments as well as educational experiences: If contextualization is constrained to active design decisions, then the agency of contextualization is always with the educational designer, teacher, or lecturer. Such designs require pre-arranged learning processes for every supported context. However, the concept of situated learning suggests that all learning is contextually situated (Lave and Wenger 1991). This implies that arrangements in educational designs could have affordances towards certain contexts without being explicitly tailored to them. Different to context-aware approaches, which depend on tight context relations, contextual affordances would rely on the learners' situational perception of learning opportunities.

Answering the question requires educational design elements that *minimize* contextual dependencies. Such dependencies include context-specific tasks, rules, or learning resources, as well as implicit contextual requirements such as presentation requirements of multimedia resources, connectivity requirements for online activities, or the learning resources' handling time. If minimizing contextual dependencies for learning activities have *no* contextual affordances, then learners should primarily perform these activities in the same settings as they would while using the non-minimized counter parts.

To test the above assumption, an existing educational design could be extended with a mobile app that provides minimized variants of already existing learning activities. The mobile solution would be available and easily accessible in a wide variety of contexts, which allows for analyzing how learners experience their learning environment. The following analysis uses the *Mobler* app for presenting alternative learning activities in an educational design of an introductory module at the University of Zurich with five consecutive cohorts.

Mobler (Glahn 2013; Glahn et al. 2015) is a mobile learning app for Android and iOS smartphones that implements the micro-learning approach. Micro-learning describes learning processes that consist of short and complete learning activities (Glahn et al. 2004; Gassler et al. 2004). Any micro-learning activity has three phases: an activity activation or task description, a performance with a measurable outcome, and feedback on the learners' performance. A micro-learning activity is only given if an activity cannot get further divided into smaller activities that have all of these phases (Glahn 2013).

The app is designed for facilitating practices and it uses test items that are provided by a learning management system (LMS). Such test items would normally be used in

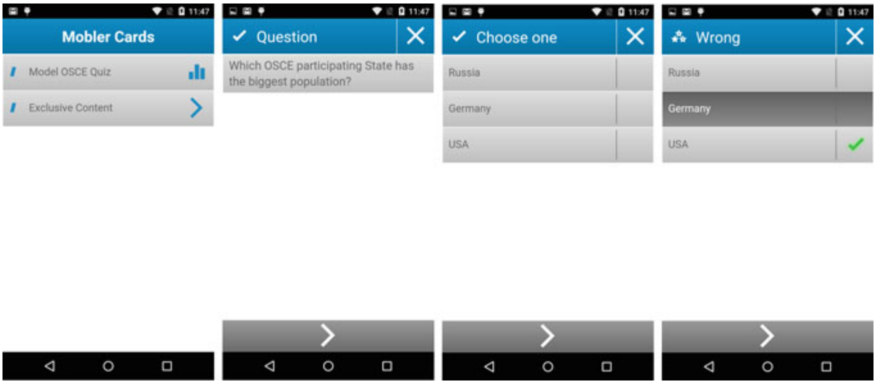

Fig. 2.4 *Mobler* Screenshots (Android version)—from left to right: course selection, question (task affordance phase), question answering (performance phase), feedback by showing the correct response in comparison with the provided response

tests and e-assessments. *Mobler* relies on interoperability standards for exchanging data with an LMS. While conventional e-assessments bundle test items and require the learners to complete all items in one attempt, *Mobler* isolates each test item and presents it independently. Based on the learners' responses and overall progress the app chooses the most suitable test items for the next activity. Immediately after the learners complete a task performance, they receive feedback on their performance. This feedback is automatically generated based on the test item's scoring definition. Educational designers can enrich the automated feedback with optional qualitative information. All test items are arranged as an endless loop that learners can interrupt at any time and continue at a later point. Figure 2.4 shows the user interface for these steps.

The app uses no device sensors or push-notifications for active contextualization. *Mobler* minimizes contextual dependencies through the following features.

- Offline caching of test items and learner performance;
- No gamification through challenge modes;
- Non-interactive data synchronization with the LMS;
- Isolating test items into independent micro-learning activities;
- Pseudo-random selection of test items based on the learners' prior performance.

The features reduce the explicit activity context only to the framing course and the present learning activity. The offline function and the non-interactive data synchronization minimize network-related constraints that would otherwise restrict learners to contexts with sufficient network bandwidth and latency. These features also allow the learners to initiate and stop learning activities anywhere as long they have access to their mobile phone. This minimizes the preference towards learning contexts.

The *Mobler* app has been used between 2014 and 2018 with five consecutive student cohorts in an annually recurring introductory lecture on communication sciences (Table 2.3). The app was a voluntary addition to the blended learning design of

Table 2.3 Enrolled course participants and **Mobler** usage per cohort

Cohort (year)	2014	2015	2016	2017	2018
Enrolled students	410	343	323	342	327
Mobler adoption rate (%)	74	83.9	84.8	84.8	87.7
Mobler weekly use (%)	32	51.6	44.1	47.5	43.1
Mobler daily use (%)	24	26.9	30.5	27.1	36.9
Questionaire response rate (%)	12	27	18	17	20

the lecture. The test items presented in the app were also available to the students in online tests for self-assessment. The adoption rate of this optional component started at 74% and consistently grew to 87% in 2018.

After each term, an online survey asked the students about their perceived learning behavior using the *Mobler* app. The survey was combined with the regular course evaluation, which is implemented after the end of the lecture and after the exams. The survey includes items on technology acceptance and ownership, the mobile media consumption, the acceptance as well as learning habits using the *Mobler* app (Glahn et al. 2015). The part on learning habits using *Mobler* includes items on the frequency of the mobile usage “at home”, “in transit (e.g., in public transport or car)”, “at work”, “on campus/in the library”, and “during leisure time (e.g., while meeting friends)”.

The 332 student responses to the survey represent 19% of all 1745 students. The surveys indicate a 100% smartphone adoption among the participants and show daily usage of mobile apps in various contexts. The data indicate that the students use these devices irrespective of the context.

A growing number of students answered that they have used *Mobler* occasionally or frequently during the term, starting from 74% in 2014 increasing to 87.7% in 2018. The distribution app usage frequency is similar to the use of the telephony or navigation features on the smartphone, with occasional use (at least once per week) at around 45% and daily use growing from 24% in 2014 up to 37% in 2018 (Table 2.3).

The students were asked to indicate their use of *Mobler* in different contexts. The data shows that students across all cohorts used the app primarily in two contexts: “at home” and “in transit”. The other contexts were of lesser relevance irrespectively of the cohort (Fig. 2.5). The home context has been expected for self-study experiences because these pointed to the primary educational intention for the self-assessment. “In transit” is a new learning context that was not planned as part of the courses’ learning experience. Other contexts were less relevant for the participants’ learning experience with the app.

The findings indicate that the students attribute specific contexts to the app because the students reported almost equal smartphone usage frequency for all contexts and the app minimizes contextual dependencies. This suggests that the students responded to contextualizing affordances in the mobile learning activities. The data indicate clearly that these affordances are not intrinsic to the device, but are related to the design of the app.

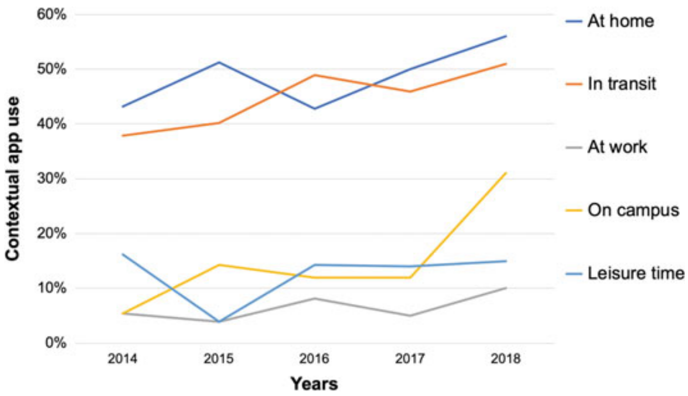

Fig. 2.5 Repeated use of the *Mobler* app per cohort, by context

The results suggest that contexts can influence the learning experiences, even if they are not explicitly part of an educational design. Instead, the affordances of a tool or learning resource may allow students to expand their learning experiences into new contexts. Different from active contextualization of context-aware systems, an affordance-guided passive contextualization can be achieved through re-organizing and re-arranging learning activities or resources.

2.6 Conclusions

This chapter focused on "context" as an educational design principle. Many educational design models do not consider context or consider context as a passive component that structures learning resources. The increasing availability and integration of sensors and actuators in mobile technologies and the Internet of Things questions the passive perception of context. Concepts such as seamless learning highlight a new perspective on context in educational designs and learning experiences.

The relation of context to existing educational design models is a major challenge because the necessary concepts are often missing. Simultaneously, there are several studies that focus on contextualization as a form of adaptation of interactive systems. This raises the question for educational design, whether only adaptation can contextualize learning experiences. The findings presented in this chapter suggest that contextual experiences are not only the result of such adaptation. Interactive environments and learning resources can also offer passive forms of contextualization by allowing learners to expand their learning environment into new settings. One approach to achieve this form of contextualization is based on minimizing the contextual dependencies of an educational tool.

Either approach to contextualization can be challenging for educational designers because it involves greater awareness about the different contextual factors that influence learning experiences. In order to abstract these underpinning relations, this chapter proposes an inverted perspective on Engeström's activity theory model. The model provides a foundation for operationalizing seamless learning as the interplay of active contextualization and passive contextual affordances of tools and learning resources. The model's key principles guide the integration of the *Mobler* app into a higher education course curriculum.

The presented findings confirm the plausibility of the initial assumptions about contextual influences on learning experiences. This points towards a new rationale for educational designs and interactive systems that reflects context as an active factor for learning experiences. Yet, further research must use our findings with caution when deducing implications for educational design theories and models. Research can overcome the shortcomings of the present study by addressing the following key questions.

1. What are the relations between the different abstraction levels of contextual dimensions and how do they influence learning experiences?
2. How do affordances of learning resources and tools, educational rules, tasks, and contexts influence each other, and are there context-specific affordances inherent to apps, devices or device types?
3. Are there universal design principles for context-awareness and contextualization that are relevant for educational design?

Glossary

Affordance The quality or property of objects or tools that define their possible uses or makes clear how they can or should be used.

Assessment Any form of comparison of performances with benchmarks or objectives.

Blended learning All forms of combining different technology-enhanced learning approaches with each other and with conventional educational practices and interventions.

Context-awareness The use of context to provide task-relevant information and services. In education, context-awareness refers to explicit use of context or contextual factors for creating and moderating learning experiences.

Contextual affordance Properties of objects or tools that bind usages to contexts. These properties are connected to contextual dimensions.

Contextual requirements The contextual preconditions that are necessary for learners to perform learning activities or to make learning experiences.

Contextualization The use of context to change information and services. In education, contextualization refers to the use of context for selecting learning activities as well as for changing the conditions of one or more learning activities.

Device sensors The sensor-network built into digital devices, such as microphone, camera, gyroscope, or compass.

Digital natives Generations who only experienced a world with ubiquitous presence of digital technologies in daily life.

Educational design Planning and arrangement of learning activities into educational processes that include the assessment of learning objectives. It complements *learning design* that focuses on the design of learning tasks and *instructional design* that primarily addresses the design of learning resources.

Learning activity Educational tasks including necessary resources, environment, intended performances, expected outcomes, as well as relevant feedback. Learning activities typically consider a learner role and a facilitator role but can also address multiple roles in different social interactions. Learning activities abstract beyond individual performances and refer to planned educational interventions.

Learning environment The setting of one or more learning activities. Learning environments provide learning resources that are needed to perform a learning activity. Moreover, learning environments determine the context of learning activities. A learning environment can bind a learning activity in terms of the activity's framing as well as it can be part of an activity in terms of structured resources.

Learning experience The sensory and emotional impressions of learners when performing a learning activity or being exposed to a learning environment.

Micro-learning Educational design patterns that utilize atomic learning activities as fundamental building blocks. Learning activities consist of a task, performance assessment, and performance feedback, learning activities are atomic, if they cannot get further separated into sub-activities with this structure intact.

Perceived learning behavior The learners' self-reported perception of their own learning and/or of their personal engagement in learning activities.

Seamless learning Seamless learning happens when persons or groups experience a continuity of learning, and consciously bridge the multifaceted learning efforts across a combination of locations, times, technologies, or social settings. In educational design, seamless learning refers to approaches that create continuous learning experiences that leverage the diverse contexts of learners to shape learning experiences. *Mobile seamless learning* refers to applications of mobile technologies such as smartphones to facilitate learning in context and/or to bridge between contexts.

Technology-enhanced learning Combines all approaches and applications, in which digital technologies are used for supporting education and learning processes. This includes but is not limited to e-learning, online learning, and MOOCs, mobile learning, game-based learning, simulations, gamification, educational approaches to augmented and mixed reality, virtual and remote labs, as well as virtual worlds.

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Chapter 3
Technologies for Lifelong and Lifewide Learning and Recognition: A Vision for the Future

Kumiko Aoki

Abstract In this rapidly changing society, it has been widely acknowledged that education needs to happen continuously, lifelong and lifewide. The concept of lifelong learning is well established and the need for learning at many intervals throughout one's life is well recognized. Lifewide learning refers to the learning which takes place in a variety of different environments and situations covering formal, non-formal, and informal learning. Ideally learning for an individual should be holistic, not separating different contexts of his/her life. Learning can occur at many different places including schools, homes, communities, workplaces, and public places, but often times individuals lack awareness of their own learning when it comes to learning outside of formal schooling. In this age of open educational resources (OER) and massive open online courses (MOOCs), the materials for learning are ubiquitous and knowledge access is easy. Potentials for linking informal or non-formal learning to formal learning have become salient. However, the means to assess and visualize one's own lifewide and lifelong learning paths organizing all those learning resources are rarely discussed. With the current tremendous power of cloud computing, digital storage and mobile devices, technologies afford us to keep all the personal learning records throughout our lives as well as across different contexts of our lives. These technologies also give the possibility of integrating and visualizing all the disparate learning and recognizing it throughout one's life. This paper discusses potentials of the technologies to assist actualizing the vision.

3.1 Introduction

Traditionally education has been formalized and institutionalized due to the needs of providing sequential standardized curricula to individuals and recognizing their age finite learning. There have been distinct stages in one's life that are solely dedicated to receiving education and then individuals leave the stages for working life in which

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they leave the formal education behind. The educational periods are also divided into academic years and semesters to maintain the formal structures.

In this rapidly changing society, it has been widely acknowledged that education needs to happen continuously, lifelong and lifewide. The concept of lifelong learning is well established since the late 1960s and the need for learning at many intervals throughout one's life is well recognized. In old days, one's workplace or profession did not change often throughout one's life, and the preparation for the workplace or profession could have been done before entering the field. However, nowadays, workplace and profession often change due to the economic instability/development and technological advancement/deployment. It is imperative for individuals to continue learning for their job security as well as their personal development for the individual fulfilment in life.

In contrast to lifelong learning which spans in time, lifewide learning occurs in different spaces. In other words, lifelong learning is a vertical integration of one's learning while lifewide learning is a horizontal integration of one's learning (Cropley 1980). Lifewide learning refers to the learning which takes place in a variety of different environments and situations covering formal, non-formal, and informal learning. Informal learning includes learning in a variety of spaces that is not necessarily organized or formal in nature like a school or organization (Melnic and Botez 2014). It also includes activities that are carried out not primarily for the purpose of learning, but as a bi-product of the attempts to accomplish something. Jackson (2013) states that: "One of the goals of lifewide education is to make people more aware of their learning in all its forms but particularly how it relates to the realization of themselves as a person." The lifewide dimension of human experience gives lifelong learning ecological significance. Now with the mobile technologies, individuals are increasingly using fragmented time to learn through fragmented resources, making them so-called "learning nomads" (Barnett 2010). Ideally learning for an individual should be holistic, not separating different contexts of his/her life. Learning can occur at many different places including schools, homes, communities, workplaces, and public places, but often times individuals lack awareness of their own learning when it comes to learning outside of formal schooling as it tends to be fragmented.

This chapter starts with a description of personal learning paths for keeping track of one's learning in the past, present and future. Then, it analyzes the potential technologies and services to keeping the personal learning paths in light of the learning ecosystem. Finally, it examines the stakeholders of personal learning ecosystem that help develop and maintain personal learning paths for individuals.

3.2 Personal Learning Paths

Digital environments provide individuals with ample opportunities for learning in and out of formal school settings. A variety of contents for learning exist online for free or at a minimal fee nowadays with the forms of open educational resources (OERs) and massive open online courses (MOOCs) (Witthaus et al. 2016; King et al.

2014; Baggaley 2013; Kay et al. 2013). “Personalized learning” or “personalized learning environment” has become a buzzword for educational programs based on the learners’ background and needs to reach their maximum potential (Miliband 2006; Grant and Bayes 2014; Roberts-Mahoney et al. 2016). However, the means of keeping track of all the lifelong and lifewide learning in a coherent manner is not existent, and the opportunities for assessing and recognizing what is learnt are still scant though there is an increasing possibility with the prevalence and standardization of digital credentials (Smolenski 2016).

If learning is initiated only for personal satisfaction, just accessing available learning content or resources of one’s interest may suffice. However, if learning is initiated for career development or even for a fulfillment in life, a person may want to create a plan not only to learn, but also to be assessed and recognized for the learning. In addition, the person may want to know what is missing and what needs to be learnt further to attain the goal he/she sets for the plan. To make it possible, the person needs to develop a personal learning path (Chen 2008).

A personal learning path should be flexible as it may change depending on the needs and interests in one’s life stage. It should also be multi-layered as it is not usually a single path with a single goal, but comprises multiple paths with multiple goals in one’s lifewide and lifelong learning. It is important to keep track of the learning path based on the person’s learning profile. With digital learning and online learning, it is possible to record and accumulate all the individual learning activities and processes. Though so far all those learning records have been stored in the databases of institutions that offer learning activities, it is ideal for individuals to manage and take responsibility of ones’ own learning records as the learners are at the heart of all the education systems. Personal learning should shift the role of students from being simply a consumer of education to a co-producer and collaborator of their learning pathway (Bates 2014). Learners need to be self-directed for pursuing the goal of the learning instead of passive consumers of educational content and play an active role in designing and executing their own personal learning path.

Learning analytics has been discussed mainly from the perspectives of educators and educational institutions using data gathered from institutional learning management systems (Siemens and Long 2011). However, learning analytics can be very useful in analyzing personal learning records to identify strengths and weaknesses of one’s own learning, to uncover shortcomings, and to suggest the directions an individual can take in future towards achieving the goal of the individual. Prior to the digital era, it was almost impossible to accumulate all the records of learning done at different locations over time by one individual. Now with the digital learning, the learning records can be stored digitally in one place. All the records stored in the learning path should belong to the person, not the institution or organization that has provided the learning experiences.

Personal learning paths encompass learning in and outside of formal educational settings, and focus on not where and when the person has studied, but on how and what the person has achieved through learning. A personal learning path should contain a record of the past learning as an e-portfolio, a present profile including

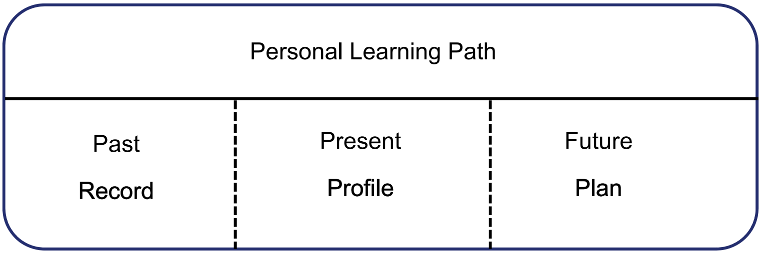

Fig. 3.1 Personal learning path

current interests and learning styles (Kolb and Kolb 2005), and a plan for the future learning (See Fig. 3.1).

As all the learning records of a particular individual's learning process as well as learning performance is stored in one virtual place, the learner doesn't have to be assessed every time to gauge the person's pre-knowledge prior to registering for a course or enrolling in a program. Hence, the sequence of learning can be designed efficiently and effectively.

In addition, the individual's learning style and preference is also stored in the personal learning path, which should be taken into consideration when selecting the courses and programs for learning. Learning style and preference may encompass multiple variables relating to study mode, learning contents, sequences, and user interfaces. As the learning style and preference of an individual may change throughout his/her life, the learning style and preference in the profile is continuously assessed and modified in the course of learning. In the present profile, the current circumstance of a learner in terms of available time, locations and environments of studying, available devices used, and goals of learning is indicated.

The learning plan in the personal learning path should be adjusted and optimized dynamically according to the past and present learning records and the current objective for learning. A learner should be presented with multiple options in terms of future plans for learning and be in control of choosing the one he/she thinks most suitable to make the person feel actively involved in making the plan for his/her own learning.

With the personal learning path, an individual can pursue coherent learning even without an extended time span available for learning as it keeps track of what the person has learned and suggest the path to pick up where the individual left in the past. The individual can easily mix and match learning activities, working, and personal.

3.3 Personal Learning Ecosystem

For each individual to maintain his/her own personal learning path, the learning ecosystem needs to be present that consists of: (1) learning content/resource provision, (2) assessment of learning, (3) recognition of learning, and (4) learning path management as shown in Fig. 3.2.

Each component in the personal learning ecosystem is described in the following.

(1) **Learning Content/Resources**

The means of digital learning in different contexts and situations are well documented. In this age of digital educational resources (DER), open educational resources (OER) and massive open online courses (MOOCs), the explosive growth of learning resources and the sheer quantity of available resources is overwhelming and the materials for teaching and learning are abundant. With the prevalence of mobile devices, those learning resources are accessible anytime anywhere on the go (Sun et al. 2018). However, in order for a learning experience to be effective, the content or resources need to be monitored, selected and sequenced based on the personal learning path instead of randomly accessing on a whim.

In an ideal world, every available learning resources is tagged with standardized metadata so that the resource suitable to a learner's needs, preference, and goal can be searched and identified globally from the huge pool. Such repositories of learning resources may be abundant today, but few are actually linked to allow a learner to do a federated search of all the repositories. The technology of artificial intelligence (AI), defined as computing agents that are able to perform tasks that normally require human intelligence based on data received from the environment (Russell and Norvig 2016), shows a promise of a learning agent searching for suitable materials in a timely manner for the learner and weeding out useless information that could end up wasting the learner's time.

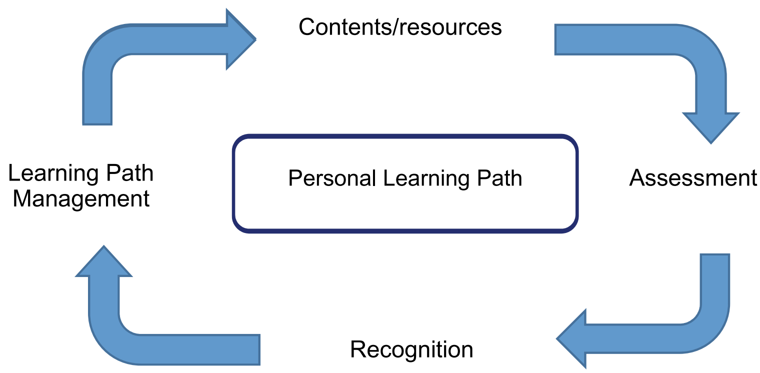

Fig. 3.2 Personal learning ecosystem

It is ideal that learning resources may be customized based on the individual learner's needs and preferences in terms of contents, granularity of chunks, and presentation styles to avoid cognitive overload and make learning efficient. In using learning resources, it is also ideal that online tutoring is available when a learner faces difficulty understanding the materials. Databases of skilled tutors should be available that also contain information on the areas of study, academic backgrounds, track records, user ratings, availability, cost, etc.

Learners of the same learning resource should be connected allowing connected learning, collaborative learning and social learning though each learner may learn at his/her own pace. Learners need to participate in learning activities that encompass teamwork, collaboration, and peer-to-peer learning as learning tends to be passive and limited if it involves only watching and reading of materials. Connected learning and social learning enable formation of learning communities which serve as the scaffolding in the learning processes and allow active learning in individual learning processes (Kharbach 2012; Sun and Shen 2014).

(2) **Assessment**

In the personal learning path, practical learning for academic credentials or professional development and learning for expanding the mind co-exist. In learning for expanding the mind, the learner may not care much about being assessed for his/her learning as the learning is mostly intrinsically motivated. However, in practical learning which tends to be extrinsically motivated, mastery learning should be involved and the learner needs to be assessed for his/her progress step by step to achieve the final goal of learning.

Assessments could happen at various levels and in various granularity. It could be done solely for self-assessment for reflection or for validation of learning. In any case, assessment needs to be conducted so that it is valid for the learning objective. In addition to summative assessments, ongoing formative adaptive assessments need to be implemented in consideration of scaffolding in case if the learner could not achieve the learning objective as scaffolding is essential for learners (Hmelo-Silver et al. 2007).

Multiple choice quizzes are the most popular assessment formats seen in digital learning environments as they can be easily programmed to give an automatic immediate feedback to learners. They have the potential of motivating learners if they are implemented in the right time and in the right interval. Essays and reports are still difficult to be graded without human intervention. However, the development of artificial intelligence (AI) could automate assessment of essays and reports in limited degrees in the near future. Performance assessment can be quite difficult as it usually requires a complex rubric, but considered to be authentic in evaluating skills and competencies.

Peer-assessment can be useful in learning communities as learners can further learn by evaluating others' works. However, in order for peer-assessment to be valid and reliable, a rubric with detailed instructions need to be developed and communicated. Each learner can be assessed as a peer evaluator in multiple activities and rated based on his/her performance as an evaluator so that evaluation by a particular evaluator can be weighted based on the past performance of evaluation.

Whatever the means of assessment, the assessment needs to be reliable and valid so that a decision can be made whether the learner should continue learning or be recognized for the learning and move on to the next stage of learning. Assessment can be done in conjunction with the content/resource provision, or independently of the provisions to assess the skills and knowledge acquired in the past.

(3) **Recognition**

After learning is assessed, it also needs to be validated and recognized. In digital learning environment, recognition of learning whether it is formal, non-formal, or in formal in the forms of digital badges is possible. Digital badges can link all the necessary information to authenticate the learning and be presented to an appropriate party on demand. Digital badges also visualize the progress in learning accomplished in the personal learning path so that they motivate learners to learn further. Digital badges can be issued at a variety of granularity and can be quite useful in identifying the gap in learning if the personal learning path is planned in detail. For example, digital badges can be issued for completing informal, non-formal, or formal courses, on-the-job trainings, and conference workshops, etc. (Abramovich et al. 2013; Gibson et al. 2015).

Traditionally a student needs to obtain a transcript or a certificate from the institution or organization who has issued it if the student needs to show the proof to a potential employer. With digital badges, an individual can manage and present his/her own credentials earned over years without asking the credential issuers. In addition, a potential employer can obtain a detailed information about the credentials earned by the individual.

With the premise of blockchain, which is basically a distributed ledger, it is not totally impossible to imagine that every person will have a lifelong digital portfolio or e-portfolio which permanently stores all the credentials, achievements, and certifiable experiences and activities the individual has consciously earned and completed throughout his/her life, and share some of those data when needed. The biggest advantage of such a portfolio is its independence of any single institution's resource as blockchains are distributed across networks. The owner of the e-portfolio has full control over it and not at the mercy of institutions in using their own data.

With blockchain-based e-portfolios or credentialing, individuals can easily and instantly share their credentials or digital badges with the parties they wish to share and the parties can recognize those credentials as genuine as those are verifiable with original issuers of the credentials without actually contacting them. In addition, with blockchain technology, even after the original issuer of credentials or digital badges disappears, still the credentials or digital badges can be validated (Grech and Camilleri 2017).

Blockcerts, the open standard for issuing and verifying records on the blockchain developed by the MIT Media Lab and Learning Machine, has already been used to issue diplomas at MIT, Southern New Hampshire University, Central New Mexico

Community College, East Coast Polytechnic Institute (Learning Machines 2019), the University of Melbourne, and the University of Nicosia.

The current challenge lies in the proliferation of blockchain technologies in education which may not be interoperable and, hence, beat the purpose of universally sharable transparent credentials. It is empowering individuals if the blockchain technologies give truly decentralized yet valid and reliable means of demonstrating individuals' academic and professional achievements without being vulnerable to any particular institutional policies and regulations.

(4) **Learning Path Management**

The last section of the personal learning path is the management of the learning path itself. In a limited scope of learning within an institution, the learning path management is already possible on learning management systems (LMSs). However, those LMSs tend to be closed within an institution, and only a limited amount of information about students is shared across different institutions.

If an individual owns and manages his/her own personal learning path, the problem of inter-institutional incompatibility does not occur and an individual can present necessary information to the target educational institution for receiving educational services based on the individual's needs. The recent development by the U.S. government initiative, the Advanced Distributed Learning (ADL), called Experience API (also known as Tin Can API and xAPI), enables nearly dynamic tracking of activities from any platform or software system—from traditional Learning Management Systems (LMSs) to mobile devices, simulations, wearables, physical beacons, and more. Experience API is an open source, and through its backend database called Learning Record Store (LRS), all the activities and records of an individual learner can be stored and shared regardless of types of devices and platforms anytime anywhere.

A personal learning path records all the resources accessed in the past as well as the learning activities the individual has engaged. It also keeps all the current characteristics, preferences, environments and attributes of the learner in his/her personal profile. In addition, it has to recommend the most appropriate resources and activities to be engaged in the future and the appropriate sequence of the engagement for a given learner based on his/her past and current data (Kurilovas et al. 2014). That is the aspect of learning path management in the personal learning ecosystem.

3.4 Conclusion

For lifelong and lifewide learning to be meaningful for the learner as well as the society as a whole, it is important to recognize all the learnings that occurred one's lifetime including not only formal learning, but non-formal and informal learning. In the concept of a personal learning path, an individual's past record of learning, current profile, and future plans are stored in a personal cloud and any data that the individual wishes to present to a third party will be shared as needed. As the individual has the sole ownership of all the date in his/her personal learning path, the privacy protection will not be much of an issue as any data of the individual cannot be shared without the individual's consent.

Personal learning ecosystem consists of the stakeholders that contribute to individual personal learning paths: learning contents and resources, assessments of learning, recognition of learning accomplishments, and management of the learning path. Each of those components can be independent services or more holistic educational providers that encompass multiple components.

With the technologies of cloud computing, digital certificates, blockchain, and artificial intelligence (AI) and standardization efforts like Experience API, technologically it is now possible to create the personal learning path and the personal learning ecosystem, in which individual learners are at the center of controlling what to learn, how to learn, where to learn, and how to use what the individual acquires from all the learning. Educational institutions will be the ones who help individuals progress in their personal paths and ensure the quality and the integrity of the personal learning paths.

The technological possibilities have to come with policy making, cross-sector collaboration, and organizational rearrangements that have long tradition of institutionally centered cultures. With the possibility of personal learning paths, individual learners will be empowered, but at the same time it requires individuals to be conscious decision-makers of their own learning at every stage of their personal learning paths. The necessary role of current and future educators must be to guide individuals to be autonomous, self-directed learners who can take charge of their own personal learning paths.

Glossary of Terms

Open educational resources (OER) freely accessible, openly licensed text, media, and other digital assets that are useful for teaching, learning, and assessing as well as for research purposes.

Massive open online courses (MOOCs) online courses aimed at unlimited participation and open access via the web.

Lifelong learning learning throughout one's life.

Lifewide learning learning which takes place in a variety of different environments and situations covering formal, non-formal, and informal learning.

Formal learning education normally delivered by trained teachers in a systematic intentional way within a school, higher education or university.

Non-formal learning various structured learning situations which do not either have the level of curriculum, syllabus, accreditation, and certification associated with 'formal learning'.

Informal learning learning in a variety of spaces that is not necessarily organized or formal in nature like a school or organization.

Self-directed learning a process in which individuals take the initiative without the help of others in diagnosing their learning needs, formulating goals, identifying human and material resources, and evaluating learning outcomes.

Learning analytics the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs.

Learning styles a range of theories that aim to account for differences in individuals' learning.

Artificial intelligence (AI) computing agents that are able to perform tasks that normally require human intelligence based on data received from the environment.

Connected learning a type of learning where a person has an opportunity to pursue a personal interest and passion with others so that learning is linked to academic achievements.

Social learning learning within a social context.

Learning community a group of people who share common academic goals and attitudes, who meet semi-regularly to collaborate on classwork.

Mastery learning an instructional strategy and educational philosophy which maintains that learners must achieve a level of mastery in prerequisite knowledge before moving forward to learn subsequent information.

Summative assessment the assessment of participants where the focus is on the outcome.

Formative adaptive assessment a range of formal and informal assessment procedures conducted during the learning process.

Peer-assessment an educational activity in which learners judge the performance of their peers.

Digital badges a validated indicator of accomplishment, skill, quality or interest that can be earned in various learning environments.

Blockchain distributed ledgers which are linked using cryptography.

e-portfolio a collection of electronic evidence assembled and managed by a learner, usually on the Web.

Learning management systems (LMSs) software applications for the administration, documentation, tracking, reporting, and delivery of educational courses, training programs, or learning and development programs.

Learning Record Store (LRS) a data store system that serves as a repository for learning records collected from connected systems where learning activities.

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Chapter 4
"Smart" Practices: Machine Intelligence for Transforming Pedagogy and Learning

Kelli Buckreus and Mohamed Ally

Abstract Advances in machine intelligence (MI) have coincided with recent shifts in education, across all levels and contexts, towards constructivism. As a pedagogical tool, MI promises new opportunities for adaptive learning that may help to fully actualize constructivist learning theory, transforming how learners interact with teachers, other learners, content and (technology) tools. Richer multi-modal environments for interaction, adaptive information aggregation and curatorial support, and personalized learning through analytics-informed responsive instruction, are among the possibilities, with teachers positioned in more strategic pedagogical roles vis-à-vis these teaching machine partners. So far, however, MI implementation in education has failed to live up to its promise. This failure has little to do with technological possibilities, and rather stems from limitations in how learning theory, pedagogy and imagination have informed the application of MI within education contexts. As Russell (The no significant difference phenomenon: As reported in 355 research reports, summaries and papers. Raleigh, NC, North Carolina State University, 1999) contends: Pedagogy, not technology, makes a "significant difference". As education transitions to become a lifelong learning process within the twenty-first century's "information age" context, outcomes must focus on domain knowledge as well as adaptive process skills, such as communication, critical thinking, self-direction and collaboration. In this chapter, the authors consider how MI implementation and pedagogical reform may address 21st learning goals. These will advance simultaneously with broader systemic changes, and shifts in institutional mandates towards digital resiliency. Purposeful and strategic implementation of MI at a societal scale will require careful long-term planning and new objectives, including education that supports development of MI user skills throughout the workforce and general population.

Keywords Machine intelligence · Pedagogy · Twenty-first century learning

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4.1 Introduction

Far from emulating what is imagined in science fiction literature and film, machine intelligence (MI)[1] has emerged to address some of the mundane and routine tasks of daily life (Reddy 2017; Rizzotto 2017). Nonetheless, MI promises radical shifts to our socioeconomic structures, such as those occurring in North America's workforce with the introduction of autonomous vehicles (Marshall 2017). Purposeful and strategic integration of MI on a societal scale will require careful long-term planning, a critical aspect of which will be developing MI user skills throughout the workforce and general population, evoking new objectives for education (Luckin 2016; Murphy 2018; Rizzotto 2017). As a pedagogical tool, MI offers new opportunities for adaptive, interactive and experiential learning that may help to fully actualize social constructivist learning theory (Veletsianos 2014; Woolfolk et al. 2011), transforming how learners engage with teachers, other learners and content (Garrison et al. 2010; Richardson et al. 2017; Zimmerman 2012).

The most important step forward will be increased personalization of learning (Dodgson and Gann 2017; Leopold 2017; Luckin 2016; Rizzotto 2017). MI-enabled learning analytics and instructional design offer potential for fluid and individualized approaches to curriculum, freeing teachers to pursue more strategic pedagogical tasks, while educational institutions simultaneously flex to serve growing number of learners, deliver increasingly diverse/complex curricula and "do more with less" operational resources (Richardson et al. 2017; Rizzotto 2017; Weller and Anderson 2013). To date, MI's application in education has been largely limited to rudimentary intelligent tutoring systems (ITS) and simulations, discussion forum bots and learning analytics focused on predicting student attrition rates (Luckin 2016; Lang et al. 2017; Maderer 2016; Qiu et al. 2014). Still untapped is MI's real potential for adaptive, personalized learning that provides timely interventions and improves constructivist learning, combined with new types of interactive relationships (O'Reilly 2017; Rizzotto 2017). For instance, Rizzotto (2017) envisions a virtual reality (VR) tutor embodying personal appearance, powered by MI to provide responsive, experiential and engaging real-time learning.

Critical advances for twenty-first century education will come from how MI is leveraged in conjunction with Internet communications technology (ICT) and connected mobile devices, two innovations that together have fundamentally reshaped learning and work contexts around the globe (Reddy 2017; Rizzotto 2017). Boundaries and conceptions of "otherness" that once existed have given way to collective knowledge creation and the sharing of ideas, with technology mediating the time–distance phenomenon to bring us together at the touch of a virtual button. Within distance learning contexts in particular, ICT has fostered important shifts towards balancing asynchronous and synchronous interaction, supporting individualized learning and learner self-direction, and bridging learner–teacher and learner–learner distance (Dodgson and Gann 2017; Leopold 2017; Luckin 2016; Rizzotto 2017).

[1] Throughout this chapter, we use the term "machine intelligence (MI)" instead of "artificial intelligence (AI)", as MI is a more apt descriptor of intelligence type.

Widespread integration of MI across learning environments may render the historic distinctions between face-to-face (f2f) and distance education (DE)[2] contexts immaterial, with technology-introduced “distance” leveraged to enhance learning in both contexts, as we have witnessed with the trend towards blended learning. Many of the benefits of f2f teaching and learning will be translated into virtual environments across vast geographic distances through the integration of MI, while the unique affordances of DE (such as enhanced learner independence and self-direction) will remain embedded (Dodgson and Gann 2017; Leopold 2017; Luckin 2016; Rizzotto 2017; Simonson et al. 2012) These changes will advance simultaneously with broader systemic changes, and shifts in institutional mandates towards digital resiliency[3] (Weller and Anderson 2013).

As education in the twenty-first century transitions to increased lifelong learning (across formal, informal and workplace learning environments), a foreseeable trajectory is that MI-powered ITS will become more integrated with other connected systems as they become ubiquitous and ambient (Roll and Wylie 2016; Rizzotto 2017). We have begun to witness the widespread presence of both rudimentary and sophisticated MI in our everyday interactions mediated by the Internet, and this will expand in concert with the Internet of Things (IoT). Within teaching and learning contexts, MI advancement and integration will focus on the development of more sophisticated ITS, with intelligently designed *en pointe* learning analytics protocols.

4.2 Intelligent Tutoring Systems (ITS) as Teaching Machines

The idea of ITS is not new, nor is the technology. From the 1940’s, Alan Turing and other early innovators of computing systems envisioned these intelligent machines would be used to teach humans, with personalized learning being a specific pedagogical affordance of the technology (Ferster 2014, 2017; Woolf 2010). Historically, development and implementation of intelligent tutoring systems (ITS) has aimed towards mimicking or substituting for what has been considered the “gold standard” in education: one-on-one learner–teacher interaction (Baker 2016; Ferster 2014, 2017; Roll and Wylie 2016; Woolf 2010). This “gold standard” remains a persistent challenge within distance education (DE) contexts, though recent ICT

[2]The traditional conception of “distance” refers to any separation between learner and teacher within learning contexts (Simonson et al. 2012). While geographic distance is typical, virtual distance (i.e. separation both created and mediated via digital networks) has proliferated, independent of geographic distance, as face-to-face learning contexts have adopted blended learning via networked technology (Garrison et al. 2010).

[3]Many institutions have invested in online learning for in-house education programmes, open education initiatives, or partnered with massive open online course (MOOC) providers such as edX, Coursera and Kahn Academy, as critical transitional steps towards digital resiliency (Mireles, n.d.; Weller and Anderson 2013).

advances have helped solve some of these challenges, enabling more direct learner–teacher (and learner–learner) interaction (Garrison et al. 2010; Simonson et al. 2012; Woods and Baker 2004). How might ITS build on this progress?

An important question that has shaped inquiry regarding the role of ITS and MI in education and learning is, "Can machines teach?", followed closely by the question "Should machines teach?" (Ferster 2014, 2017). Challenges in answering these questions may stem from the embedded assumption: "Can (should) machines *replace* teachers?". If we ignore this hidden question, and deal with the explicit question alone, the answer is conceptually straightforward: Yes, machines can and do (and, within the twenty-first century context, should) teach. Consider the question from a basic behaviourist perspective: Working one-to-one with an ITS, a student inputs an answer to the question or problem the ITS generates, and receives immediate feedback from the ITS, which leads the student to modify their actions (Ferster 2014, 2017; Laurillard 2012). In this scenario, the teacher (and teacher intervention) is not eliminated, but rather repositioned, and how the ITS is implemented will impact to where (i.e. repositioned to what point in the learner-ITS-teacher interaction cycle) (Laurillard 2012). The important question then becomes: "How can/should machines (ITS) teach?" (Baker 2016; Ferster 2014, 2017; Roll and Wylie 2016; Woolf 2010).

The basic concept is simple: ITS is meant to stand-in for direct one-to-one learner–teacher interaction (the "gold standard"), providing proxy teacher intervention through automated immediate feedback and scaffolding that is responsive to the learner's individual needs, capacity and pace, as the learner (typically) works independently (Baker 2016; Ferster 2014, 2017; Roll and Wylie 2016; Woolf 2010). ITS therefore has the potential to solve two persistent problems arising from the industrial model of education: (1) learner–teacher ratios that do not enable consistent one-to-one learner–teacher interaction; (2) reliance on a one-way knowledge transfer (teacher to learner) format (Ferster 2014; Jonassen 1999; Mitrovic, n.d.). Both problems shape teacher presence (per the Community of Inquiry framework) and inhibit learning by limiting the frequency and processes of social interaction, which social constructivism and situated cognition describes as the means through which learners construct knowledge (Bredo 1994; Garrison et al. 2010; Jonassen 1999; Perera 2011; Simonson et al. 2012; Woolfolk et al. 2011). Historically, teacher presence and interaction have been particularly challenging problems in distance education (DE) contexts (Garrison et al. 2010; Simonson et al. 2012).

The implications of answering "Yes, machines can (should) teach" become more salient when the goals for contemporary education are considered, along with expectations for changing teacher roles within this new paradigm (Baker 2016; Ferster 2014, 2017; Roll and Wylie 2016; Woolf 2010). Roll and Wylie (2016) describe learning outcomes shifting from product (i.e. domain knowledge) to process (e.g. metacognition, critical thinking, self-regulation, collaboration, motivation), across diverse formal and informal learning environments that people traverse throughout their lifetime (p. 589). Rather than being the primary source of domain knowledge, teachers take on a supportive role, guiding learners in constructing their own learning (independently and/or collaboratively) through seeking, evaluating and synthesizing knowledge from diverse sources (Roll and Wylie 2016; Siemens 2005). Amidst this new learner–teacher relationship, machines can serve as an intermediary source for accessing domain knowledge, and as supportive tools helping teachers create/design learning experiences to adapt to individual learner level (Baker 2016; Roll and Wylie 2016).

ITS implementation has differed across countries and regions, however. Kronk (2018) describes that while in North America, ITS serves a primarily supplemental/supportive role vis-à-vis the teacher, in China, ITS (with more sophisticated MI) has taken over the teacher role completely in some cases. For instance, the ITS LAIX (pronounced “Likes”), a new Chinese start-up for English language learning, is completely teacher-free in its delivery (Kronk 2018).

Mitrovic (n.d.) describes that ITS applications facilitate communication and knowledge construction, with a high degree of control situated within the hands of the learner. In other words, ITS helps foster personalization and learner-centeredness through learning tailored to individual learner differences; supporting motivation; supporting self-direction; and pacing learning with individual learners’ capacity and existing knowledge and skills (Ferster 2014, 2017; Laurillard 2012; Reigeluth and Carr-Chellman 2009). Mitrovic (n.d., slide 11) identifies common ITS features that foster learner-centeredness:

- Adaptive sequencing
- Adaptive problem generation
- Student diagnosis
- Adaptive feedback generation
- Fading of scaffolding
- Adaptive dialogue management.

The one-to-one interaction “gold standard” is clearly reflected in conventional ITS structure, which embeds a student model comprising a qualitative rendering of the individual learner’s persona (behaviour, emotions, existing skills and knowledge), which informs how the ITS applies the domain model and tutoring model (Baker 2016; Brusilovsky 1999; Ferster 2014, 2017; Huang and Chen 2016; Mitrovic, n.d.; Nye 2015; Roll and Wylie 2016).

Figure 4.1 provides a sense of how these three models intersect and are mutually informing. Ferster (2017, para. 12) describes that ITS contains “*a semantically connected conceptualization of the content to be taught, a way of knowing what the learner does and doesn’t understand, and a delivery method that adapts that instruction accordingly*”. Figure 4.2 depicts this in application.

Applications of ITS align well with constructivism and the ideal of personalized learning by leveraging technological affordance for integrating multi-model learning objects and tasks (Perera 2011; Rizzotto 2017). For example, Shufti, an ITS developed at the University of Alberta in Canada, for students learning to identify lesions in radiologic images, capitalizes on kinetic user input to foster the learner’s development of both visual and psychomotor skills (Johnson and Zaiane 2012, 2017). The learner is presented with a radiological image and moves either their finger or the curser around the image on the screen to identify lesions. A virtual thermometer appearing

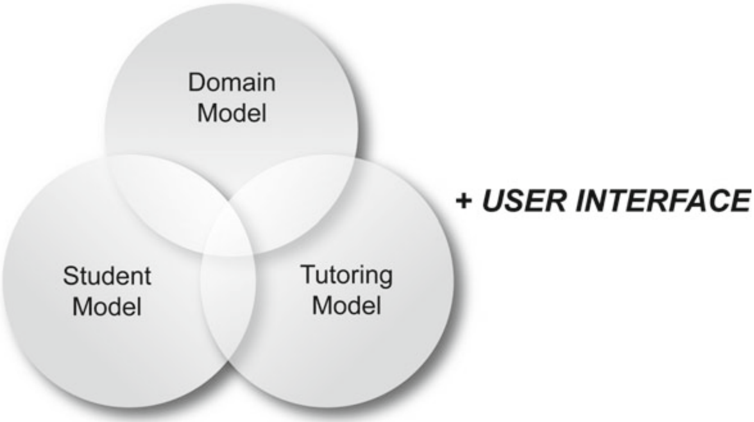

Fig. 4.1 Conventional ITS structure (modified from Bourdeau & Grandbastien, 2010). *Note* Domain Model = content knowledge; Student Model = compilation of data regarding student behaviour, existing knowledge and skills, emotions, etc.; Tutoring Model = pedagogical strategies

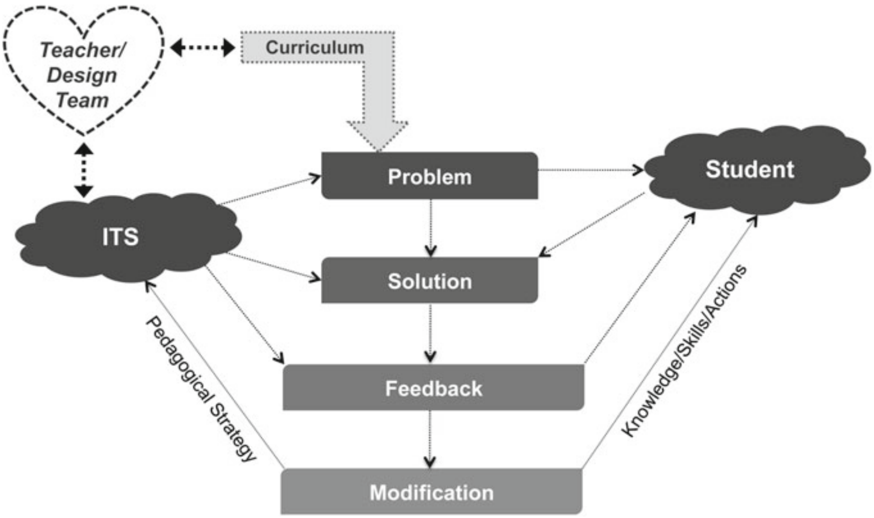

Fig. 4.2 Typical ITS framework (The framework becomes more complicated with specific approaches to modelling, such as constraint-based modelling (Bourdeau and Grandbastien 2010; Brusilovsky 1999; Desmarais and Baker 2012; Huang and Chen 2016; MacLellan 2017; MacLellan et al. 2015; Westerfield et al. 2015) (from Brusilovsky 1999, with modifications). *Note* We have added the "Teacher/Design Team" element to Brusilovsky's framework, to capture the shift towards collaborative instructional design and how it may be positioned within the typical ITS framework

on-screen adjacent to the radiologic image provides an adaptive visualization of the learner's identification accuracy: As the student's finger or cursor gets closer to the lesion in the image, the thermometer's virtual mercury rises and approaches red on the blue–red spectrum (red = warmer = closer; blue = colder = farther away). The ITS prevents the learner from advancing to the next level in the activity, until the learner has demonstrated mastery of the targeted identification skills at that level. Not only does Shufti support the visual and psychomotor skills needed for working with radiological images, but also enables students to gain experience using a tool that is used in clinical practice[4] (Johnson and Zaiane 2012, 2017).

Shufti is an example of technological and pedagogical integration that redefines learning (per Puentedura's SAMR[5] model) (Puentedura 2014). In other words, Shufti enables learning that would not be possible without the use of the technology. Shufti's interface allows for authentic kinetic user input and is responsive to this input with a sensitivity that no human teacher could achieve. This would be especially true in a strictly DE context, wherein the teacher could not easily observe the minutia of the student's psychomotor skills as the student is working (Baker 2016; Johnson and Zaiane 2012, 2017; Roll and Wylie 2016). Shufti demonstrates how the technological affordances of learner–machine interaction via ITS can be leveraged to foster constructivist learning.

However, as an application of MI, ITS in general have failed to leverage the affordances of MI for constructivism in human learning, and, as Baker (2016), Ferster (2014, 2017) and Woolf (2010) suggest, ITS have fallen short of their promise to revolutionize education. These failures have little to do with the technological possibilities, and rather stem from limitations in how theory, pedagogy and imagination have informed both ITS programming and implementation.

Figures 4.1 and 4.2 clearly reflect that the conventional ITS structure and implementation framework privileges domain knowledge, rather than focusing on the process learning that Roll and Wylie (2016) describe as a critical goals for twenty-first century education (discussed below).

In general, the focus has been on how ITS can promote learner-centredness and enable personalized learning as solutions to the logistical challenges of one-to-one learner–teacher interaction within the backdrop of the industrial education model (Baker 2016; Ferster 2014, 2017; Roll and Wylie 2016). However, this focus foments a teacher-centred approach, with the embedded assumption that one-to-one learner–teacher interaction is the "gold standard" (Baker 2016; Roll and Wylie 2016). As ITS development and implementation move forward with more sophisticated applications of MI, this assumption must be abandoned, so that focus can be resituated to how learner-ITS interaction might more fully support learning towards the twenty-first century education goals that Roll and Wylie (2016, p. 508) identify: skills in

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[4]Shufti2, the second iteration of this ITS, has been implemented in clinical settings and is utilized for clinical diagnostics by radiologic imaging technicians and radiologists (Johnson and Zaiane 2012, 2017).

[5]**S**ubstitution → **A**ugmentation → **M**odification → **R**edefinition.

communication, metacognition, critical thinking, self-direction, motivation and collaboration. This will require changes in how ITS interacts with both teachers and learners, and in how ITS mediates learner–teacher interaction. Roll and Wylie (2016) ask why would we limit ITS use to mimicking human teachers, when ITS can do in learning contexts what humans cannot do?

4.3 It's Time for Intelligent Tutors to Live up to Their Promised Potential

ITS and MI have historically been intertwined, though to date, ITS has been slow to leverage the affordances that MI offers. However, the 2018 New Media Consortium Horizon Report for Higher Education (Becker et al. 2018) estimated a two-to-three year time to adoption for adaptive learning technologies and MI, linking this to expanding capacities for personalized learning. Complementing this, training targets around the world aim towards producing skilled MI programmers, as well as supporting educators in gaining MI competencies (Baker 2016; Crowe et al. 2017; Nye 2015). The time is right, and the opportunity is here, for ITS to be re-imagined.

4.4 Learning Outcomes and Pedagogical Competencies for Emerging Learning Environments

Roll and Wylie (2016) assert that the following three areas should inform ITS development, and ITS and pedagogical integration:

(1) Educational goals

To address the needs of twenty-first century learners and our global society, learning outcomes must transition from domain knowledge[6] to adaptive process skills: communication, critical thinking, metacognition, motivation, self-direction and collaboration (Roll and Wylie 2016, p. 589). New learning taxonomies and assessment strategies must also be developed and implemented, to effectively evaluate these process skills and to better enable assessment outside formal education environments (Roll and Wiley 2016).

For instance, since much domain knowledge resides in databases and is instantly accessible through connected devices (including mobile devices), learning and

[6] Roll and Wylie (2016) note that much of the ITS research conducted to date has focused on domain-level learning, whereas research on motivation has been limited to measuring learner satisfaction, rather than other aspects of motivation such as self-efficacy.

assessment must support learners in developing skills for finding, evaluating,[7] interpreting,[8] synthesizing, sharing and using information when needed, rather than the acquisition of factual knowledge (Floridi 2013, 2014; Roll and Wylie 2016; Siemens 2005).

(2) Teacher/Facilitator (Classroom) Practices

Teacher competencies and education research must focus on how technology influences pedagogy, in concert with twenty-first century learning goals, including what aspects of teaching may be replaced by technology. Pedagogy, across learning contexts, must place greater emphasis on experiential learning, focusing on authentic learning content (e.g. everyday tasks and challenges), settings (e.g. at home, in the workplace, in public spaces), multi-modal language (such as text, music and code), and manner (learner and peer actions and interaction) (Floridi 2013, 2014; Roll and Wylie 2016).

In conjunction with this, Roll and Wylie (2016) suggest the complexity of learning activities and assignments must also increase, to include problem-based learning, collective knowledge construction, information seeking and technology/information literacy. This shift will require teachers to attain new pedagogical competencies, including facilitation (rather than domain knowledge transfer), interpersonal skills (e.g. emotion-based responses), intuition, digital skills and collaborative skills for working as part of instructional design teams or working collaboratively with students (Floridi 2013, 2014; Mitrovic, n.d.; Roll and Wylie 2016; Siemens 2005).

(3) Environments

Roll and Wylie (2016) describe two dimensions relating to learning environments: First is the technology ecosystem, which embeds multiple spaces (contexts) that both learners and teachers move across in their everyday lives. Pedagogy must shape learning to parallel “organic” technology-mediated processes, fostering digital literacy that is relevant across the ecosystem.

Second is technological affordance for context awareness and novel forms of (collaborative) learning engagement (Roll and Wylie 2016). As an example, Roll and Wylie (2016) describe mobile device sensors (such as GPS) and novel input devices (such as cameras), which can foster direct interaction among learners as they move within distal contexts. In this example, an ITS could analyse how learners interact and how devices interact, and either directly adapt tasks to foster collaborative learning, or report to the teacher who would then provide design intervention (Baker 2016; Roll and Wylie 2016, p. 594).

A takeaway from the above is that social constructivism is enhanced through support/guidance, and that appropriate support/guidance for twenty-first century learning entails a partnership between teacher and machine (Baker 2016; Roll and Wylie 2016).

[7]Including the ability to evaluate knowledge half-life (Siemens 2005).

[8]Including multimodal interpretation (Floridi 2013, 2014).

Compared to traditional f2f contexts, distance learning has historically required a higher degree of learner independence, due to the inherent separation between learner and teacher (Simonson et al. 2012). Within contemporary distance learning contexts, the process skills that Roll and Wylie (2016) identify, and technology literacy in general, are iteratively constructed as learners engage in learning activities, synchronously and asynchronously, independently and collaboratively (Floridi 2013, 2014). Crowe et al. (2017) point to both curriculum and administrative teacher/developer task support as an important benefit that ITS may offer for DE contexts.

4.5 Moving Practice Forward: Learning Analytics & ITS Reporting to Leverage Human Intelligence

Baker (2016) argues that intelligent machines should not be the end-goal of technological advancement in education:

> Perhaps instead what we need, what we are already developing, is stupid tutoring systems. Tutors that do not, themselves, behave very intelligently. But tutors that are designed intelligently, and that leverage human intelligence. (p. 603)

In other words, Baker envisions intelligence *amplification*, whereby human decision-making is informed by machine-mediated data mining and learning analytics (Baker 2016; Siemens 2013; Siemens and Baker 2012; Sin and Muthu 2015). The idea is that, rather than designing sophisticated machines that embed complex student modelling that automates personalized learning (see Fig. 4.1), the machines are instead designed as tools that intelligently collect and report complex data to humans for analysis, to inform instructional design and teacher intervention.

Baker (2016) notes that ITS has unique affordances that could facilitate this approach, within both f2f and DE contexts, such as the ability to report to multiple human decision-makers simultaneously; and the ability to report to teachers in real-time, so that teachers can immediately implement interventions.

One implication is that ITS development focus on intelligent system design that aids human decision-makers to identify when intervention is needed, what intervention is needed, how to implement the intervention, and why the intervention works (Baker 2016). Designing systems that capture the richest possible data from learners, to inform teachers, instructional designers, etc., would be one aspect of this. The critical point here is that decision-making is situated within the hands of a human, rather than being an automated solution determined by the ITS (Baker 2016).

Baker (2016) points to the ASSISTments ITS as an example where this iterative approach has been successful in supporting personalized learning and learner achievement. Teachers receive daily reports summarizing data drawn from student work during the previous day (such as frequent A/B tests, which Baker describes serve as mini randomized control trials), and use this data to tailor subsequent learning content and activities (Baker 2016).

The impetus for exploring a different trajectory for ITS development and implementation stems from a number of observations of current ITS limitations:

- MI in facilitating learner-ITS interaction has not been as robust as anticipated;
- ITS has not been effectively trialed in semantically complex subjects, such as English or history;
- ITS privileges domain knowledge;
- ITS does not yet integrate easily with learning management systems, because the programming requires specific technical expertise;
- ITS development is labour-intensive; and,
- Automated systems (and interventions) tend to be brittle (Baker 2016; Ferster 2014, 2017; Nye 2015; Roll and Wylie 2016).

Roll and Wylie (2016) describe that:

> Presently, [ITS] developers develop their own content. One rare exception is ASSISTments, which uses homework assignments from existing textbooks. However, this is very labour intensive. In addition, this effort is decontextualized by nature and harder to adapt and adopt. Instead, we suggest to build [ITS] that operates as a shell or an envelope for existing learning objects. (p. 594)

Roll and Wylie (2016) suggest these existing learning objects might include open content from MOOCs, Wikipedia, open educational resources (OER) repositories, browser add-ons, and open assessment tools. Baker (2016) contends this approach might help with system scalability, something that has been problematic for systems that embed complex structural models.

Both system complexity and lack of openness are aspects that contribute to automated ITS being brittle (Baker 2016). Baker (2016) describes that:

> [A]n automated system cannot recognize when a model is clearly wrong; and if an automated intervention is not working, it is difficult for the system to recognize and correct for this. (p. 607)
>
> and,
>
> [S]tudents change over time; automated systems need to be checked and revised over time. (p. 608)

Baker (2016) points out that humans are flexible, however; and suggests that ITS be designed to foster a human–machine partnership leveraging the affordances of each: "*What humans cannot do is sift through large amounts of data quickly, but, once informed, can respond quickly*" (p. 608).

4.6 How Can (Should) ITS Teach? New Pedagogies for New Types of Interaction

There is a critical disconnect between ITS development/implementation and contemporary learning theory. Although existing ITS has been effective in supporting personalized learning, acquisition of domain knowledge has remained privileged as a primary learning outcome, and this is clearly reflected in the conventional ITS model-based structure (Fig. 4.1) and application framework (Fig. 4.2). This structure is consistent with constructionism, in which knowledge is individually constructed through a learner's interaction with their prior experience, and with constructivism, in which knowledge is individually constructed through a learner's interaction with their environment (Jonassen 1999; Perera 2011). However, in focusing on the individual, ITS structures to date have been inconsistent with (1) social constructivism, in which learning is a collaborative process wherein individuals construct knowledge through interacting with others' experience as part of the learning environment; and, (2) situated cognition, in which knowledge is linked to action and specific context that is constituted through interaction with others (Bredo 1994; Jonassen 1999; Perera 2011). It is collaborative environments that both Baker (2016) and Roll and Wylie (2016) envision for the future of ITS for both learners and teachers, to address the process learning that is critical for the goals of twenty-first century education (Baker 2016; Roll and Wylie 2016).

Laurillard (2012) describes teaching as a design science, an approach that is particularly appropriate for technology-mediated learning environments. The idea is for a teacher-design team to design learning experiences (leveraging the affordances of media/technology, matched to task and learning outcome) that enable the iterative cycles of interaction and knowledge construction/modification depicted in Fig. 4.3, with teacher intervention inserted at regular points in the cycle. Although learner–teacher interaction is not direct, teacher presence nonetheless remains present. Of

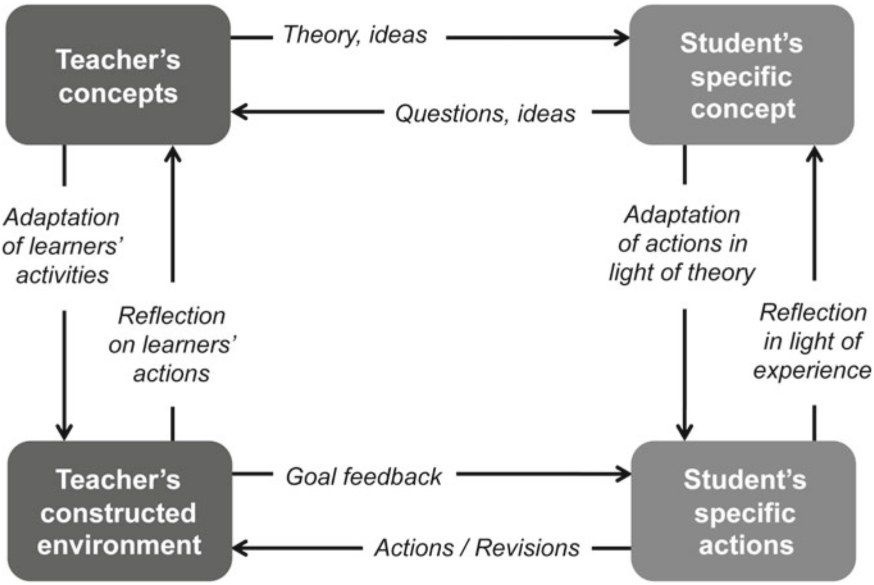

Fig. 4.3 Laurillard's Conversational Framework (from Laurillard 2012)

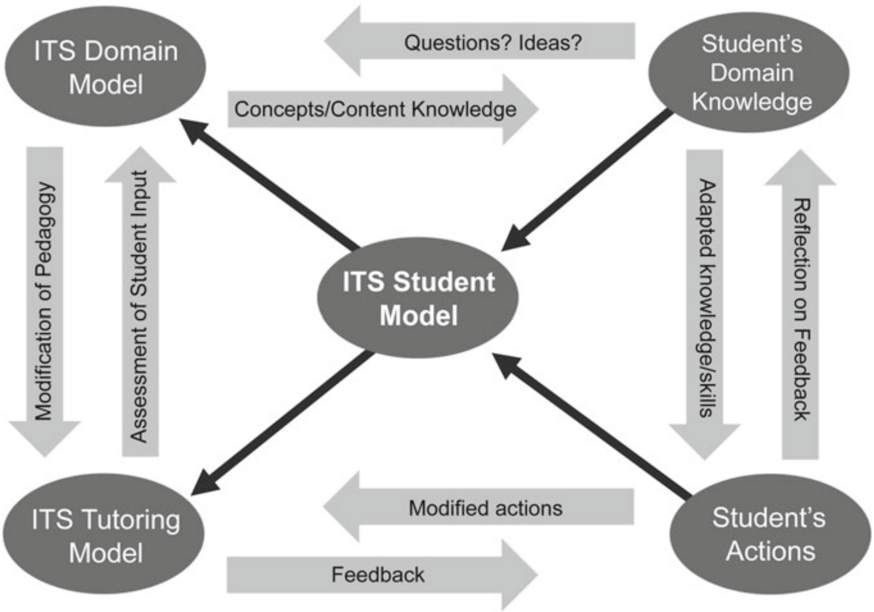

Fig. 4.4 Conventional ITS framework mapped to Laurillard's (2012) Conversational Framework

note, this framework also encompasses interaction with other learners and interaction with technology.

The ITS framework depicted in Fig. 4.4 centralizes interaction in a way that is consistent with both social constructivism and situated cognition, embedding the process skills that are relevant to twenty-first century education and lifelong learning (Bredo 1994; Jonassen 1999; Perera 2011; Roll and Wylie 2016). However, expanding on Laurillard's (2012) Conversation Framework, Fig. 4.4 depicts how knowledge is constructed through interaction with both others and with machines, wherein machines contribute to the creation of context/environment when they are incorporated into the learning experience. In other words, machines become part of the "social" environment and contribute to learners' collective and individual knowledge construction.

Approaching ITS development and implementation from this perspective may be particularly important for DE contexts, wherein immediacy and teacher presence might be enhanced through aspects of ITS design premised on the iterative cycles of interaction and knowledge construction depicted in Figs. 4.3 and 4.4: Learner–teacher and learner–learner interaction may not need to be direct, if learner-ITS interaction is able to provide a collective environment comprising all (Garrison et al. 2010; Laurillard 2012; Simonson et al. 2012). Distance, therefore, may not be the barrier it once was in DE, and may actually represent an enhancement that f2f contexts adopt through implementing ITS, if richer environments are able to be created through the use of technology.

Another shortcoming of conventional ITS structure is that most application frameworks privilege technical components, and omit the collaborative teacher/design team component, which is added to Fig. 4.2. The addition of this teacher/design team component to Fig. 4.2 is a simple way to help developers re-imagine ITS possibilities for teaching and learning, providing a vision of where human decision-makers might be integrated within learner-ITS interaction, in line with Baker (2016) and Roll and Wylie (2016). Baker (2016) goes so far as to envision ITS that embeds intelligent automated supports for teachers, aggregating best practice guidelines or crowd-sourced recommendations, and flagging these to teachers when deviation is detected.

4.7 Some Cautionary Reflections

Britain's industrial revolution between the 1700s and 1900s saw technological and industrial advancements that rapidly moved human development (economic and otherwise) forward, while at the same time creating new dimensions of social disenfranchisement and human suffering (Industrial Revolution Industrial Revolution 2018). Advances in MI have brought us to the precipice of our next techno-industrial leap promising revolutionary changes to the human condition, but with perhaps even greater potential for human tragedy (as technology invades further into private, personal spheres) if we are not mindful and purposeful as we proceed.

4.8 Threats to Personal Freedoms

Our initial experiences with the scale and spread of Internet ventures powered by machine-mediated data mining and MI have provided society with some experiential learning on the kind of threats to privacy that data mining poses. With the student model continuing as a critical programming structure enabling ITS MI to support personalized learning, and with learning analytics feeding into this, ITS will have the capacity to embed an increasingly detailed psychological profile of the student, including reflections of the student's private thoughts (Pardo and Siemens 2014; Rizzotto 2017; Slade and Prinsloo 2013).

Aside from obvious issues regarding data security, protection of and access to personal information, and how the use of personal information may impact the person, important issues relating to new types of learner–teacher interaction may arise from ITS MI advancement. For instance, what potential is there for the creation of (new) hierarchy within the learner–teacher relationship, privileging the teacher who has access to the student's detailed psychological profile? (Buckreus 2018). And how might this hierarchy influence student engagement in terms of social presence? For instance, how might an environment of surveillance influence student motivation?

Haridy (2018) describes how social presence is impacted in one f2f Chinese classroom where an MI-enabled device is used for behaviour management. The device scans the room every 30 seconds, and records and provides metrics to the teacher, which may be used to inform intervention. One student from this classroom describes his experience:

> Previously when I had classes that I didn’t like very much, I would be lazy and maybe take a nap on the desk or flick through other textbooks. But I don’t dare be distracted since the cameras were installed in the classrooms. It’s like a pair of mystery eyes are constantly watching me. (Haridy 2018, para. 5)

It is easy to envision how surveillance strategies like this could support teacher responsiveness and personalized learning overall, especially in distance learning contexts. However, the student quote above reminds us that, as MI development and implementation proceeds, we must be mindful of potential costs that may end up counteracting our benevolent purpose (Pardo and Siemens 2014; Rizzotto 2017; Slade and Prinsloo 2013). The example described here demonstrates how ITS MI privileges extrinsic motivation, and has encouraged the student towards less-than-authentic social presence (Haridy 2018; Garrison et al. 2010).

4.9 Threats to Meta-skills and Metacognition

Siemens’ (2005) *connectivism* framework emerged to account for learning relating to new meta-skills that are relevant to our current and future information-based global society. These meta-skills include:

- delineating patterns and connections within a mass of technology-mediated knowledge that is rapidly changing/increasing and only tenuously under the learner’s control;
- evaluating the value of content (i.e. whether information/knowledge is worth being learned); and
- determining when and what knowledge should be retired and replaced with updated knowledge (the meta-skill of unlearning obsolete knowledge). (Buckreus 2014, para. 3)

As described above, the goals of education overall are shifting towards communication, critical thinking, self-regulation and metacognition, all of which align with connectivism (Roll and Wylie 2016; Siemens 2005). One support that MI offers is the ability to scrub the Internet to aggregate and tailor content to match individual learner needs, a time-saving affordance for both learner and teacher. (This integrated capacity could be especially supportive for DE learners, who may not have easy access to traditional institutional supports, such as subject matter librarians.)

An important meta-skill for our current and future information-based society—across learning, workplace and personal contexts—will be learning how to use MI-enabled machines to perform these tasks for us (Siemens 2005; Rizzotto 2017). However, fostering development of this meta-skill in the learner, without attending also to the development of curatorial and evaluative meta-skills, may pose a risk to metacognitive development by situating too much of the strategic decision-making in the virtual hands of a machine (Floridi 2014; Siemens 2005). If the MI revolution is to position us, as members of society, to take on more strategic roles vis-à-vis machines, as Rizzotto (2017) describes, then one scenario might be an ITS MI that scrubs digital content and reports options to the learner, but with decision-making left to the learner regarding what content to select to best match their task-at-hand and learning goals (a process that itself could become a loci for skills assessment). However, it will be ideal if the machine can be taught how to select genuine and appropriate learning materials and strategies to match the level of the learner.

4.10 Threats to Digital and Educational Equity

DE and mobile learning (mLearning) in particular have supported critical education gains in developing nations/regions, and ITS MI offers great potential for this trajectory continuing, with "the right" implementation strategies informed by diverse user contexts, and the use or creation of flexible and modifiable platforms (Nye 2015).

In a recent systematic review, Nye (2015) reported that the majority of ITS research has focused on developed regions (Europe and North America) and on computer-based interfaces. Research bias, such as this, informing ITS development and privileging the already privileged, could neutralize the gains towards equity that DE and mLearning have fostered (Nye 2015). Not only could developing regions be excluded from access to important technological advances, but also from the twenty-first century learning these technologies support (Nye 2015; Roll and Wylie 2016). Broader ramifications could include reducing developing regions' hard-won competitiveness within the global economy. A caveat to this is that technological and socioeconomic inequities persist even within developed regions,[9] which DE and mLearning could play a critical role in addressing.

ITS and MI research and development must proceed, informed by equity as a constitutive goal. In doing so, not only might worldwide digital and educational inequity be addressed (for common socioeconomic benefit), but technological and pedagogical innovations may be discovered that are relevant for learners in developed and developing regions alike (Nye 2015).

4.11 Conclusion

The future of MI and ITS in education will move towards more integration in the Internet of Things era with connected digital systems, offering new affordances for both learner and teacher, and leveraging new types of technology-mediated relationships that enhance immediacy and teacher presence to support learning. Development will

[9] e.g. First Nations and Inuit communities in Canada.

need to address the process skills relevant to twenty-first century education, within more personalized learning contexts. Learning analytics will aid in this personalization and will influence teacher roles relative to ITS and MI, supporting teachers in decision-making by collecting and reporting on data that teachers otherwise would not be able to (efficiently) access. With the use of neural networks and deep learning technology, machines will be able learn as they interact with learners to adapt the learning for individual learners. There will be a shift from designing “learning for all” to designing “learning for you”.

Though conventional ITS structure and implementation to date has largely focused on constructivist learning (conceiving of knowledge construction centred on the individual), shifting to target the process skills comprising twenty-first century education goals will move ITS development more towards social constructivism and situated cognition, which emphasize interaction as the means for knowledge construction. Coinciding with this shift, MI will take on an expanded role as a social actor in learning interactions, vis-à-vis learners and teachers.

In DE contexts in particular, new MI-powered technologies that foster interaction with fidelity, and that create richer experiential learning environments, will help mitigate the impact of separation between learner and teacher, rending the distinctions between f2f and DE contexts immaterial.

Glossary of Terms

Machine Intelligence (MI) Non-human intelligence, primarily residing in computer-based systems.

Artificial Intelligence (AI) See: Machine Intelligence.

Intelligent tutoring system(s) (ITS) A computer-based agent utilized for delivering personalized learning.

Learning analytics Indicators of the learner’s progress towards learning objectives/outcomes, aggregated from micro-phenomena data observed/collected (usually by a computer-based technology) about the learner’s activities and context, then analysed and reported to support responsive instruction and personalized learning.

Social presence Per the Community of Inquiry framework, the degree of authenticity in the online identity a user creates and utilizes in online interactions towards developing relationships and identifying with the community.

Twenty-first century learning/teaching/education Learning, teaching and education comprising skills and knowledge necessary for learning, working and living in an information-based society and emerging technology era.

Personalized learning Learning (including environments, tasks/activities, objectives/outcomes, content and pedagogy) adapted to the needs, strengths, capacity and pace of the individual learner.

Responsive instruction For the purpose of delivering personalized learning, pedagogy that adapts in response to indicators regarding the individual learner's progress towards learning objectives/outcomes.

Digital resiliency An institution's or organization's capacity to adapt to compete within twenty-first century's digital economies and environments.

mLearning Learning engagement via networked mobile device interfaces.

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Chapter 5
More Than a MOOC—Seven Learning and Teaching Scenarios to Use MOOCs in Higher Education and Beyond

Martin Ebner, Sandra Schön and Clarissa Braun

Abstract Since 2010, Massive Open Online Courses (MOOCs) have been one of the most discussed and researched topics in the area of educational technology. Due to their open nature such courses attract thousands of learners worldwide and more and more higher education institutions begin to produce their own MOOCs. Even the (international) press is full of reports and articles of how MOOCs can revolutionize education. In this chapter, we will take a look from a meta-level. After years of experiences with different MOOCs, we recognize that many MOOCs are used in different ways by teachers, lecturers, trainers and learners. So, there are different learning and teaching scenarios in the background often not visible to the broader public. Therefore, we like to address the following research question: "*How can MOOCs be used in Higher Education learning and teaching scenarios and beyond?*" In the study, the authors will focus on the seven identified scenarios how particular MOOCs were used for teaching and learning and therefore illustrate, that a MOOC can be "more than a MOOC". MOOCs are one of the key drivers for open education using Open Educational Resources. The use of open licenses for MOOC resources are the mechanism for potential innovations in learning and teachings scenarios.

Keywords MOOC · Inverse blended learning · Online learning · Curriculum · Flipped classroom

5.1 Introduction

Massive Open Online Courses, short MOOCs, are well known for many years and is an important part of the research area of Technology Enhanced Learning. More than 8 years ago, George Siemens and Stephen Downes started their first online course on open global online learning (McAuley et al. 2010; Perry 2010). Just a

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couple of months later, famous universities like Stanford, Harvard or MIT attracted thousands of learners all over the world with their MOOCs on their MOOC platforms (Carson and Schmidt 2012). In 2012 we celebrated the "Year of the MOOC" (Pappano 2012). Due to Sebastian Thrun, who attracted more than 160,000 participants with his course on Artificial Intelligence in the summer of 2011, MOOCs gained attention and got wide publicity (Fred 2012). Since then an online course with more than 150 participants (Dunbar number) was called MOOC if the crucial elements were fulfilled: The course must be open to anyone, online accessible and finally presented within a course framework (start- and end-time of the course, weekly new content, etc.).

In parallel, a lot of studies were carried out on how to improve online courses as well as the learning process (Khalil and Ebner 2016a, b). Especially the phenomena of a high drop-out rate was an issue and got more understandable (Jordan 2013; Khalil and Ebner 2014). In recent years, the topic "Learning Analytics and MOOCs" was one of the most investigated ones, due to the MOOCs' nature dealing with a huge amount of data (Leitner et al. 2017).

In this chapter, we like to go a step further and take a look from a meta-level. After more than 5 years of experience in development and implementation of MOOCs as well as MOOC platform provider, we saw different stories behind MOOCs and helped to carry out different learning and teaching scenarios. We realized that MOOCs are in many cases not only used as online resource. We have as well recognized that a single MOOC is often used in different scenarios by teachers, trainers, lecturers as well learners. Nevertheless, most of these scenarios are not very visible or transparent from the public perspective, as, e.g., the participation on that learning and teaching approach is not open to all. Therefore, we like to address the following research question: "*How can MOOCs be used in Higher Education and beyond?*". In the study, we will focus on learning and teaching scenarios on how particular MOOCs were used for teaching and learning and we will then give practical insights and outcomes.

5.2 iMooX—a MOOC Platform

iMooX is the first and until now the only MOOC platform in Austria. It was founded in 2014 by the University of Graz and Graz University of Technology aim to bring online courses to a broad public (Kopp and Ebner 2015).

Figure 5.1 is a screenshot of the actual start screen of the platform iMooX. Currently, about 50 different courses are available with a broad range of topics. Furthermore, more than 15 universities as well as three federal ministries in the area of German speaking countries in middle Europe are associate partners of the platform.

It is important to note that every course on iMooX uses Open Educational Resources explicitly, so, each single learning object holds open licenses (creative commons) (Ebner et al. 2016a). In contrast to other big MOOC platforms like Udacity or edX, iMooX interprets "open" in the sense of offering Open Education based

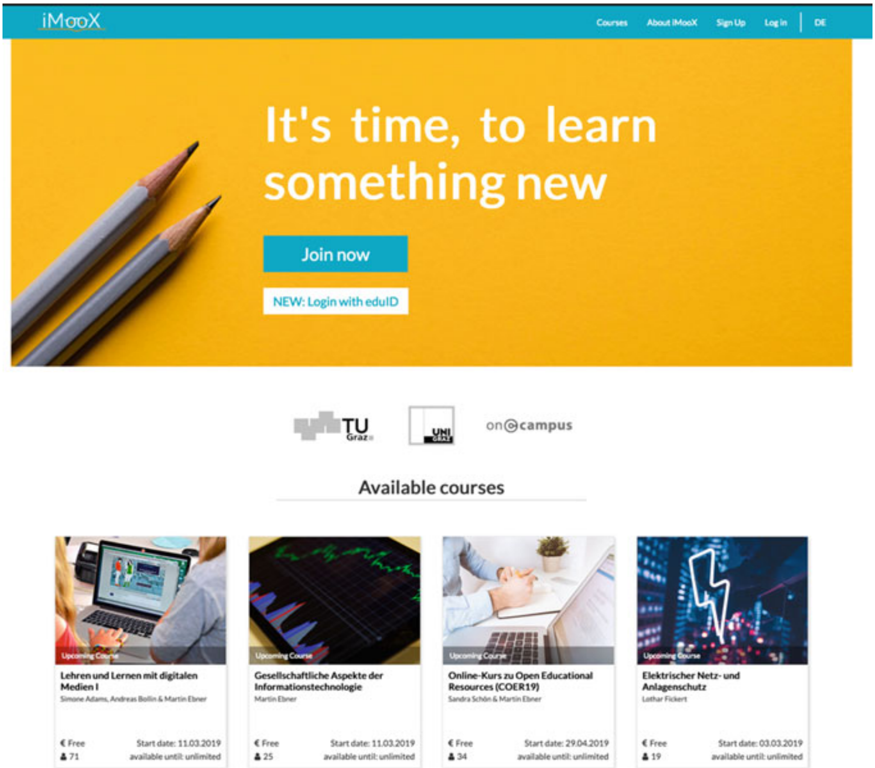

Fig. 5.1 iMooX—Austrian wide MOOC platform

on open-licensed learning objects and also does not delete or hide an ended course. So, each course is also available after its run for self-paced learning.

Each MOOC on iMooX follows more a less the same structure:

- Each MOOC is offered by a number of weekly sections. Usually, a MOOC lasts 6–10 weeks typically.
- The main content of each MOOC consists of a number of learning videos. At least one per week, often more than two.
- Each MOOC offers additional learning content (presentations, documents or hyperlinks) for in-depth study.
- Each MOOC holds a discussion forum for the exchange between presenters and students or students and students.
- Finally, each MOOC has a self-assessment for each section. If those are done with a success rate of at least 75% for each assessment the learner gets a certificate for the whole course. Additionally, in each week so-called badges can be earned (Kopp and Ebner 2017).

It can be summarized, that iMooX offers so-called xMOOCs extensively for years now and gathered a lot of experiences to implement MOOCs for a broad public in the sense of Open Education (Neuböck et al. 2015).

5.3 Research Design

In this research study, we are following a heuristic approach. We have examined all offered MOOCs done on iMooX since 2010 by conducting interviews with 11 MOOC experts, which also include instructional designers and platform providers as well as the corresponding lecturers in winter 2018/2019. We asked them how they finally integrated the MOOC within the corresponding curriculum and learning setting. We also examined how they embedded the MOOC in their daily teaching practice and how the MOOC was integrated. Afterwards, we clustered the examples and carried out a typology of seven different learning and teaching scenarios of MOOCs.

5.4 Typology of Learning and Teaching Scenarios with MOOCs

As a result of the conducted interviews, we clustered the possible ways how MOOCs were used and tried to get an overall approach. In summary, we found seven different ways to use MOOCs for teaching and learning. We, therefore, identified several features we used to distinguish diverse types, as face-to-face phases, MOOC or LMS usage and final assessment. We used these as well in our visualization of the different learning and teaching scenarios: Fig. 5.2 points out the legend for the following seven MOOC types.

For every MOOC type, we visualized a start and endpoint of the MOOC. Furthermore, any face-to-face part is pointed out as well as optional assessments to get credits for the course. “Forum: A/P” indicates either an active discussion forum in which MOOC participants are explicitly requested to post something in it or a passive forum which is only offered if learners have questions or comments on the course.

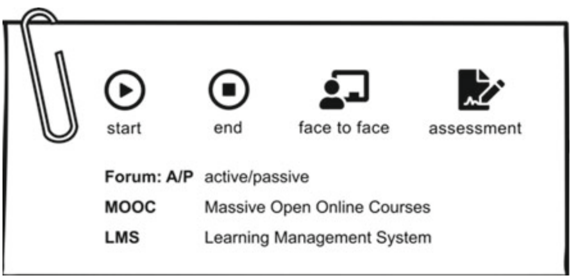

Fig. 5.2 Legend for MOOC types

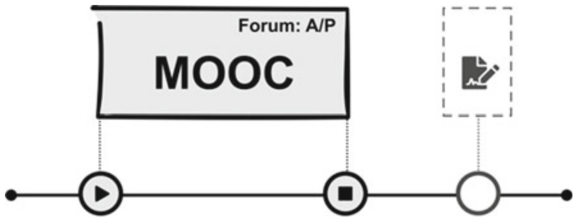

Fig. 5.3 The conventional MOOC

MOOC is the abbreviation for Massive Open Online Course and LMS stands for Learning Management System.

Type 1: **The conventional MOOC**

The first type of MOOC is a conventional one. It is an online course which reaches a massive amount of people. There is no further face-to-face interaction and often only mere online tutoring in the background (see Fig. 5.3). Sometimes, a face-to-face assessment is offered to get formal credits for the course. Due to the online nature of these courses, many learners can be found there, in other words, the course is characterized by thousands of learners worldwide.

A sample MOOC for the conventional type on the iMooX platform is for example "Pocket Code". This MOOC should help children between the age of 10–14 years to learn how to program a first game on their smartphones. The course itself is—as far we know—typically used completely online and it took 5 weeks in total to finish it (Grandl et al. 2018).

Type 2: **The Pre-MOOC**

In type 2, the pre-MOOC scenario, the MOOC starts and ends before the face-to-face education. This type of MOOC is used when students (or other learners) need to have some prior knowledge. This makes it easier for the lecturer to work with them in the face-to-face session (see Fig. 5.4). In some cases, there was an additional assessment before the face-to-face interaction and in some cases the lecturer decided to administer the assessment after the face-to-face session.

A sample MOOC on the iMooX platform is the "eMOOCs pre-conference MOOC". Here, a new concept for enhancing discussions at a scientific conference was introduced. The "best-paper-awarded" participants were asked to provide a short

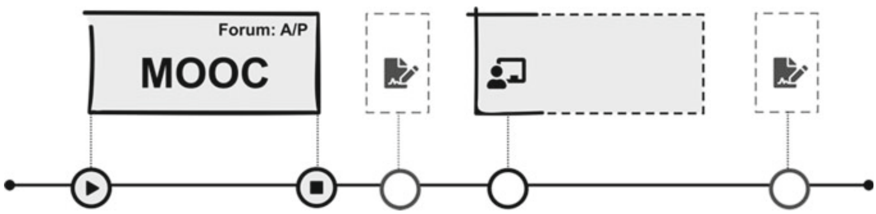

Fig. 5.4 The Pre-MOOC

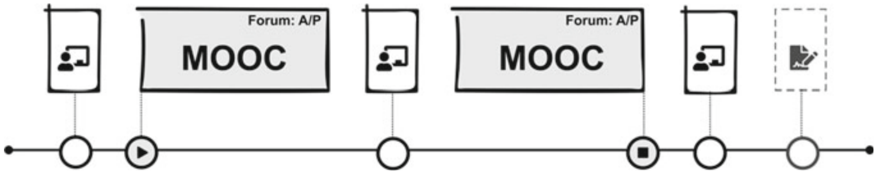

Fig. 5.5 The blended MOOC

video (about 10–15 min long) showing their results. Before the conference started, the videos and additional documents were provided. This concept was then sent out as a pre-conference MOOC. At the conference, a discussion session was given instead of classic paper presentation session.

Type 3: **The Blended MOOC**

The third type of MOOC follows the typical Blended Learning approach, therefore, we name it "Blended MOOC". It starts with a face-to-face meeting mainly to introduce learners to each other and is directly followed by a MOOC part. In the middle of the course, another face-to-face interaction takes place, followed by the second part of the MOOC. The whole learning scenario finishes with the final face-to-face session with an optional assessment in the end (see Fig. 5.5).

A sample MOOC on the iMooX platform is "Climbing with 360° videos" (original title in German: "Klettern mit 360° Videos"). This lecture followed the traditional Blended Learning concept. Students get theoretical skills via video at home and are now prepared for on-site training. Every week they went to the climbing hall and trained face-to-face with their teacher at the climbing wall. Students gave very good feedback on the MOOC arrangement: they stated that they had more time to practice climbing right at the wall because they have already done the theoretical parts online (Gänsluckner et al. 2017).

Type 4: **The In-Between MOOC**

The In-Between MOOC can be seen as a special form of the Blended MOOC, with the MOOC as only online phase (see Fig. 5.6). This type seems to be used very often in the area of continuing education.

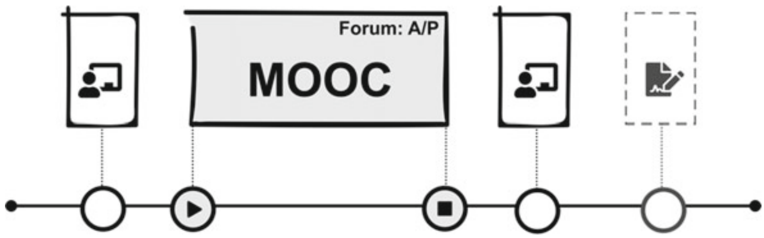

Fig. 5.6 The in-between MOOC

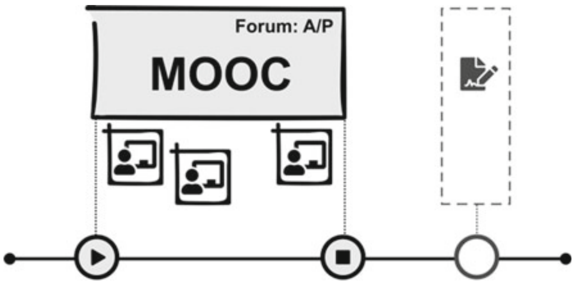

Fig. 5.7 The inverse-blended MOOC

Sample MOOC on the iMooX platform is “E-Learning & Law” (original title in German “E-Learning & Recht”) where students got an offline introduction session on the topic for about 8 h. Afterwards they had to do the MOOC and also complete the self-assessment with additional exercises. A final presentation of their results was provided two weeks after the end of the MOOC.

Type 5: **The Inverse-Blended MOOC**

The Inverse-Blended-Learning MOOC is following the design approach of “Inverse Blended Learning” (IBL) which is the opposite of Blended Learning. Instead of enhanced face-to-face education with online events, IBL enriches online course with face-to-face meetings by offering additional offline learning events on a regular basis. The offline sessions are not arranged like typical classroom lessons (see Fig. 5.7). They should be a place for exchanging learned issues during the MOOC. This approach should help so that learners can get guided training sessions to reflect on their knowledge and skills. Typically, these sessions are held offline in very small groups all over the world. In some cases, learners also used online webinar tools to participate in these “offline”—sessions.

A sample MOOC on the iMooX platform is “AEmooc—a digital tool for trainers in adult education” (original title in German “EBmooc—Digitale Werkzeuge für ErwachsenenbildnerInnen”). In this case, more than 40 different accompanying offline learning events were offered at different locations in German-speaking areas. The events differ arbitrarily in frequency (from weekly to occasionally), in duration (from half an hour up to two hours), in costs (5-299€) as well as in terms of content (from repetition to reflection of the content) (Ebner et al. 2017).

Type 6: **The Flipped MOOC**

The Flipped MOOC mainly follows the teaching scenario of flipped or inverted classroom (Li et al. 2015). Students study the content of the lecture at home by regularly using a MOOC as learning tool. After watching the videos, they come back to class for discussions, practical examples, and exercises. A final examination can be done if necessary (see Fig. 5.8). The Flipped MOOC could as well be seen as a variation of Type 3, a blended MOOC, with a focus on a special didactical approach: the MOOC is used for sharing knowledge to get room and time to apply, train or discuss these within the face-to-face meetings. Nevertheless, we see not so clear

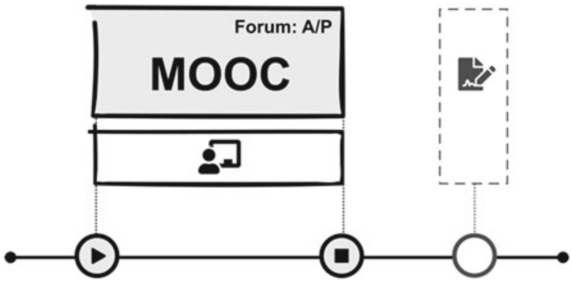

Fig. 5.8 The flipped MOOC

offline and online phases for Flipped MOOCs, as typically MOOC and face-to-face settings are used as parallel offers and not phases.

A Sample MOOC on the iMooX platform is the MOOC "Entrepreneurship for Engineers". Therefore, the lecture content was prepared by using videos in presentation style as well as interviews with experts. Students watched the whole MOOC at home and came to class every week to discuss their personal experiences with the lecturer, asking questions or giving feedback.

Type 7: **The Lecture MOOC**

This last MOOC typology is typically used in university lectures, where the MOOC itself is used as the online resource and a second system for the tasks. In order to get grades, the students have to do tasks which they also find online. Sometimes the MOOC is interrupted with face-to-face events and if necessary there can be a final examination at the end (see Fig. 5.9).

A sample MOOC on the iMooX platform is "Social Aspects of Information technology" (original title in German "Gesellschaftliche Aspekte der Informationstechnologie"). In this lecture, a MOOC was done by providing interviews with experts as MOOC content on a weekly basis. The students watched the videos for 10 weeks and wrote short essays about the MOOC's topics in parallel with it. The essays have been uploaded to the university-wide learning management system. Here, the whole lecture description, a discussion forums, and further support have been given to the students for further studies. In the end, students also had to upload the final certificate which verifies successful participation in the MOOC. The final grades were given

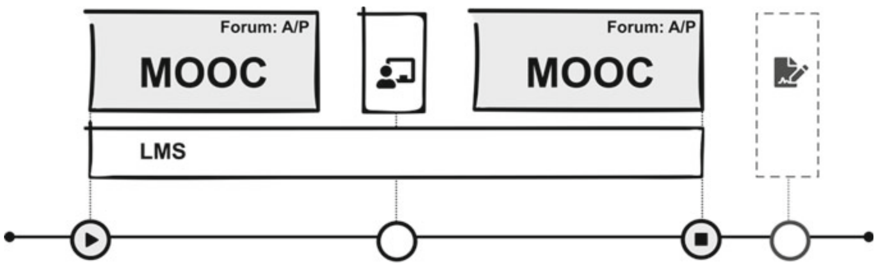

Fig. 5.9 The lecture MOOC

by additionally grading the essays. Typically, this scenario of a MOOC only works for students at a particular university, where they are currently enrolled. Of course, external participants can use the MOOC in the conventional mode (type 1).

5.5 Summary and Discussion

Within this contribution, we presented a typology of MOOC integration in current educational scenarios from higher education and beyond. We, therefore, identified the following seven types

- Type 1: The conventional MOOC—a purely online course for many users
- Type 2: The Pre-MOOC—an online course as preparation for the following learning event
- Type 3: The Blended MOOC—a MOOC that is integrated in-between several face-to-face learning events
- Type 4: The In-Between MOOC—is a special form of type 3, where the MOOC is in-between two face-to-face-events
- Type 5: The Inverse-Blended MOOC—a type of MOOC which is enriched by face-to-face meetings and events
- Type 6: The Flipped MOOC—a MOOC is used to flipped/inverted classroom concept: the MOOC prepares parallel for the face-to-face phases which are focused to discuss, train or apply knowledge
- Type 7: The Lecture MOOC—is accompanied by online activities in the LMS of an educational organization, which allows, e.g., additional non-public discussions and tests.

Of course, this new typology of MOOC application in educational scenarios is only a description of all potential usages. We see, for example, in several of the types the face-to-face meeting could be as well organized as an online meeting for a certain group (for example, in an LMS.). But we tried to focus to develop an overview of types, which does not describe any potential application but describes typical (new) usages of MOOCs in learning and teaching scenarios. This includes the possibility of needed changes and adaption of this typology in the future.

In summary, we as well provided insights and examples that MOOCs are not only and always conventional MOOC, even if there is no obvious different scenario or integration in higher education (or other educational sectors) visible at a first sight (e.g., the MOOC platform). So, we showed that a MOOC is in many cases "*more than a MOOC*".

5.6 Conclusion

To put it in other words, we learned that the lecturers use the MOOCs in many different ways and situations. This brings flexibility in their teaching because different learning scenarios with different learning and teaching scenarios, e.g., Flipped Classroom, Inverse Blended Learning, can be used. Can MOOCs be seen as drivers to innovate learning and teaching scenarios?

For us, this is a very obvious thing. The existence of these open and public available offers allows a lot of other usages as well as integrations in educational settings—even with the same MOOC, e.g., by several organizations such as universities) or within several branches (e.g., adult education as well as higher education) and within several scenarios (e.g., as in-between MOOC and pre-MOOC).

MOOCs should, therefore, not only be reduced as online available course materials, as the MOOC as well have the feature of a public available resource. Each MOOC is available to the general public which is a nice add-on for learners. MOOCs allow for discussions which have the potential for more perspectives, including international perspectives or interdisciplinary exchanges. This is an interesting feature for the presenter/facilitator and the hosting organization as well. If a lecturer wants to spread her/his knowledge a MOOC allows a very fast knowledge transfer from university to those who are interested in it. When we think about the European Bologna process and the idea to guarantee a fast and uncomplicated exchange of students, MOOCs will be highly enabling for this transfer. In a whitepaper about “Digital Bologna”, MOOCs are playing an important role there.

iMoox’ Open Educational Resources approach is such an enabler for many of new scenarios, especially if they are not provided by the original MOOC developers (and copyright holders). The open licenses allow to reuse any content anywhere. We saw that with more or less the same content different MOOC usages were provided. So, OER can be seen as a motor for the development of this (and potential future) new scenarios in higher education (see Ebner et al. 2016b).

It can be summarized that MOOCs have a very high potential to assist not only mere online learning situations but also to assist a mix between face-to-face and online learning scenarios. If the content is also available as Open Educational Resources, the exchange between other institutions and usage of external organization becomes rather simple and legal—OER works as motor. MOOCs can be a great driver for open education in a long run.

Glossary of Terms

MOOC massive open online course: a course of study offered over the Internet which is free and has a very large number of participants.

Inverse Blended Learning (IBL) Instead of enhanced face-to-face education with online events, as in Blended Learning, IBL enriches online course with face-to-face meetings by offering additional offline learning events on a regular basis.

Flipped Classroom is an instructional strategy and a type of blended learning that reverses the traditional learning environment by delivering instructional content, often online, outside of the classroom. It moves activities, including those that may have traditionally been considered homework, into the classroom.

OER Open Educational Resources are teaching, learning and research materials in any medium—digital or otherwise—that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions.

Pocket Code is learning tool for kids and teens aged from 10 to 17 to playfully discover how programming works. They can for example program their first own games interactive music videos, animations or other apps.

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Chapter 6
An Emergent Pedagogical Framework for Integrating Emergent Technologies into Curriculum Design

Norine Wark and Mohamed Ally

Abstract The current educational climate is in a state of flux. Emergent technologies is ushering in a new era, facilitating a dramatic shift from information scarcity to information abundance, while rendering the historically-dominant knowledge transmission model increasingly irrelevant as learners transform from passive knowledge recipients to active knowledge innovators, curators, and disseminators. The dilemma that educational stakeholders, *especially learners*, face is determining what educational paradigm most empowers them to thoughtfully and perpetually integrate emergent technologies for learning on demand during this tumultuous period and in the nebulous future beyond. Two disparate educational paradigms and three approaches to learning are considered herein. Next, a critical review of technology integration frameworks, models, and taxonomies indicate that none are sufficient for guiding stakeholders in helping learners develop the mindset that is required to learn within such dynamically-changing contexts. Thus, a Paradigm Framework is introduced. The framework encapsulates the traditional behavioural and emerging perceptual paradigms, as well as the shift between them. It also includes pedagogical and andragogical approaches to learning, as well as the emerging heutagogical approach. This framework helps stakeholders to identify existing learning contexts, as well as intentionally select or design contexts that cohesively bind theory with practice. The Omni-tech taxonomy included in the framework ensures that emergent technologies are also coherently integrated according to the theoretical and practical elements that define specific learning contexts. A practical example of how the framework can be used within an online graduate student context concludes the chapter.

Keywords Emergent technologies · Pedagogical framework · Curriculum design · Heutagogy · Pedagogy · Andragogy

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6.1 Introduction

The proposed chapter provides a theoretical framework for integrating emergent technology into any K-12 or higher education curriculum design within the context of learners' dynamic real and virtual worlds. The chapter begins with a broad overview of the current educational landscape. It outlines the global race by educational stakeholders to keep abreast of the dizzying array of exponentially-emerging, unpredictable technologies in their effort to harness the potential of these technologies for enhanced learning. The chapter then moves on to consider how best to prepare learners for lifelong and life-wide learning within the fluxing milieu of this educational landscape.

Two disparate educational paradigms, their related systems, contexts, and approaches to learning are described and a Paradigm Shift Model is presented. Next, an analytical summary of various technology integration frameworks, models, and taxonomies is provided before the Paradigm Shift Framework (Wark 2018) is introduced. The Paradigm Shift Framework (consisting of the Paradigm Shift Model and Omni-tech taxonomy) assist educational stakeholders in assessing current learning contexts by determining what educational paradigm and learning approach to emergent technology integration are being used in delivering curricula, and how this affects what is being learned about the identified technology. Perhaps more importantly, the framework is also designed to create and implement curricula that foster the mindset learners need to move beyond formal schooling competency measures to the lifelong, life-wide capacities characteristic of self-determined learning (Hase and Kenyon 2001, 2013).

Lastly, highlights from an exploratory transformative mixed methods dissertation (Wark 2018) offers readers with a practical illustration that employs the Paradigm Shift Framework to (1) assess one group of voluntary online graduate students' current learning environments and mindsets, and (2) determine how these factors affected their ability to integrate 16 emergent technologies included in the study.

6.2 Emerging Technologies and Learning Contexts

Any educational context may employ a myriad of emerging technologies, such as new device hard- and software, communication technologies (for example, the Internet and wireless connectivity), and old technologies that are used in innovative manners. Yet, emergent technologies are not just tools. They are much more than that, encompassing "concepts, innovations, and advancements utilized in diverse educational settings to serve varied education-related purposes" (Veletsianos 2010, p. 33). This more inclusive definition of emergent technologies may assist educational stakeholders in realizing that *who* is involved in a learning context, as well as *where, when, how,* and *why* learners use these technologies to learn matters significantly more than *what* technologies are chosen. In other words, emergent technologies can be used equally well to replicate and advance traditional educational contexts or to create and cultivate new ways of perceiving and interacting in the world (Wark 2018).

6.2.1 From Formal to Personal Learning Contexts

Major epochs in the evolution of humanity are typically precipitated by the widespread adoption of general-purpose technologies (GPTs; Brynjolfsson and McAfee 2014). One need only consider the Stone, Bronze, and Iron Ages, the stirrup, gun powder, and electricity to recognize the profound influence that technology has on our world. Oral and written language, Guttenberg's press, and the pencil, for instance, have had indisputable impacts on learning. Emergent technologies like the Internet, social media, and wireless communication are once again transforming the world of education. These innovative technologies are not only blurring the lines between traditional face-to-face (f-2-f) and distance education (DE), but also between formal and informal learning contexts, prompting growing recognition that learning extends beyond formal schooling and is, indeed, a lifelong and life-wide process (Collins and Halverson 2010; Palalas and Wark 2017a, b; Wark 2018).

An increasing number of post-secondary institutions are changing admission policies and using prior learning assessment recognition (PLAR) evaluation processes to award formal academic credit, based upon non-formal and informal knowledge and skills learners have earned through workplace learning, self-study, and informal DE (Collins and Halverson 2010; Conrad 2008). Certificates, digital badges, open badges, and micro-certificates are also awarded for industry-specific training achievements by technical organizations and companies and in online educational contexts, such as MOOCs (massive open online courses; Collins and Halverson 2010; Friedman 2014). Certificates and badges could be perceived as a threat to the traditional educational system that currently holds the monopoly on formal credentialing (Jacobs 2012). Nevertheless, the existence of these certificates and badges does highlight how views on learning are changing, as well as the role that emerging technologies play in enabling on-demand access to the specific knowledge, skills, and education that learners seek.

While translating the conception of education into a holistic system that merges formal and informal learning contexts into practical reality is a complex and multifaceted process, demanding rational and innovative thinking to circumvent unfortunate consequences for learners and society, there are substantive benefits to such an endeavour (Collins and Halverson 2010; Wark 2018). Research demonstrates that learners become more actively engaged, intrinsically-motivated, self-regulated, and therefore self-determined learners who demonstrate increased learning capacity when focused on personally-meaningful and relevant topics (Deci and Ryan 2002; Hase and Kenyon 2001, 2013; Jeno et al. 2017; Palalas and Wark 2017a, b; Pink 2009; Ryan and Deci 2000a, b; Sha et al. 2012).

Transformation to a holistic learning system can be facilitated by the use of individual educational plans (IEPs) with the support of other emergent technologies.

Such technologies enhance learners' abilities to connect and interact with human and non-human resources, and to form personal learning networks (PLNs), while dynamically and seamlessly merging their unique real and virtual worlds. Thus, by merging technology-enabled formal and informal contexts, learners are empowered "to customize, contextualize, and control their learning experiences according to increasingly individualized needs, time/space parameters, interests, and goals" (Wark 2018, p. 80), creating a personal learning environment (PLN) .

6.2.2 Omni-Learning

Over half of the world's population (51.8%) is now using the Internet and nearly 60% of households have Internet access (as opposed to 20% in 2005; ITU 2018). Less than half of households have a computer, though, which indicates that the Internet is also being accessed through mobile devices at home. Mobile access to telecommunication systems is also burgeoning. Mobile cellular subscriptions currently exceed the global population, although the spread is not as pervasive in developing countries as it is in the rest of the world. Furthermore, almost everyone lives within range of a mobile cellular network signal. Most of the population has access to networks of 3G or higher quality. Mobile networks are expanding faster than the percentage of people using the Internet. Finally, Internet traffic and international bandwidth are growing more rapidly than access to information communication technologies (ICTs) and the percentage of people using the Internet, indicating that people stay online longer and are engaged in activities that consume greater amounts of data (e.g., streaming videos, engaging in online gaming).

As the rapid spread of wireless ICTs across the globe continues, nearly limitless access to information and learning networks may soon be available to learners across the globe (Harsh and Sohail 2002; Idiegbeyan-ose et al. 2015). For instance, on-demand, even urgent, learning opportunities in the most isolated places imaginable are currently being made possible through advances in remote augmented reality (RAR; Ally and Wark 2017; ScopeAR 2019). Emergent technologies are indeed transforming the world of learning by "offering access, communication, inclusion, and sharing on a hitherto unknown scale. In short, these technologies are rapidly creating a global context for "omni-learning" (Wark 2018, p. 81).

Omni-learning is defined as "the ability to learn anywhere, anytime, with anyone, on-demand, typically with the support of emerging technology" (Wark 2018, p. 81). Such technologies assist learners in choosing what, how, where, when, why, and with whom they learn while fostering intrinsic motivation, promoting learner empowerment, and enhancing learner-determination. The adoption of an omni-learning mindset is becoming increasingly crucial during this turbulent era wherein nation-governed formal education contexts and knowledge transmission technologies are being supplanted by global learning contexts and exponentially-emerging multimedia knowledge capturing, innovating, curating, investigating, and communicating technologies (Bates 2005; Moore 1965/1998; Wark 2018). The task set before educators is to determine what educational paradigm most enhances learners' omni-learning capacity during this global knowledge shift and the unforeseeable future beyond. The Paradigm Shift Framework presented herein provides stakeholders with a theoretically-grounded foundation to foster the development of a learner-determined omni-learning mindset.

6.3 Shifting Paradigms

The previous section establishes the role that emergent technologies are playing in precipitating the shift of knowledge creation and ownership from formal learning contexts orchestrated by national political and educational leaders to self-determined learners within their PLEs. This section moves on to the theoretical foundations, systems, and approaches to learning that generate and sustain these contexts. A review of two educational paradigms and three approaches to learning are presented first. A Paradigm Shift Framework is then introduced.

6.3.1 Behavioural Versus Perceptual Learning Paradigms

The term, *paradigm*, was originally defined by Kuhn (1962) to identify camps, schools of thought, or "worldviews" among specific scientific groups, although the term is now applied to other disciplines as well. Paradigms are founded upon unique epistemologies, values, assumptions, theories, methodologies, and instruments. A *paradigm shift* involves the movement or change from one worldview or paradigm to another (Kuhn 1962). Brynjolfsson and McAfee (2014) point out that the invention of a GPT (like the stirrup, gunpowder, or the written word) typically catalyzes a paradigm shift which, in turn, dynamically transforms existing social, economic, political, cultural, educational, and other institutions in a given society. When the term, paradigm, is used in this discussion, it relates to specific worldviews on learning.

Two disparate paradigms are explored herein. Written accounts of the epistemologies underlying each one trace back to the Greek philosophers, Plato (427–347 BC) and Aristotle (384–322 BC). Plato, the rationalist, surmised that truth and knowledge were found within the individual. The empiricist, Aristotle, countered that truth and knowledge were only obtainable through sensory interaction with the external world (Hammond et al. 2001). Aristotle's epistemology was eventually adopted as the foundation for the behavioural paradigm, while Plato's became the foundation for the perceptual paradigm.

These opposing epistemic stances and resultant paradigms are manifested to varying degrees in the learning theories and approaches that have evolved from these notions over millennia. In practice, though, the most prevalent differences are who has ownership over knowledge, how that knowledge is distributed and ultimately, who controls learning (Emery 1981; Wark 2018).

The most prevalent paradigm of our day is behaviourism; it is also the first major paradigm to be adopted by twentieth-century educational institutions. Based on the Industrial Age model, the role of these "traditional" educational institutions is to disseminate government-controlled and funded mass public education. The educational system operationalizing the behavioural paradigm reflects a top-down hierarchal dictatorship. The curriculum is abstract, fractured, linear, one-size-fits-all, ageist, and determined by ranking power. The institution and instructor control instructional time, pace, place, content, resources, delivery, and evaluation. Transmission of sanctified, objective knowledge and facts is verified through measurable behavioural competencies and tangible product evidence. Learners are prompted to passively regurgitate accepted knowledge through a system of external rewards and punishments (e.g., letter grades) meted out by those in power. Learning officially occurs in the formal schooling context (e.g., face-to-face, laboratory-like classroom settings), typically during the learners' youth (Atkisson 2010; Gregory 2016; Hammond et al. 2001; Hauser n.d.; Kazamias 2009; Laliberte 2009; Tomic 1993; Wark 2018; Wark and Ally 2018).

The perceptual paradigm (also referred to as the "learner-determined paradigm") is based upon the belief that innate perceptions are the key to learning (Emery 1981). Thus, only learners can control their learning. Moreover, learning occurs naturally in any setting throughout life (Benson et al. 2007; Dewey 1897, 1903, 1916/2007, 2011; Emery, 1981; Hase and Kenyon 2001, 2013; Wark 2018). Through a continual process of synthesizing and generalizing individual perceptions (or "pattern-making"), people conceptualize and perceive in variances that help them to dynamically interpret the fluctuating world as they interact with it (Emery 1981; Wark 2018).

In a perceptual learning system, the institution is a networked democracy emulating principles of autonomy, diversity, openness, interactivity (Downes 2010), and responsibility (Freire 1970/1993). The curriculum is holistic, individualistic, and based upon a learner-determined IEP. The learner controls their learning throughout life within their unique PLEs with the support of their PLNs. Through this learning process, the learner hones their capacity for transformative learning and leading (Wark 2018). (Transformative learning is a dynamic blend of rational thought, involving logic and affective thinking, and creative intuition, leading to change in perception; Kant 1781/2013; Mezirow 1981; Peat 2000; Vygotsky 1986; Wark 2018.)

6.3.2 Three Approaches to Learning

The beliefs, values, and theories underlying these opposing paradigms are translated into praxis through varying methods and practices, or "approaches" to learning. This chapter considers three approaches to learning: pedagogy, andragogy (Knowles 1970, 1984), and heutagogy (Hase and Kenyon 2001).

6.3.2.1 Pedagogy

Pedagogy is derived from *paidogogos*, a Greek word meaning "leader of a male child." Thus, *pedagogy* may be understood as the art and science of teaching children (Palaiologos 2011). While the term, pedagogy, is often used as a general term encapsulating all approaches to teaching and learning (see, for instance, Freire 1970/1993; Murphy 1996), within this context pedagogy is considered as one specific approach.

Pedagogy emerged in monastic schools during the seventh century. Reinforced by the behavioural paradigm of the twentieth century, pedagogy became, and has remained, the dominant approach to teaching in all areas and levels of formal schooling (Emery 1981; Holmes and Abington-Cooper 2000; Keller 2008; Murphy 1996). The aim of this patriarchal approach is to transmit sanctified truths, facts, and logic from the politically, socially, and culturally dominant to the masses; learners' informal or incident knowledge and experience are rejected (Bourne 1917; Emery 1981; Freire 1970/1993). The government-standardized curriculum guides the transmission of age- or level-appropriate snippets of knowledge and skills (Murphy 1996), which may hold sparse relevance to the learners' real-world needs, interests, abilities, or contexts. Concentration is on the development of instrumental reasoning: rote memorization, description, classification, and tangible, measurable application of new learning to demonstrate understanding, solve problems, or operate as trained to (Murphy 1996). Teachers need to maintain strict control over sources and timing of environmental stimuli to ensure that learners absorb the "correct" associations and generalizations. With the incentive of externally-delivered rewards and punishments, students are expected to passively and compliantly regurgitate what may be beyond their capacity to understand. In such settings, student discipline and literacy precede knowledge acquisition (Emery 1981; Hase and Kenyon 2001, 2013; Murphy 1996; Wark 2018).

6.3.2.2 Andragogy

In 1833 Kapp coined the term, andragogy, to describe Plato's educational theory (Nottingham Andragogy Group 1983). Knowles later defined *andragogy* as the "art and science of helping adults learn" (Holmes and Abington-Cooper 2000).

Knowles (1973) asserted that pedagogy was teacher-driven content-transmission model concentrating upon what skills and information must be taught, whereas andragogy was a teacher-facilitated process-driven enterprise that helped learners to acquire skills and information with decreasing teacher support. Thus, the purpose of adult educators was to facilitate and support the development of self-directed adult learners (Holmes and Abington-Cooper 2000; Knowles 1984).

As envisioned by Knowles (1973), the andragogical classroom environment is less formal than the pedagogical one. The teacher is no longer the ultimate authority figure and source of knowledge; instead, mutual respect and collaboration are modelled. Learning becomes a shared teacher-learner process involving diagnosis of learning needs, development of plans, and engagement in experiential learning and problem-solving. Negotiated meaning and shared understanding are derived from discourse and interaction with the teacher, students, and possibly other experts. However, while the learner may control some aspects of the learning environment, the teacher retains final authority over the learning process, tasks, and assessment (Knowles 1970; Palalas and Wark 2017b). Given that andragogy represents a transitional process wherein control of learning oscillates between teacher and learner, it appears to represent a shift between the behavioural and perceptual paradigms.

6.3.2.3 Heutagogy

Heutagogy is defined as "the study of self-determined learning" (Hase and Kenyon 2001). It is a humanistic learning (not teaching) approach embodying "constructivism, neuroscience, cognition, affect, motivation (Pink 2009), active learning and reflection (Argyris and Schön 1978; 1996), Complexity Theory (Lissack 1999; Stacey et al. 2000; Waldrop 1992) and systems thinking (Blaschke and Hase 2016; Emery and Trist 1965; Emery 1993; Hase and Kenyon 2001, 2013)" (Wark 2018, p. 42).

While pedagogy focuses upon what to learn (the product) and andragogy centers on how to learn (the process), heutagogy encompasses the what, how, when (timing), where (context) , why (the meaning), and who (who is involved and who controls the power) of learning (Hase and Kenyon 2013; Wark 2018).

In a heutagogical learning environment, learners must relearn how to accept their "own perceptions as a direct form of knowledge and [learn] to suspect forms of knowledge that advance themselves by systematically discounting direct knowledge that people have in their life-sized range of things, events and processes" (Emery 1981, p. 41). Learner needs, goals, and PLEs dictate the learning process, timing, and outcomes. The educator (or "learning leader"; Hase 2014, 2015) is a transient facilitator who creatively and dynamically assists the learner in assuming control and responsibility for their own learning. The acquisition of transmitted knowledge and skills demonstrated through competency measures in formal schooling contexts is replaced by active, relevant, and meaningful engagement in the learner's PLE that fosters learning capabilities (defined as "deeper cognitive processes… using competencies in new contexts and challenging situations"; Hase and Kenyon 2013, p. 25). The aim of heutagogy is to: enhance higher levels of cognition, deeper levels of reflection, positive emotional development, creativity, and the intrinsic motivation to be lifelong self-determined learners (Blaschke 2012; Blaschke and Hase 2016; Hase and Kenyon 2001, 2013).

The following Paradigm Shift Model encapsulates both paradigms and all three learning approaches.

6.3.3 Paradigm Shift Model

Expressed graphically as a Venn diagram (Fig. 6.1), the Paradigm Shift Model assists

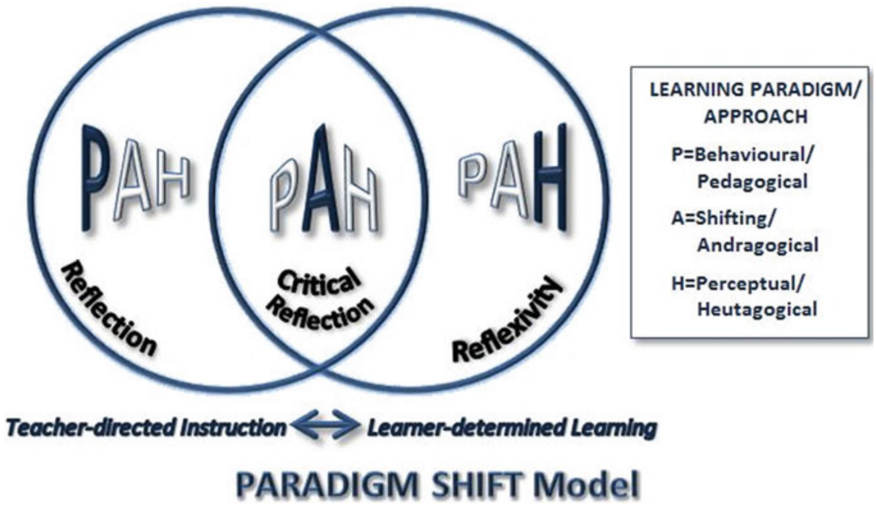

Fig. 6.1 Paradigm shift model illustrating movement between a teacher-directed and student-determined approach to learning. *P* indicates a pedagogical, *A* an andragogical, and *H* a heutagogical approach to learning

educational stakeholders in identifying existing paradigms, approaches, and contexts, and in the intentional generation of future theoretically- and practically-cohesive learning contexts.

The acronym, PAH, is used in the diagram to represent the relationships between various learning paradigms and approaches. To illustrate, the large *P*, mid-sized *A*, and small *H* in the left circle indicate that the behavioural paradigm and pedagogical teaching approach are most prevalent in this learning context. The mid-sized *A* indicates that some shift between paradigms and an andragogical approach to learning may be present in this context as well. Finally, the small H suggests that little, if any representation of the perceptual paradigm and heutagogical approach would be found in this context. The center oval suggests a shift between paradigms and an andragogical approach to learning would be most prevalent in this learning context, while P and H would likely be less obvious and nearly equally represented. Lastly, the large H in the right circle indicates that the perceptual paradigm and heutagogical approach to learning would be dominant in this learning context, *A* would be less prevalent, and *P* would be virtually non-existent.

Each of these three contexts primarily manifests the prevalent paradigm and approach in terms of who controls the curriculum as well as the instructional time, pace, place, content, resources, delivery, and evaluation of learning.

The model is not expressed as a continuum for numerous reasons. First, it does not reflect the individual learner's paradigm or approach to learning. For instance, a self-determined student who adopts a heutagogical approach to learning can be found in a predominately *P* environment. That student may have even made the choice to be in that environment *because it meets their self-determined needs and goals.*

Second, an A environment can quickly become either a *P* or *H* environment simply by changing the balance of power between teacher and learner. Third, a continuum would suggest that learners would necessarily begin in a *P* environment, move to an *A* environment, and eventually graduate to an *H* environment. Yet literature on how preschool children learn suggests that they are naturally self-determined learners (Dewey 1897, 1903, 1916/2007; Hase and Kenyon 2013), suggesting that they would learn best in an *H* environment. Moreover, the current diagram strives to convey the notion that learning is not linear or hierarchal in nature, but is rather a messy, dynamic, and complex process (Garnett and O'Beirne 2013; Hase and Kenyon 2013; Wark 2018).

6.3.3.1 Reflection as Agency

The model includes consideration of three forms of reflective thought. In a *P*-dominate environment, the educational focus is primarily upon reflection; how to improve the efficiency and effectiveness of performance (Finlay 2008; Schön 1983, 1987; Smyth 1992). An *A* environment fosters critical reflection or the individual analysis of existing conceptions in light of new knowledge or experience (Fook et al. 2006; Rose 2013). Finally, an *H* environment encourages reflexivity; the introspection of self, praxis, and human nature (Freire 1970/1993; Ryan n.d.; Smyth 1992). To clarify, these are the prime forms of reflective thought encouraged within each of these contexts. However, while an educator may be facilitating critical reflection in an *A* environment, for example, it is quite possible that a student in this environment may be engaging in reflective or reflexive thinking instead.

6.4 Technology Integration Frameworks, Models, and Taxonomies

A number of technology integration frameworks, models, and taxonomies are reviewed in this section for their ability to help learners integrate emergent technologies within *P*, *A*, and *H* contexts. These include: the Framework for the Rational Analysis of Mobile Education (FRAME; Koole 2009) model, the Bring Your Own Device (BYOD; Stead 2012) framework, the Padagagy Wheel (Carrington 2015), the Substitution, Amplification, Modification, and Redefinition (SAMR; Puenterdura 2006, 2013) taxonomy, the Replacement, Amplification, and Transformation (RAT; Hughes et al. 2006) framework, and the Replacement, Amplification, Transformation and Leadership (RATL; Hesselbein 2014) model.

The FRAME, BYOD, and Padagogy Wheel blend theory with practice providing an umbrella approach to merging various individual, technological, and social aspects of mobile learning. All three reflect a shifting paradigm that focuses predominately on cognitive development, with the Padagogy Wheel offering the greatest opportunity for enhancing self-directed learning.

While the FRAME, BYOD and Padagogy Wheel focus specifically on mobile learning and are theoretically dense in nature, the SAMR, RAT, and RAT(L) taxonomies are less theoretical and intended to facilitate the integration of generic technologies for specific activities or situations. All three taxonomies adhere to a behavioural paradigm and pedagogical approach, although the RAT(L) does contain one level aimed at developing teacher leadership.

Wark's (2018) review of the aforementioned frameworks and taxonomies led to the following conclusions: (1) no literature clearly defined or operationalized all features, aspects, concepts, or terms, (2) all had little to no academic scrutiny or field research conducted on them, (3) the relationship between theory and practice was incomplete, confusing, or inconsistently applied in the reviewed frameworks, (4) all were intended to be used within a *P* or an *A* environment, (5) all focused exclusively or primarily upon the development of cognitive skills, especially instrumental reasoning (e.g., efficiency and effectiveness of technology integration). Ultimately, none were adequate for integrating emergent technologies within an *H* environment, or flexible enough to be used within the contexts of *P*, *A*, and *H* environments.

6.4.1 Omni-Tech

The omni-tech taxonomy defines the teaching and learning emergent technology integration goals within the *P*, *A*, and *H* environments (Fig. 6.2). Students acquire and practice developing efficient and effective use of emergent technologies within the P environment. In the *A* environment, instruction shifts from how to use particular technologies to more fully and seamlessly integrating technology as the learner connects to and interacts with human and non-human resources. The H environment addresses emergent technology integration in a holistic manner, responding to the

Fig. 6.2 Omni-tech taxonomy. Illustrates various levels of technology integration anticipated in relation to a behavioural/pedagogical (left column), shifting/andragogical (middle column), and learner-determined/heutagogical (right column) educational paradigms

learner's self-determined needs, drives, and goals within their PLEs, and with the support of their PLNs.

The arrows in Fig. 6.2 conveys the notion that learning is not linear. Nevertheless, the linear nature of government-imposed curricula in *P* and *A* environments is based upon the behavioural assumption that skill development starts with acquisition, moves to practice, and culminates in competency (Ertmer and Newby 2013; Garnett and O'Beirne 2013). The arrows reflect this mandated curricular approach, while simultaneously expressing the reality that learners can, for instance, demonstrate competency with a particular technology in one context, while still practicing how to use that technology in other contexts. The endlessly-looping circle in the *H* environment portrays the messy learner-determined curricula and double-loop learning. The learner accesses information from their PLEs and PLNs, practices, masters, and innovatively uses emergent technologies on an omni-learning basis, while employing instrumental reasoning, rational thought, and creative intuition as needed. The learner models leadership "by actively engaging in their learning, learning from and with others, and sharing what they have learned" (Wark 2018, p. 92).

Figure 6.3 provides a closer look at the transformative learning and leading segment of the omni-tech model. As explained in Wark (2018):

> A learner's emergent technology integration perceptions and experiences dynamically influence each other through reflexivity and by innate drives to find purpose, achieve mastery, gain autonomy, and innovate within the learner's natural, holistic omni-learning context. The learning process engages instrumental reasoning, rational thought, and creative intuition on [the learner's] demand. These mental processes not only help the learner to interpret experiences, but when used reflexively, may transform perceptions, alter experiences, and change reality, while enhancing intrinsic motivation to achieve higher levels of purpose, mastery, autonomy, and innovation (p. 93).

A learner's intrinsic drives are unique and dynamic. To illustrate, one learner may be driven to master the integration of a new technology simply for the challenge, another may be driven to master technology integration for social reasons, and a third may be driven by both desires. Furthermore, the motivational drive to achieve mastery may change for a learner depending upon, for instance, evolving perceptions, purposes, and contexts. Learning leaders must understand a learner's emergent technology integration perceptions and experiences in order to help the learner clarify: (1) why the learner views the integration as being important, (2) what learning is needed, (3) how the technology can be used (including possible consideration of novel solutions and opportunities), (4) where and when to learn, and (5) who should be involved in the learning process (Wark 2018).

The development of reflexive thinking gives learners the ability to challenge personal and collective moral reasons for integrating (or not integrating) a particular technology, as well as the opportunity to possess the imagination, means, and courage to transform reality. The learning leader's foremost goal, therefore, is to help the learner foster the mindset needed to challenge the purpose and value for integrating the emergent technology. Part of this process includes aiding the learner in identifying extrinsic and intrinsic motivations for integrating the technology, and learning how to enhance intrinsic motivators while reducing dependency upon extrinsic ones. In

Fig. 6.3 Integrating emergent technology naturally. A learner's emergent technology integration perceptions and experiences dynamically influence each other through reflexivity and by innate drives to find purpose, achieve mastery, gain autonomy, and innovate within in the learner's natural, holistic omni-learning context. The learning process engages instrumental reasoning, rational thought, and creative intuition to help the learner interpret experiences and reflexively transform perceptions, while enhancing intrinsic drives

doing so, the learning leader helps the learner hone instrumental reasoning, rational thinking, and creative intuition, thereby promoting reflection, transforming perceptions, and changing reality for the learner and perhaps others, including the learning leader (Wark 2018).

6.4.2 The Paradigm Shift Framework

The Paradigm Shift Framework (Fig. 6.4) merges the Omni-tech taxonomy with the Paradigm Shift Model. The paradigmatic shift is complete when the *P* or *A* learner realizes that they alone control their learning path. At this point, they move permanently into the H realm, fully reclaiming their natural, holistic ability to learn.

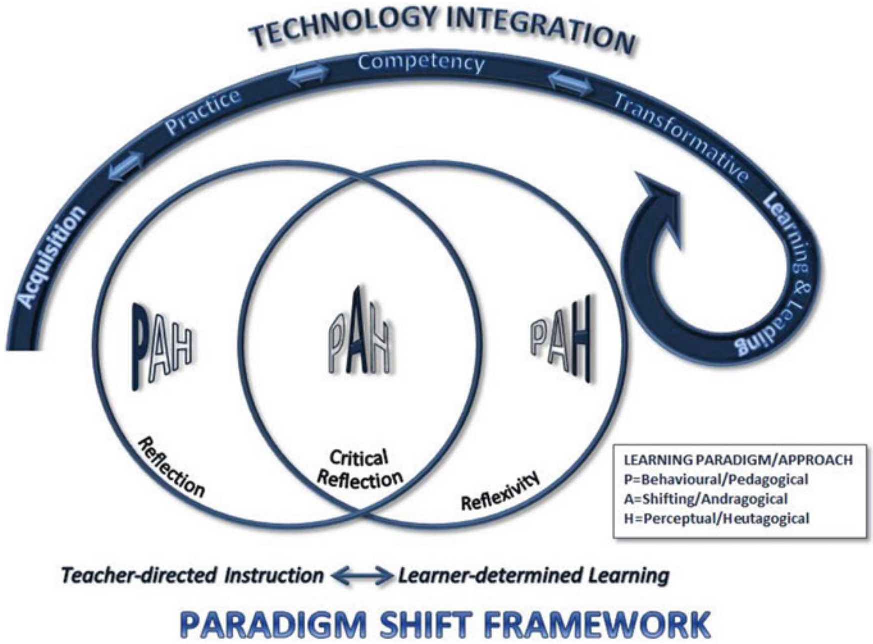

Fig. 6.4 Paradigm Shift Framework, illustrating the merger of the omni-tech taxonomy (dark blue technology integration arrow at the top of this image) with the paradigm shift model

6.4.3 Illustrating the Paradigm Shift Framework in Action

The Paradigm Shift Framework was employed to determine what key factors and, ultimately, what paradigm most empowered online graduate students to integrate emergent technologies for learning on demand. During the Spring 2017 term, volunteer students completed pre- and post-term questionnaires and participated in mid- and post-term interviews. This information was combined with course instructor interviews, public University website information, and researcher observations. The Paradigm Shift Framework was used to determine that the participating class contexts were very similar in nature, offering *A* and *H* opportunities within the larger *P* setting of the University (Wark 2018).

Results indicated that at the beginning of the term there was a nearly even split between the preference for a *P*, *A*, or *H* learning environment among the respondents. When asked to rate their level of integration with the 16 emergent technologies included in the study, participants indicated that, on average, they were beginning to practice integration with these technologies.

During the term, three-quarters of the participants indicated a change in their paradigmatic preferences; some increasing their preferences for *P*, others for *A*, and the remainder for *H* environments. Even those who expressed a consistent preference for one paradigm indicated fluctuations in motivational drives. These findings support the claim that learning is a dynamic, complex, and messy process (Garnett & O'Beirne 2013; Hase and Kenyon 2013).

By the end of the term, there was a moderate preference for an *H* environment among participants. Those who preferred a *P* environment indicated a slight drop from their pre-term practice level with the 16 emergent technologies. They did not set any emergent technology integration goals for the term. Participants who showed a preference for the *A* environment reported a slight to moderate increase, although they remained at the practice level when the term was over. The *A* participants who set goals experienced a slight increase in their practice level, while those who set and changed their goals during the term reported a moderate increase. Lastly, those aligning with an *H* environment reported a significant increase, achieving early competency in their technology mastery level. All *H* respondents reported setting goals.

Interestingly, *P* and *H* respondents felt that they required less scaffolding and experienced less of a learning curve in relation to emergent technology integration during the term than their classmates did. It seems logical that the *P* respondents did not require emergent technology integration scaffolding or experience much of a learning curve, because they did not set emergent technology integration goals or report an increase in mastery with emergent technologies during the term. The reason why *H* respondents did not require much scaffolding either, despite setting goals and achieving the highest level of technology integration mastery during the term was because these learners were self-determined learning leaders who relied upon trial-and-error experimentation, as well as their expansive PLEs and PLNs to help them integrate technologies. The respondents who felt that they required the most scaffolding and experienced the greatest learning curve were the *A* respondents who set and changed their goals during the term. This was explained by their shifting dependence for learning from the instructor to themselves throughout the term. Ultimately, most respondents felt that, in the future, an *AH* or *H* environment would most empower them to integrate emergent technologies for learning on demand throughout life.

6.5 Conclusion

Exponential growth in emergent technologies is rapidly and dynamically changing the world. Some of these technologies have precipitated a shift in the knowledge economy from millennia of information scarcity to information explosion. These technologies offer humanity with the potential to transform learning by replacing the prevalent knowledge transmission model with a knowledge capture, curation, investigation, communication, and innovation model. Educational stakeholders are tasked with determining what paradigm and approaches to learning best facilitate the mindset learners need to purposively and perpetually integrate emergent technologies for learning on demand.

A review of existing emergent technology integration frameworks, models, and taxonomies indicates that none are capable of assisting stakeholders in identifying, selecting, and designing educational contexts that cohesively and coherently bind theory with practice from more than one paradigmatic stance. Most of the reviewed frameworks, models, and taxonomies subscribe to a behavioural paradigm, a few reflect a shift between paradigms, and none exemplify the emerging perceptual paradigm.

The Paradigm Shift Framework assists educational stakeholders, including learners, in identifying what prevalent paradigm, as well as what approaches to learning and emergent technology integration are being adopted in any learning context. The framework also enables stakeholders to intentionally design or participate in the learning context that best meets desired learning goals and objectives. Moreover, the framework can assist stakeholders in shifting from one paradigm and approach to learning to another.

The framework is not meant to be interpreted as a continuum; it based upon evidence that learning is messy, dynamic, and individualistic (Garnett and O'Beirne 2013: Hase and Kenyon 2013; Wark 2018).

Finally, the framework has been field-tested in one exploratory study (i.e., Wark 2018). It is anticipated that further testing will result in revision, refinement, and evolution of the framework.

Glossary of Terms

Andragogy An adult learning theory, most commonly associated with Knowles (1970) that includes the notion of the "self-directed" learner, who becomes increasingly less dependent upon the instructor for learning needs, while typically fostering greater participation in and reliance upon professional communities of practice.

Behaviourism An educational paradigm founded on the belief that the external, objective world is the only source of knowledge. Sensory interaction with this world evokes learning.

Context The collective sum of all environmental, social, and/or other circumstances and conditions found in a particular place or situation, or related to a particular notion or statement; the setting.

Emergent technology New or existing technologies, including "concepts, innovations, and advancements" (Veletsianos 2010, p. 33) that are being used in innovative manners and Contextfor educational purposes.

Emerging paradigm A previously obscure or unknown school of thought, based upon unique beliefs, and related practices, which is gaining popularity. Examples include twenty-first-century learning and "connectivism" (Siemens 2005a, b).

Formal learning Learning that occurs within structured educational systems and contexts, which is usually certified by official governing bodies. Examples include public schools, universities, and technical institutions.

General Purpose Technology (GPT) Widespread or pervasive use in a society of a particular technology, such as the steam or combustion engine, or electricity (Brynjolfsson & McAfee 2014).

Heutagogy A term coined by Hase and Kenyon (2001), to describe a learning approach derived from the perceptual learning paradigm. Heutagogy is based upon the belief that learning is learner-determined (that is, learners control their learning) and promotes the development of learner capacity for lifelong, and life-wide learning.

ICT Acronym for "information communication technologies"; technologies that transmit information (e.g., telephony or Internet connection technologies).

IEP Acronym for "individual educational plan." IEPs are typically generated during meetings that involve the learner and their learning team (e.g., educators, caregivers, other professional experts). IEP components include: short, mid-, and long-term educational goals; learner characteristics, preferences, strengths, weaknesses, barriers, and incentives; human and non-human resources; and timelines. The ideal IEP is learner-determined; other team members are considered to be transient resources. IEPs are typically reviewed, revised, and updated on a regular basis (e.g., every semester).

Informal learning Learning that occurs outside of formal, structured learning institutions or contexts; casual or incident learning.

Learner-determined learning Learning in which the learner controls the learning task, process, and context; also referred to as "self-determined learning" (Hase and Kenyon 2001, 2013). Learner-determined learning is not to be confused with "self-directed" learning (see also).

Omni-learning "Always learning"; the ability to learn anywhere, anytime, on the learner's demand (Wark 2018); mobile, augmented reality (AR), and wearable technologies enable the possibility of omni-learning.

Paradigm Or "worldview"; a term initially intended to identify particular scientific camps or schools of thought based upon specific theories, values, beliefs, assumptions, methodologies, and instruments (Kuhn 1962), but has since been extended to other disciplines as well.

Paradigm shift The change or movement from one paradigm (see also) or worldview to another (Kuhn 1962). The invention of a general-purpose technology (GPT; for instance, the printing press, electricity; Brynjolfsson and McAfee 2014) usually precipitates a paradigm shift which, in turn, significantly alters existing social, economic, political, cultural, educational, and other institutions of a particular society.

Pedagogy The original Latin term for a man leading a boy in learning; adheres to the behavioural paradigm, and teacher-directed approaches to learning most commonly used with children and novice learners.

Perception The identification, interpretation, and organization of sensory information in the brain used to represent, understand, and interact with the environment.

Perceptual learning The dynamic interplay between the environment and one's senses, cognitive thought, affective reasoning, emotions, and neurophysiological functioning; the foundational tenet of a learner-determined or perceptual paradigm (see also).

Perceptual paradigm A learning paradigm based upon the belief that the source of knowledge is innate and individually unique; also referred to as "learner-determined paradigm." See also "perceptual learning."

Rational thought A process in which the meaning attached to one's sensory perceptions of the world is challenged by some experience incongruent with this meaning (Kant 1781/2013; Adorno 1951/2005). This incongruence is critically (i.e., morally and cognitively) analyzed, and judgment is made by the mind before action is taken.

Reflective thinking Review of knowledge, value, or belief in relation to evidence that supports or refutes it, and the conclusions resulting from this review; originally defined by Dewey (1910, 1933).

Reflexivity Typically associated with research; the process of examining one's knowledge, beliefs, values, and actions in relation to the research process; involves reflection on how the researcher's axiology affects research decisions, and how the researcher/research respondent relationship affects the research project.

Self-directed The learner may control some aspects of the learning context, but the teacher usually controls the learning process and task; also referred to as "learner-directed learning" (Knowles 1970); not to be confused with "learner-determined learning" (see also).

Shifting paradigms A process of movement or change between one paradigmatic mindset or worldview and another. For instance, the behavioural and perceptual paradigms represent two disparate views on the source of learning. The behavioural epistemology rests upon the belief that the source of knowledge is external and sense-based, whereas the perceptual epistemology asserts that the source of knowledge is innate human perception. Theories, approaches, and practices that manifest elements of both paradigms, such as constructivism and andragogy, indicate a shifting state between these paradigms.

Teacher-directed A learning context in which any curricular, instructional design, instructional delivery, activities, assessment, learning resources, and environment are determined by the instructor.

Technology Merger of Greek roots, *techne*, meaning art, craft, skill, or the means to obtain something, and *logos*, the outward expression of an inner thought or feeling; "tools devices, systems, or procedures …[that] order and transform matter, energy, and information to realize certain valued ends" (Funk 1999).

Technology integration Seamless inclusion of technologies in learning contexts wherein the use of a given technology comes naturally to the learner in support of their learning, rather than being the focus of their learning; also defined as a process where the learner is becoming accustomed to using a technology for learning also defined as a process where the learner is becoming accustomed to using a technology for learning.

Traditional learning Formal learning theories, contexts, and practices typifying the Industrial Age educational system, and based upon the behavioural paradigm; characterized by patriarchal management, face-to-face teacher-directed interactions, knowledge transmission (e.g., rote learning), passive learning (e.g., independent seat work), and strict rules and routines, set within the context of brick-and-mortar buildings and laboratory-like classrooms.

Transformation Dramatic alteration in appearance, form, and/or function metamorphosis.

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Norine Wark Norine began her educational career in the early 1990s, working in the Canadian K-12 public school system as a classroom teacher. She was the first educator in her school district to receive the Outstanding Classroom Teacher Award in recognition of her dedication to her students, and her innovative approaches to teaching and learning. Norine was the recipient of this award for two consecutive years before accepting learning assistance and teacher-mentorship position in the district. While obtaining Master's and Doctoral degrees in Distance Education at Athabasca University, she worked on numerous research projects that examined the use of a variety of pedagogical approaches and emergent technologies for adult industrial training and online higher education. This book chapter reflects Norine's current understanding of traditional and emerging learning paradigm, pedagogies, and technologies drawn from her years as an educator, online and distance learner, and researcher, as well as her recent doctoral dissertation on these topics.

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Chapter 7
A Teacher Professional Development Program on Teaching STEM-Related Topics Using Augmented Reality in Secondary Education

Lasica Ilona-Elefteryja, Maria Meletiou-Mavrotheris and Konstantinos Katzis

Abstract Science, Technology, Engineering and Mathematics (STEM) Education is a field in which schools invest considerable resources and time to bring innovative solutions within their curricula. At the same time, Augmented reality (AR) is an emerging technology in the Immersive Learning Landscape. The EU-funded Erasmus + project Enlivened Laboratories in STEM (EL-STEM) aims to introduce a new approach, through the provision of integrated inquiry-based STEM learning approaches supported by Augmented Reality in school classrooms and laboratories. A multifaceted Teacher Professional Development (TPD) program has been designed within EL-STEM to familiarize teachers with the potential of AR technology for enhancing the teaching and learning processes in secondary STEM education. Teachers can, therefore, employ this technology, to further encourage student's engagement and strengthen their twenty-first-century skills. This chapter highlights the necessity of designing and implementing such a TPD program, provides an overview of the pedagogical framework underlying the current state of the suggested EL-STEM TPD program and outlines its content and structure.

7.1 Introduction

During the past twenty years, the "STEM pipeline" problem (Cannady et al. 2014; Sanders 2009) as well as the need of Europe (and not only) for human resources equipped with twenty-first-century skills (i.e., critical thinking, inquiry, creativity,

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problem-solving, collaboration) (Xue and Larson 2015) have been highlighted in the research community. In addition, cross-national studies concerning students' achievements (e.g., TIMSS, PISA) indicate that there is a significant number of underachievers in STEM-related courses in all educational levels, including secondary education, while attractiveness, motivation, and engagement in STEM, also appear in low rates (Gasiewski et al. 2012). Statistics are also discouraging concerning students' tendency towards STEM studies and careers (Aeschlimann et al. 2016; Wang and Degol 2013). This situation calls for urgent action since STEM skills (Bybee 2010) are among key competencies needed in a knowledge-based society for employment, personal fulfilment and development (EU Skills Panorama 2016; OECD 2016).

One aspect that could contribute to the improvement of the abovementioned is the growth of recent technological advances, which provide the opportunity to develop innovative learning environments in STEM education by upgrading the educational process. One promising approach recently explored, is the potential of integrating Augmented (AR) and Mixed Reality (MR) within secondary education, as a means of making STEM-related subjects more understandable and attractive for students. AR is an emerging technology in the Immersive Learning Landscape and has gained a growing interest among researchers during the last two decades (Bacca et al. 2014; Ibáñez and Delgado-Kloos 2018; Lee 2012; Lytridis et al. 2018). Despite the increased interest towards this field, the amount of available research concerning AR integration into teaching and learning is still relatively small due to the novelty of the technologies (Bacca et al. 2014; Ibáñez and Delgado-Kloos 2018). Nonetheless, the majority of existing studies point towards numerous positive attributes that have the potential to enhance both learning and teaching (Bacca et al. 2014; Akçayir and Akçayir 2017).

AR is being treated as a concept rather than a sole technology (Wu et al. 2013) offering new learning opportunities but also, creating new challenges in the educational process (Wu et al. 2013; Akçayir and Akçayir 2017). For its successful integration within STEM education, it should be accompanied by innovative pedagogical approaches and re-contextualized learning environments focused on inquiry and problem-solving. Teachers are key persons in realizing the "how, what and why" of AR within STEM education, as they can provide the necessary instructional support to students, maximizing the impact of this technology (Lasica et al. 2018). However, a number of studies have asserted that changing teaching practices is proving difficult, while many teachers remain unprepared to effectively employ technology-enhanced teaching practices (McNair and Green 2016). Thus, the provision of high-quality preservice and in-service teacher training that will equip teachers with the required knowledge and skills to effectively apply AR into teaching and learning is of utmost importance (Delello 2014). Teachers should be encouraged to recognize the true potential and the added value that AR could have on teaching, learning, and assessment, and should be informed concerning best practices in their exploitation as instructional tools (Dunleavy and Dede 2014). Many teachers reject new technologies for reasons such as fear and lack of confidence in their use, lack of time or motivation for acquiring new technological skills and adapting new pedagogical strategies, lack of existing educational resources, and the fact that they feel uncomfortable with student-centered approaches enhanced by new technologies (Delello 2014; Dunleavy and Dede 2014; McNair and Green 2016).

Changes in teaching cultures that will improve students' performance and attitudes, and reduce disparities in STEM outcomes between different EU countries are required. For this purpose, training that involves applying AR and other innovative technological tools through standards-based pedagogical approaches seem to be a priority. The current chapter presents a renovated TPD program to familiarize teachers with the potential of AR technology for enhancing the teaching and learning processes in secondary STEM education.

7.2 Teacher Professional Development Concerning STEM-Related Issues and Innovative Technologies

Teachers' professional development (TPD) programs targeting the instruction of twenty-first-century skills (Ertmer et al. 2014) supported by learner-centred forms of pedagogy, focusing on inquiry and problem-solving based learning (Sanders 2009), are of critical importance. There is a gap within STEM education between the required skills and knowledge to teach a STEM topic and the way STEM topics are actually taught within classrooms (Corlu et al. 2014). Usually teachers, when teaching a STEM-related topic, tend to focus instruction on the subject of their expertise. STEM education, however, requires teachers to "*excel in utilizing natural and active exchanges of knowledge, skills, and beliefs among STEM disciplines*" (Corlu et al. 2014, p. 76).

Integrating recent technologies within STEM education should also be accompanied with innovative pedagogical approaches and re-contextualized learning environments in order to be successful (Pedaste et al. 2016). The challenges arising are for the teachers to gain the "knowhow" concerning the: (i) identification of the new technologies that are appropriate for them from those that are available, and (ii) use of these technologies in a specific STEM-related topic for improved understanding (Kriek 2016). To convince teachers applying new technologies in their courses, they need to realize their added value and benefits in enhancing teaching and learning (Overbay et al. 2010). Teachers, who have not experienced new methodologies as teachers or as learners, require a different skillset compared to conventional teaching, while trying a new approach can put additional pressure and be intimidating (Dotong et al. 2016; Ertmer et al. 2014). A critical challenge remains the fact that European countries lack a single policy concerning TPD (OECD 2016) and as a result, many teachers remain unprepared to effectively employ new technologies in their teaching practices (Howard and Mozejko 2015). Without such frameworks, the application of technology within the classroom is often superficial and unproductive and teachers hesitate to proceed with innovative applications within their classrooms (Ertmer et al. 2012).

In an increasingly knowledge-based economy, EU needs well-prepared STEM teachers who can raise the current generation with a capacity to innovate (Corlu et al. 2014), prepared through appropriate TPD programs, so as to effectively integrate new technologies within the instructional process.

7.3 The EL-STEM Project

Responding to the needs described above, the Enlivened Laboratories for STEM Education (EL-STEM) project has developed, and is currently pilot testing an innovative Teacher Professional Development (TPD) program targeting EU secondary school STEM teachers, that offers high-quality in-service training on the effective integration of AR/MR technologies within existing school curricula. EL-STEM is an Erasmus + Action 2 program funded by the EU, with nine partners from five EU countries (CY, EL, EE, FIN, PT). The project's objective is to develop a new approach, combining AR/MR technologies with Remote and/or Local Laboratories, for encouraging 12–18 year-old students' STEM engagement.

In particular, it targets students of lower and upper secondary education and irrespective of the expected varying individual inclination to STEM subjects, aiming to (Mavrotheris et al. 2018): (a) attract students who currently might not be interested in STEM-related studies/careers and enhance the interest of those who have already chosen this field of studies/careers, and (b) improve students' performance in courses related to STEM education.

7.4 Designing the TPD EL-STEM Program

The theoretical framework underpinning the EL-STEM in-service TPD program is grounded on and structured under the interrelated bodies of Problem-Based Learning and Inquiry-Based and Contemporary Learning Approach, promoting scaffolding and collaboration in STEM education (Pedaste et al. 2015).

Moreover, TPACK (Technological Pedagogical and Content Knowledge) has been applied as a research framework for facilitating and assessing teachers' professional development in the use of ICT in STEM education. TPACK is a dynamic conceptual framework (Mishra and Koehler 2006) that was proposed as a response to the absence of theory guiding the technology integration into education. According to TPACK, teachers' training on innovative technologies cannot be treated as context-free, but should be accompanied with emphasis on how technology relates to pedagogy and content. The aim is to move teachers beyond technocentric strategies that focus on technology, and to promote their critical reflection on the use of AR in STEM education. Concurring with Phillips (2013), the suggested TPD program considers TPACK not as an individually acquired attribute but as an embodied phenomenon shaped by social, organizational, and cultural factors extending beyond individuals, putting emphasis on the socially mediated contexts in which in-service teachers develop their knowledge.

As far as the effective integration of ICT within the educational process is concerned (in particular AR technology), a deep understanding (by the teachers) of the relations between the three components (Technology, Pedagogy, and Content) of the TPACK framework is required. The contexts' definition could contribute positively to this direction and to the effective implementation of the TPACK framework (Philips 2016) within the TPD program suggested. Table 7.1 (Lasica et al. 2018) describes the necessary knowledge axes of the TPD program (Jimoyiannis 2010) to the related knowledge that lies at the TPACK framework intersections (PCK, TCK, TPK).

To ensure the successful implementation of TPACK, the suggested TPD program involves teachers in both the design of the educational activities (through the Lesson Plans) and the creation of AR Learning Objects (LOs) (supporting the Lesson Plans designed) that they will then apply in their own classrooms and/or school laboratories. In addition, the familiarization with AR (tools, applications, etc.), could be achieved through the teachers' involvement in solving hypothetical educational STEM-related problems during the face-to-face meetings. The authors, in collaboration with the rest of the EL-STEM consortium members, have been coordinating the whole effort, supporting the teachers in tackling any difficulties, concerns, and obstacles they might encounter. The effectiveness of the educational activities will depend on their structure and instructional design phases based on inquiry learning and scaffolding.

Table 7.1 Matching of TPACK knowledge intersection with knowledge axe within secondary education in the suggested TPD program (Lasica et al. 2018)

TPACK Knowledge	Knowledge Axes within secondary education
PCK	Awareness of curricula concerning STEM-related courses (Mathematics, Physics, Chemistry, Computer Science etc.)
	Scientific Knowledge of STEM-related topics/concepts
	Awareness of difficulties and misconceptions in STEM-related topics
	Pedagogical Models—Teaching Approaches concerning STEM courses—Willingness for collaboration between teachers of different courses—promotion of student-centered approaches
TPK	Pedagogical Models—Teaching Approaches based on ICT, especially AR technology
	Promotion of Inquiry-Based learning and interdisciplinary within STEM courses, supported by AR
	Self-esteem and real experience acquirement concerning the usage of AR during the educational process
TCK	Familiarization with AR (tools, applications, existing libraries, etc.)
	Knowledge and skills on the effective integration of AR within the educational process in the context of STEM-related courses
	Technical Issues prediction and/or resolution

7.5 Implementing the Theoretical Framework: Design of the EL-STEM in-Service TPD Program

Having recognized the promising prospect of AR for upgrading STEM education, the design of the EL-STEM in-service TPD Program is described below, on how to effectively implement inquiry-based instruction within the school curricula through the functional integration of AR with existing core curricular ideas. Drawing upon the relevant literature, the suggested TPD program applies adult appropriate teaching strategies (Lieb and Goodlad 2005; Ruey 2010). For this reason, a blended approach has been adapted, to offer teachers time flexibility, provide easy access to additional content (articles, videos, etc.), encourage communication, and develop a personal contact with the participants. In the context of this approach face-to-face training seminars as well as the EL-STEM project online course is being provided.

The TPD program is divided into two phases: (i) Fall 2018-Spring 2019, when teachers participate in both face-to-face training seminars and the online course, to get equipped with the required knowledge and competences to scaffold their students in engaging with problem-solving, inquiry-based activities and innovative technologies that can help raise their interest in STEM and promote the attainment of important twenty-first-century skills, (ii) Spring 2019-Fall 2019, the guided field practice, when at a final stage, teachers will undertake a teaching experiment. During the second phase (already running by some teachers feeling confident with the use of tools to create AR educational content), teachers customize and expand upon the digital tools and the instructional material provided to them, and apply them in their own classrooms, through appropriate Lesson Plans and AR Learning Objects. The researchers in collaboration with the EL-STEM project consortium members, act as mentors, providing their support to teachers.

7.5.1 Objectives and Target Groups

The main aim of the TPD program designed is to develop a supportive culture, motivating teachers of STEM-related courses on effectively integrating AR with core STEM curricular ideas to transform their classrooms and/or laboratories into a smart-learning environment both by (a) using existing AR Learning Objects (LOs) and (b) creating their own AR LOs and Lesson Plans (LPs) with appropriate tools (Lasica et al. 2018). Teachers are trained on how to implement inquiry-based learning LPs in the fields of STEM, supported by AR, in order to engage their students in authentic problem-solving activities. They also get familiarized with different tools for developing AR LOs within STEM-related courses and existing repositories of AR LOs, such as HP Reveal, ARTutor, ZapWorks, EON Experience, Scratch and Unity. These LPs and LOs will be pilot tested with their students during a follow-up classroom experimentation. The AR LOs are not expected to be designed to enhance extra-curricular activities, but instead, to become an important part of the main curricula and consist of reusable educational material for teachers in EU.

Secondary Education in-service teachers of STEM-related courses, not extensively using laboratories and innovative technologies within their courses consist of the core target group selected for participating in the in-service teacher training, in order to motivate them to change their teaching cultures. Also, teachers of STEM-related courses already using laboratories, applying innovative approaches within their courses and/or willing to include AR technologies are also included in the training to obtain full benefits of AR, and to act as pioneers in their countries. Priority has been given to teachers serving in classes with a particularly high proportion of students from low socio-economic backgrounds. However, since the TPD program sparked interest among other teachers as well (primary education teachers), they have also been encouraged to join the TPD program. The school management team has a critical role in the implementation of the TPD program, being responsible for promoting the program and encouraging the school teachers to attend it, as well as encouraging the guided field practice in their schools. Finally, students attending STEM-related courses are a directly related target group, after the in-service TPD program completion. It is also necessary to involve the students' parents through additional informational activities so that the school has their approval and support (Hornby and Lafaele 2011).

7.5.2 Face-to-Face Training Seminars

The seminars consist of a combination of mini-workshops that include presentations by experts, AR-based and hands-on activities in small groups, familiarization with AR tools/applications, role-play, and discussions. Following the design of the EL-STEM TPD program, the face-to-face training seminars are currently taking place in each partner country of the EL-STEM project with around sixty (60) participating teachers from Cyprus, Greece, Estonia, and Finland. The face-to-face training started during Fall 2018, with a series of hands-on professional development seminars and the project's staff training, are currently running and will continue during Spring and Fall 2019.

During the face-to-face training seminars, teachers are currently provided with ample opportunities for interactive and collaborative learning through the use of contemporary technologies and related equipment and are engaged in authentic collaborative educational activities. The personal contact developed between the researchers and the teachers is critical for their future applications in their real classrooms.

The instructional strategies of the suggested TPD program, include open-ended investigations, AR visualizations, collaboration and reflection on one's own and on others' ideas and experiences, providing a learning environment that helps participating teachers gain a better understanding of AR supported education, inquiry, and interdisciplinarity. Moreover, the learning environment is expected to serve as a model to the teachers they should also employ in their own schools with their colleagues, and then, in their own classrooms and school laboratories, to promote student motivation towards STEM-related studies and careers. The face-to-face training seminars have been culturally differentiated for each country of the EL-STEM consortium, to accommodate local conditions in each participating country.

7.5.3 EL-STEM Online Course Content

As already mentioned, the course aims to enrich European secondary school students' (aged between 12 and 18) experiences in STEM-related topics, through developing their teachers' knowledge and skills in teaching using the EL-STEM approach. It has been designed to promote teaching STEM-related topics as a transversal skill for all secondary education teachers regardless of discipline. Teachers taking the course develop their knowledge and skills in teaching and learning using the EL-STEM approach through exposure to innovative learning methodologies and resources, and cross-cultural exchange of experiences and ideas. Central to the course design is the functional integration of technology with existing core curricular ideas, and specifically, the integration of Augmented Reality and other technology-enhanced tools and resources provided by the EL-STEM platform. Online moderated discussions allow participating teachers across partner countries to share content, ideas, and instructional strategies. Moreover, educational content in various formats is shared (online text, videos, manuals, additional readings, tutorials, etc.) allowing teachers to deepen their knowledge.

The Enlivened Laboratory Methodological Guidelines (ELMG) consist of the "heart" of the EL-STEM approach and the core content of the online course. They provide guidelines to the teachers on how to apply the methodology of the Enlivened Laboratories (EL-STEM), in order to create their own Lesson Plans and AR Learning Objects within their STEM-related courses. More specifically, they provide answers to core questions, including: (a) **whom** they are addressed to and to whom they can be applied, (b) **where** they could be implemented, (c) **why** they should be applied within the context of STEM-related disciplines, (d) **what** approaches, and which tools could be used and finally, (e) **how** they could be applied to teach STEM-related disciplines in secondary education using AR technologies. These guidelines are explained in-depth through the online course's content, made of seven modules, covering the following topics:

- Module 1: Introduction to the EL-STEM project, which is an introduction to the project and the TPD program.
- Module 2: Enlivened Laboratory Methodological Guidelines (ELMG) (Part 1—Who, Where, Why), which consists of a module to motivate teachers to use student-centred approaches in their STEM-related courses and apply innovative technologies, such as AR in their classrooms and school laboratories.
- Module 3: Enlivened Laboratory Methodological Guidelines (Part 2—What), which consists of the main theory of the online course, including STEM-related

concepts/Instructional & Learning Approaches related to STEM education and AR environments/Understanding the differences of Virtual, Augmented and Mixed Reality, as well as the value of laboratories within STEM education/Features and Affordances of AR in education/Case studies of AR/MR in STEM education.

- Module 4: Enlivened Laboratory Methodological Guidelines (Part 3—How), which includes all the necessary guidelines and tools/application on (a) how to create a Lesson Plan applying the ELMG (teachers are also provided with Lesson Plans examples and ideas on how to integrate the EL-STEM approach into the school classrooms and laboratories) (b) how to create an AR/MR Learning Object applying the ELMG (teachers are also provided with reusable educational content to be used in different STEM-related courses) and (c) tips for applying and promoting the ELMG.
- Module 5: Using the EL-STEM Platform, including tutorials on how to share the Lesson Plans and AR Learning Objects created, through the EL-STEM platform.
- Module 6: Evaluating the Augmented Reality STEM Teacher, which describes the quality assurance strategy for the Augmented Reality STEM teacher training evaluation, while assessment instruments for the inquiry-based STEM learning outcomes are provided.
- Module 7: Getting Ready for the Pilot AR/MR STEM Laboratories! (guided field practice), where teachers are guided for teaching their courses as "Augmented Reality STEM teachers".

A special emphasis of the EL-STEM TPD program is on building an online community through collaboration tools promoting dialogue (such as forums, chats, social media, etc.) for the exchange of ideas, educational content, tools/applications, and instructional approaches among the European secondary education teachers, participating in the training.

7.6 Data Collection During the TPD Program

In the context of the suggested TPD program, data collection is being implemented since the design-preparation phase, currently, while the TPD program is running and will continue when the teachers are going to implement their own interventions in their classrooms/laboratories (guided field practice). Part of the EL-STEM TPD program consists of the case study in Cyprus. Case studies are widely applied in education and offer a personal engaging approach to collect data (Marrelli 2007; Stake 2003). They are of added value in exploratory research areas where there is limited previous work, similarly to the current study. During a case study, the researchers are in close contact with the target groups (i.e., teachers and students) to collect the necessary information. Through the deep and personal perspectives obtained, they can identify issues that are not easily detected through other data collection methods. It is important in data collection efforts including personal views of the target groups, to use two or more methods of obtaining data to ensure a broad perspective (Marrelli 2007).

In this research, since teachers' stated beliefs towards technology integration do not always align with their instructional practices (Lawless and Pellegrino 2007), they should be triangulated with (a) the responses to teachers' questionnaires concerning AR acceptance, (b) interviews' content, (c) designed lesson plans, and (d) researchers' observation of the instructional practices in authentic environments, to achieve better understanding. Similarly, when referring to students, since their stated motivation towards STEM-related disciplines does not always align with their performance and twenty-first-century skills acquired, they should be triangulated with (a) the students' performance assessment (worksheets, achievements, tests, etc.) (b) interviews' content and (c) researchers' observation of the learning process in authentic environments to achieve better understanding.

Gall et al. (2007) identified five different tools of collecting research data in the context of case studies in educational research: self-report measures, questionnaires, performance assessments, interviews, and observations. Taking this into consideration, the current research uses multiple data collection tools with the purpose of (a) triangulation while seeking convergence of findings and (b) expansion to extend the breadth and range of inquiry. Because of the complex nature of this study, both qualitative and quantitative data are necessary to reach more in-depth results.

7.7 Concluding Remarks

There are already numerous studies highlighting the benefits of Augmented Reality technology to teach STEM-related concepts. Providing teachers with professional development opportunities that will equip them with the required knowledge and skills to effectively infuse AR into teaching and learning is of utmost importance. In order to bring the necessary changes in teaching cultures that will enable teachers to effectively implement inquiry-based instruction within the school curricula through the functional integration of AR with existing core curricular ideas, in the context of the EL-STEM project, a high quality in-service TPD program has been designed, developed and currently running, based on STEM-related theoretical frameworks, with emphasis on Phillips' revised TPACK framework.

The innovation of this framework lies on the adoption of a more systemic approach, putting emphasis on the socially mediated contexts in which in-service teachers develop their TPACK. Our anticipation is that the TPD program described, will contribute to the efforts within STEM education for effective integration of AR technologies. The utilization of the socio-cultural context in which teachers' professional development occurs, will promote teachers' and other key stakeholders' active participation, and the development of a culture of dialogue. This, in turn, could contribute towards the creation of a flexible environment that supports the exchange of ideas, experiences, cooperation, and experimentation as processes of added value. Through the use of these strategies, we provide a blended learning environment that can help participants gain better understanding of STEM education, inquiry and interdisciplinarity, as well as innovative technologies, such as AR. Moreover, the learning environment serves as a model to the teachers concerning the learning situations, technologies, and curricula they should employ in their own classrooms to promote student motivation towards STEM studies and careers.

To sum up, the abovementioned TPD program suggested for in-service teachers of STEM-related courses, aims not only to enhance the competencies of the participants in the context of the EL-STEM project, but also set the foundations for designing EU in-service TPD programs focused on AR technologies. The TPACK framework is expected to create a positive and supportive culture concerning AR and finally, lead to the effective integration of these technologies within STEM-related courses.

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Glossary of Terms

Augmented Reality (AR) an enhanced (augmented) version of the real environment overlaying digital information/objects being viewed through a device (such as a smartphone and/or tablet camera).

ELMG The Enlivened Laboratories Methodological Guidelines (ELMG) consist of the “heart” of the EL-STEM approach, useful for enhancing the teaching and learning processes in the context of STEM-related disciplines by using the innovative technologies of AR and MR.

Learning Object online resources or interactive software used for learning. A single image, a page of text, an interactive simulation, or an entire course could all be examples of learning objects.

STEM Science, Technology, Engineering, and Mathematics.

STEM pipeline the decrease in the number of students pursuing STEM-related studies and careers.

STEM Skills those skills expected to be held by people in the subjects of science, technology, engineering, and mathematics.

Teachers in-service lower and upper secondary education teachers of STEM-related courses, teaching Mathematics, Physics, Chemistry, Computer Science, etc. (unless stated otherwise).

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Chapter 8
Emerging Technologies: Impacting Learning, Pedagogy and Curriculum Development

Margarete Grimus

Abstract This chapter explains the relationship and interconnection of general issues involved in the development of digital skills as an essential precondition for lifelong learning. While technology is changing faster than ever, it is necessary to develope skills early in education with inclusion of appropriate core skills for digital citizenship. This includes formal education (from early learning to higher education), with implications on curriculum development and educational policies. Even more important is an ongoing curriculum adaption in the field of teacher education and professional development. It includes rethinking the roles of teachers and learners and transforming the learning environment. New pedagogies are supporting individual learning strategies for knowledge development and self-directed learning. Since education systems are rationally developing slowly, examples are presented for supplementing personalized learning with open pedagogy and integration of educational technologies. In higher education, new tools and strategies offer a wider range of personalized learning opportunities, for example, massive open online courses (MOOCs) and open educational resources (OER). These tools offer new ways for self-directed learning and at the same time demand educational institutions and lecturers to cooperate and reorganize learning material, curricula and study plans. Furthermore, it challenges governments to provide appropriate infrastructure in general and especially in institutions for education.

Keywords Digital citizenship · Digital skills · Innovative pedagogy · Curriculum development · Policies in education

The use of emerging technology and software is commonplace in everyday life, and digital competence is vital for participation in today's society and economy. Digital technology has led to an increased interest in considering its potential applications in education. Learning in a world of emerging technologies challenges theories of teaching and learning. The move from instructor- to learner-based education is a major

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paradigm shift, both fueled and supported by advances in technology. The affordability of low-cost mobile technology has induced intense interest and experimentation. The challenge is to make effective use of new technologies while preparing students for productive lives in the twenty-first century (Spector 2014). This is putting high pressure on governments and stakeholders. It implies changes in education systems, policies (adapting the curriculum to future needs), educational leadership (coordination of institutions) and taking advantage of emerging fields (e.g., learning analytics, adaptive learning, flipped classrooms, next generation of MOOCs and artificial intelligence). Furthermore, it challenges the education ecosystem in terms of investments in ICT infrastructure and developers of software and content (Reeves 2009). Learning analytics, for example, is still evolving and gaining traction within higher education (Johnson et al. 2015).

8.1 Background

The impact of globalization and technological innovation on all areas of human life is creating both new demands and opportunities for emerging markets. Everybody needs to become a responsible member in the digital citizenship. 'Digital citizenship is the responsible use of technology to learn, create, and participate in today's society.' James et al. (2019) briefly worded as '*the way a person participates in society online*' (Mossberger 2009). Twenty-first-century skills are a sample of learning skills, literacy skills and life skills (Thoughtful Learning n.d.). They must be tackled in general, but especially in a significant transformation in the development of education and learning skills (Auer et al. 2018; Bates 2015).

The half-life-time of skills is rapidly falling, placing huge demands on learning. The exponential acceleration of technological developments and the need for flexibility and agility are challenging learners over all ages. There is increasing understanding that new areas of knowledge, competences and behaviors need to be integrated into curricula if young people are going to function well in an increasingly complex global society (Hughes and Acedo 2016).

Digital competence of young people is crucially important when technology is changing faster than society. The labor market increasingly demands higher-order skills. Development of soft skills such as creative problem solving, conflict resolution, communication and teamwork build the connections between classroom and real-world learning. Businesses seek to keep up to date with rapidly changing technology through training, and students must be prepared for lifelong learning to keep up with transformations in work and workplaces. However, there is a considerable body of literature arguing that current education systems are failing learners in an increasingly digital world (Selwyn 2011).

Some interacting issues influencing developments in learning and education in the light of lifelong learning are depicted in Fig. 8.1.

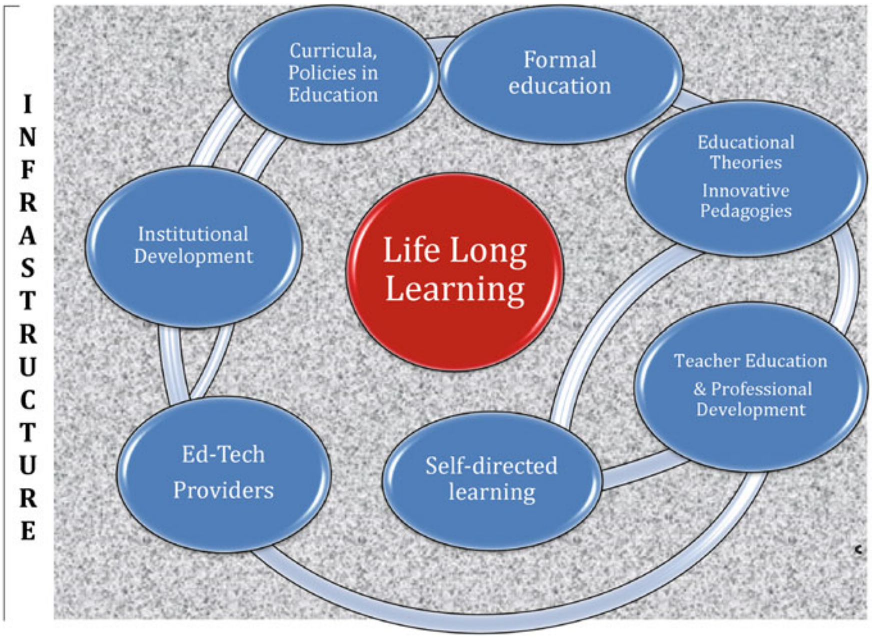

Fig. 8.1 Relevant dimensions influencing education, formal and informal learning in a digitally driven world selection

8.2 Learning in a World of Emerging Technologies

Learning occurs *seamlessly between the classroom and everyday activities* (Hegarty 2014). Learning is facilitated not only by teachers, even more often by peers and in the workplace. The learner must be able to reflect on the experience, use analytical skills to conceptualize the experience, make decisions and solve problems to use the ideas gained from the experience. Knowledge is continuously gained through both personal and environmental experiences. Digital technologies allow for students to have far more access to constant information than past generations and technology bridges learning inside of the classroom into student's everyday lives.

8.2.1 Twenty-First-Century Skills, Requirements for Lifelong Learning

Twenty-first-century (learning) skills are outlined as a set of abilities that students need to develop in order to succeed in the information age. The International Education Advisory Board suggests that twenty-first-century learning is and will continue to be linked to information technology. That's why there is an increasing demand for a thorough review of knowledge, skills and character necessary for deep and relevant learning. Governments around the world seek to equip young people with the skills they need for life and employment (Hughes and Acedo 2016; Cruz n.d; Schuwer 2017).

8.2.2 Digital Literacy

Twenty-first-century Literacy Skills comprise skills in Information Literacy, Media Literacy skills and Technology Literacy, briefly summarized as Digital Literacy. Information Literacy refers to effective search strategies and evaluation techniques (learn how to evaluate the quality, credibility and validity of websites). Digital literacy is the ability to find, evaluate, utilize, create and share content in meaningful ways that require critical and creative thinking skills. (Spires et al. 2018; New Zealand MLP, 2015; Lynch 2018a).

With the increased importance of technology in society, digital literacy has gained recognition as a most valuable tool for lifelong learning. It is important to be aware of limits and barriers of technology for self-directed and lifelong learning. A digitally fluent person can articulate why the tools he/she is using will provide the desired outcome (New Zealand 2016; Guo 2016) (Fig. 8.2).

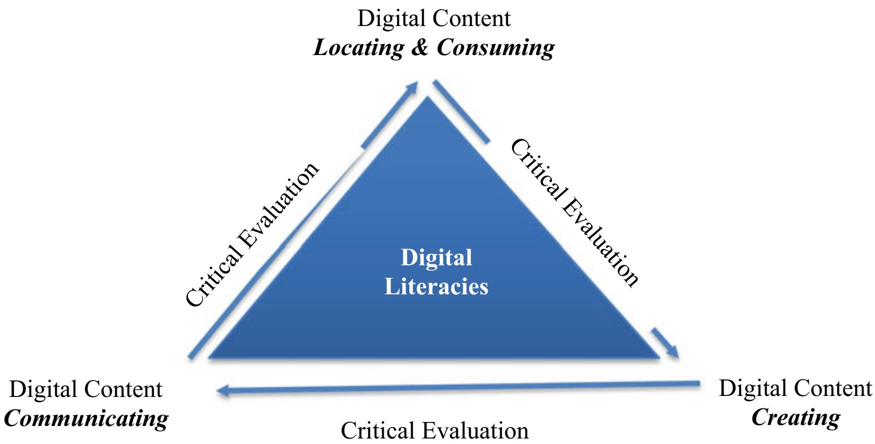

Fig. 8.2 Digital literacy (adapted from Spires & Barlett 2012)

8.2.3 Skills

Digital literacy encompasses skills that differ for educators and learners, because teaching with technology is inherently different from learning with it (Johnson et al. 2015; IFLA 2017; Kavanagh and O'Rourke 2016). It addresses the vision for young people to be confident, connected, actively involved lifelong learners. Safety and security concerns underscore the need for children and young people to learn—and for teachers to teach—digital literacy (New Zealand 2016). Briefly summarized, digital literacy benefits learning by confident using digital content and tools that match the purpose in learning; it enables people to continue learning after having left the classroom and make the best of available opportunities (Grand-Clement et al. 2017; Spante et al. 2018).

Soft Skills: Soft skills together with the use of technology empower finding, analyzing and synthesizing information aimed at solving problems.

- Critical Thinking: The ability to think clearly and rationally, to analyze and combine information to develop their own understandings, separating facts from fiction as well as being able to reflect independently (questioning how authentic, valid and useful digital information is).
- Creative Thinking: Using digital tools for accessing, creating, designing and sharing digital content in purposeful ways, develop approaches to problem solving (important when a problem requires an innovative solution). This encourages to grow and encourages (young) people to take risks.
- Collaborating and Communicating with people of different cultures: Cloud computing enables collaboration that transcends physical distance and geopolitical borders to establish and strengthen positive online communication and collaborating with others (adapted from Grand-Clement et al. 2017; Bolstad 2017; Guo 2016).

8.3 Learning and Education

Learning is a constructive process, involving the active construction of knowledge in both formal and informal learning. Technology is transforming the teaching process into one that is more interactive, allowing working collaboratively to share ideas, documents and video in a cloud-based environment. It allows teachers to focus on how the technological, pedagogical content knowledge is changing the student's interactions with their learning goals.

Technology-enhanced learning takes place in different forms and contexts, types of learning get blurred, including formal and informal settings, individual and collaborative learning, learning in the classroom, at home, at work, and outdoor in real-life situations, as well as desktop-based learning and learning by using mobile devices (Graf et al. 2012).

Lifelong learning, as defined by the Organization for Economic Cooperation and Development (OECD 2016a), comprises a combination of formal, non-formal and informal learning.

Formal learning opportunities are usually arranged by schools or institutions; learning is planned, organized and structured, guided by a curriculum or a formal program, corresponding to laws and norms. It provides results in a predefined time frame and is quantifiable and measurable (Werguin 2010). Formal learning is not a lifelong process.

Non-formal and informal learning can make it more attractive for people to engage in self-directed learning and can reduce the costs associated with formal learning (e.g., shortening the time required to acquire qualifications in formal education) (ibid).

Non-formal learning may or may not be intentional or arranged by an institution but is usually organized in some way. There are no formal credits granted (ibid).

Informal learning is never organized or predesigned to achieve a particular set of skills in a set time frame. It is quite difficult to quantify and measure (validation and recognition of the informally obtained knowledge). Rather than being guided by a rigid curriculum, it is often thought of experiential and spontaneous activities (Werguin 2010). Informal learners are motivated and eager to learn. They are not only interested in gaining deeper knowledge, but they get a better understanding of the subject under discussion (Raccon Gang Blog 2018).

Because learning goes beyond the classroom in various and potentially challenging ways in terms of managing the access to sensitive information or potentially harmful content, it is also necessary to include relevant topics into the curriculum (Grand-Clement et al. 2017).

8.4 Pedagogy: Integration of Educational Technologies

Pedagogy needs to enable different ways of learning and to rethink students' interactions with specific topics. The role of technology in schools increases and can help to make schools more effective and engaging. Young people appreciate digital technologies to connect, communicate, play, create and learn in ways never imagined just few years ago. They need to develop confidence and skills for research on issues they are interested in by themselves. Education needs to empower young people to use these resources confidently and wisely and in positive ways. Students cannot simply be taught specific solutions; they must be prepared to learn how to learn.

Teachers should question themselves *how well the technology tools are helping students meet the learning goals and possibly enhance the learning goals* when considering a specific strategy (Kolb 2017).

Some recommendations for teachers to focus on how technology is meeting and possibly exceeding the learning goals are outlined below.

- Does this strategy help student's engage in learning about the content?
- Does this technology
  - help student's focus their attention on the content?
  - help them develop a more sophisticated understanding of the content?
  - move students from passive to active learners in the content?
  - create a way to make it easier for the students to understand or interact with the content? allow students to demonstrate an understanding of the content that they could not do with traditional tools? (adapted from Kolb 2017).

8.5 Pedagogy—Strategies, Instructional Design

Technology enables differentiated instructional approaches and individualized delivery systems. In formal education, it is important of making the distinction between using technology to learn, rather than teaching how to use technologies (Grand-Clement et al. 2017).

A progressive–constructionist shift in pedagogy is needed to help young people prepare for life in today's society and the potential of personally initiated learning. In a learner-centered environment, learners own and co-design their learning actively; students are taking ownership of the learning process to become a lifelong learner. It implies to rethink how learning spaces should be configured, shifting from an instructor-led education to a learner-based environment (Parsons and Mac Callum 2017). Thoughtfully cultivating the use of technology in the classroom by empowering teachers to utilize the tool in ways that support their learners is critical in the transition to a personalized learning environment (Johnson et al. 2014; UNESCO 2017a; Tritz 2015).

From early learning through adulthood, digital literacy is showing the most promise for success (Lynch 2018b). Research indicates that students can develop synthesizing minds through well-designed lessons where they learn information literacy as a regular feature of each year's curriculum (Hughes and Acedo 2016).

Innovative pedagogies address practices of teaching, learning and assessment for the technology-enabled world. A brief literature review of innovative pedagogies attests the outcome of successful projects when using emerging technologies (Ferguson et al. 2019).

8.5.1 Personalized Learning, Open Pedagogy

Access to quality education means access to personalized learning (UNESCO 2017a; INTEL Toolbook 2017; INTEL Guidebook 2015). Personalized learning is teaching and learning that is focused on the background, individual needs, potential, interests and perception of the learner. It enables learner to take ownership of their learning (Bray and McClaskey 2015). Students should be given opportunities to provide feedback to their teachers so that they can adjust the learning process, including supportive technology and material to plan instruction accordingly.

Assistive technologies are valued as beneficial for personalizing learning. Research shows generally positive relationships between personalized learning and educational outcomes indicators of engagement and academic achievement (DeMink-Carthew et al. 2017; Bray and McClaskey 2015). Although personalized learning does not rely solely on new technologies, access to the online material can allow individual learners to take their learning further (UNESCO 2017a).

Critical and creative thinking requires an open-minded approach from the teacher. Open pedagogy can move learning from content to action (Hegarty 2015). Attributes for successful contribution to an open pedagogy are based on the use of participatory technologies for interacting via Web, social networks and mobile apps. It can support developing trust, confidence and openness for working with others. Furthermore, it can encourage spontaneous innovation and creativity. Ideas and resources can be shared freely to disseminate knowledge, participating in a connected community of professionals, and facilitate learner-generated contributions to open educational resources (OER). It offers opportunities for reflective practice and peer review (ibid). Students are more likely to develop critical thinking skills when they feel free to take risks, are corrected without feeling criticized, and discuss different opinions in open learning spaces (Hughes and Acedo 2016). OER can be estimated as an integral component of an open pedagogy.

8.5.2 Digital Tools in Education

Technology is now heavily involved in learning processes where students get deeper, active learning experiences. Educational technology provides the digital resources that open doors and minds to diverse learning models and teaching strategies.

Depending on the goal of learning, a growing range of options are available for enhancing teaching in face-to-face classroom settings by delivering information via digital technologies. Options are collaboration and other class activities, peer assessment, Web-based tutorials, online courses, video conferencing, multimedia presentations, and computer-assisted instruction delivered over a network, available also for using wireless handheld devices. Tools are available for feedback and grading, student-to-student and student-to-instructor interactions, collaborative activities, etc.

Technology can benefit teachers and students when it is implemented correctly. Most important is that learners are trained in advance for effective use of technology related to the didactical design (Khalikova 2017).

Technology that simply did not exist ten years ago allows now to use electronic devices to access the wireless network on the school system's filtered Internet. Students having access to tablets and smartphones outside school grounds are also already comfortable with the technology. The amount of individualized learning available on tablets that are equipped with Internet technology is virtually limitless. It offers the potential for student learning adaptation in the classroom. Bring your own device (BYOD) is nowadays common in many schools, especially in the Western world. Students who bring their own devices into the classroom eliminate initial costs for schools; the downside is that not all students can readily afford such technology.

Cloud computing technology with unlimited potential for educational collaboration is becoming an easy-to-use tool in K-12 classrooms, saving space and money. Many K-12 educators are also coming to expect that content on any given topic already is available to teachers and to students. It can be shared and does not need to be always recreated or purchased.

8.5.3 Examples for Technology Integration in Education (Selection)

- Content for flipped classroom: online available digitized lectures, e-books, videos, podcasts, Web article learning programs, news report, etc.
- Discussion boards can help to facilitate discussions and other activities during class: online chat, Skype. They can also be used for exchanging a variety of media (images, photographs, videos, audio messages, etc.).
- Social media channels for communication out of classes: Skype, Twitter (creating a classroom hashtag and invite students to tag relevant material), instant messaging apps, WhatsApp, Pinterest (creating digital collages with the possibility of commenting on and sharing collected images and videos), Snapchat, Instagram, YouTube, Tumblr, Facebook, etc.
- Quizzes.
- Gamification.
- 3D printing allows K-12 students to create tangible models for their ideas.
- Virtual reality can help students in bringing experiences to life through animation, physics, and spatial audio.
- Artificial intelligence allows innovations with deep learning capabilities that can now know users at a higher level—not merely interpreting user commands but also understanding user behaviors and emotion (adapted from European Commission 2018; Carr and Cameron-Rogers 2016; Godwin-Jones 2018).

Classroom response system (also known as *clickers*) is gaining interest for creating a poll with multiple-choice questions; clickers are distributed among students who then click a button corresponding to their chosen answer. The response system hardware is connected to the teacher's laptop and collects real-time analytics and projects them to the class. Online polling is mainly used in higher education, for example, Learning Catalytics, which works on students' personal devices, e.g., mobile phones and laptops (Khalikova 2017).

8.6 Transforming the Learning Environment

8.6.1 Rethinking Learners' and Teachers' Roles

It is observed that there is a role reversal in the digital age, moving away from the idea that learning is a one-way process, recognizing the importance of the term *coaching,* as opposed to the term *teaching* (Grand-Clement et al. 2017). The younger generation is more likely digitally literate than their teachers, because increasing information is available online.

There is no need to teach students to memorize facts, instead addressing learning as a constructive activity, where students create knowledge by interacting with tools and resources. The aim is to shift education from a passive, teacher-driven endeavor based on uniform curricula to an active process that puts students at the center by meeting students at the intersection of their abilities and their interests (Rashawn et al. 2017).

Educators' role is being more of a guide or mentor, enabling a more personal learning experience, as opposed to be a source of knowledge (Grand-Clement et al. 2017; Bray and McClaskey 2015). Educators guide the learner how to access and evaluate information and empower students to think critically, behave safely, participate responsibly and harness the full potential of technology for learning in our digital world (SWGfL 2015). Students (and teachers) learn about copyright and fair use, addressing plagiarism, distinguishing piracy, employing strategies for staying safe between inappropriate contact and positive connections (Grand-Clement et al. 2017).

Students and teachers need to develop responsibilities and rights as creators in the online spaces where they consume, create and share information. They need to use tools and materials that emphasize skill building, media creation and decision making (Bolstad 2017; Tondeur et al. 2012). It includes developing a team spirit, providing support and mentoring, asking for questions rather than asking for answers when guiding the learner into future learning avenues (Grand-Clement et al. 2017). Technology can effectively support teaching and learning, but technology cannot replace the teacher (OECD 2016b). Digital learning does not mean learning on a mobile device (tablet, smartphone); it means *bringing learning to where learners are.* It is a *way of learning* not *a type of learning* (Bersin 2017).

8.6.2 Adaptive Learning Tools

An Adaptive Learning Program (ALP) applies to content and to assessments (Lynch 2017b). Adaptive learning is a data-driven approach to instruction and remediation adjusting to students' demonstrated performance to provide content and learning resources (Keeling et al. 2015). It is a more personalized, technology-enabled, data-driven approach to teaching and learning as measured by student engagement, persistence and outcomes.

Digital adaptive learning tools use learning analytics, allowing teachers to modify the way they present material based on the performance of individual students. ALP can respond to student's interactions in real time by automatically providing the student with individual support and to enable human tailoring of responses (Lemke 2013). Students are able to track their own learning, which helps them develop self-monitoring skills and fully engage in their learning progress. Although some teachers are being forced to use online grading tools and devices, analysis tools are becoming more precise (Khalil et al. 2018).

8.6.3 Open Educational Resources (OER), Massive Open Online Courses (MOOCs)

Concepts associated with new strategies in education movement are open educational resources (OER) and massive open online courses (MOOCs). They are freely accessible resources and can be reused, revised, remixed and redistributed (known as David Wiley's four Rs (2013)). OER make learning and teaching material more accessible and useful by altering their copyright regime (James et al. 2019; Nascimbeni et al. 2018). Creative Commons (CC) license attributions became a key aspect of the OER movement (Reed 2012). Open licensing means that resources can be altered, reused and/or repurposed to suit requirements within specific contexts, depending on the exact terms of the license. Furthermore, OER can lead to greater student autonomy in the student–teacher relationship (Donovan et al. 2019).

While OER has the 'potential to place a "heavy footprint" in real-world settings across educational sectors, ages and grade levels,' OER use is not that much common as it could be in today's professional development activities around the world, and even less in the developing countries (Ehlers 2011). According to Moon and Villet (2017), there has been little work on exploring how educators utilize OER in their practice. A reason might be that it can be frustrating how and where appropriate OER can be found matching the specific need or purpose (Veletsianos and Kimmons 2012).

Another challenge commonly stated in the literature is that there is a deficit in assuring the accuracy of information diffused through OER and that quality assurance of OER is not an easy process (Wiley 2017; Cox and Trotter 2016). This is an important issue, because OER (open content and open licensing) can be very useful in teacher education and further development. Kanwar and Mishra (2015) indicated that since openness can allow any user to modify the content, a big question mark emerges in regard to the question of, 'Who is responsible for the repurposed content? (p. 121). In some states and districts in the USA, policies regarding the OER movement are documented (Bakia et al. 2012). However, there are no globally recognized standards for developing high-quality OER (Kawachi 2014; Kanwar and Mishra 2015; Emerson 2013; Andrade et al. 2011).

Kanwar and Mishra (2015) recommended intensifying cooperation in OER practices of teachers in the developing parts of the world together with those in the developed world to contribute to the expansion of the OER movement. Instructional resources and activities designed in the developing world might be translated and localized vice versa. In an age of declining school funding and increased needs for education, teacher awareness, understanding, and adoption of OER are vital. Support for (re)use and production of OER through institutional policies is a considerable issue.

A massive open online course (MOOC) is a type of online learning environment that has the potential to increase students' access to education (Khalil et al. 2018). MOOCs are becoming widely popular; they are typically asynchronous, allowing everyone and at every location in the world to participate in seminars offering them online easy access to a course or program from home (James et al. 2019). However, low completion rates in MOOCs suggest that student engagement and progression in the courses are problematic (Khalil et al. 2018; Lackner et al. 2015).

8.6.3.1 Blended Learning and Online Learning

Blended learning is a combination of face-to-face and online learning and teaching; it benefits student learning and achievement by providing flexible options (Donovan et al. 2019). Recommendations for online learning are provided by Russel (2017), for example, specific schedules for teacher presence, timely teacher feedback, varied assessments, collaborative work, etc.

8.6.3.2 Mobile Learning

An advantage to using mobile devices, compared to other technologies, is the likelihood that these devices are already familiar to students. Because of their portability, flexibility and intuitive interfaces, mobiles are gaining increased interest in schools, and a growing number of them have turned to tablets as a cost-effective strategy for one-to-one learning. They are efficient and affordable devices for sharing educational resources. Collaboration as an option of mobiles can enhance the classroom learning dynamic (Godwin-Jones 2018; West 2013). Use of mobile devices in education can be based not only on traditional pedagogies, but also on constructivist principles (Cox and Trotter 2016). It is important to raise students' awareness toward the usefulness of mobile learning. Use of mobile devices takes careful preparation. Thoughtful implementation guidelines should be developed and agreed to by all stakeholders.

8.7 Policies in Education and Resources

Policies provide advice for schools, students, parents and the wider school community on the provision of education services and decision-making processes. Policies, practices, processes and outcomes are dynamically interrelated. Governments in every country set up the overall framework that shapes the education system and defines its operation by determining the organization and structure. Educational leaders who are involved and engaged with technology initiatives can have a significant impact on school culture and on achieving desired goals. OECD researches and publishes national policies in various countries; the education system in many countries is still perceived as traditional in its structure and implementation. The challenge for policymakers is to develop processes for recognizing learning environments that will generate benefits both to individuals and to society at large (Werguin 2010).

The European Commission works closely with national policymakers to help them develop their school education policies and systems. While each country is responsible for the organization and content of its education and training systems, advantages in working together on issues of shared concern are elaborated in working groups. The working group on Digital Education, *Learning and Teaching*, developed a digital action plan (DAP) by emphasizing three main goals:

- making better use of digital technology for teaching and learning,
- developing digital competences and skills, and
- improving education through better data analysis and foresight (European Commission 2018).

Innovative and entrepreneurial spirit in education and training should be fostered and supported with clear political willingness. They point out that there is a *need to share*, *discuss and promote and*, *where possible*, *scale up innovative practice.* Concepts, tools, methods, processes, systemic thinking and design thinking need to be more accessible to support technology use and digital competence development in education. Education professionals are usually not fully aware of what is tried and tested elsewhere (ibid, p. 3).

The OECD researches policy options for a wide range of topics in education, publishing reviews on national policies with a two-year follow-up study on progress and developments. The aim is to identify and develop the knowledge and skills (e.g., low-resource schools, universities in high-income countries, and vocational centers) for evidence of successful ICT in education practices in order to support countries in shaping their policy guidelines (OECD 2016b).

8.8 Curriculum Development

Contemporary curricula are often criticized for learning within the parameters of traditional subjects as inadequate in the twenty-first century. The rigidity which has characterized the curriculum required all students to study exactly the same content in exactly the same way, often at exactly the same pace. While knowledge has emerged in recent decades, existing subject structures, roles, impact of technology and issues related to environment and sustainability do not match the demands in the curriculum any more (UNESCO 2017b). This must be replaced by a more flexible approach.

8.8.1 Affordances and Support

Only through flexibility within the curriculum can the wide and ever-changing range of needs, interests and aspirations of students truly be acknowledged. A principle of flexibility will ensure that a range of opportunities and pathways are provided to students. UNESCO's Training tool series offers training for curriculum development online, which is frequently updated (UNESCO IBE 2017a; UNESCO 2018a, b).

The impact and challenges of technology, media awareness and understanding should be taught across all subjects appropriately. Content, learner involvement, instructor guidance and technology solutions need to evolve to keep pace with developments (Tritz 2015). It is therefore important for curricula development to emphasize and assess rigorous, creative and critical use of source material, starting at an early age, with and through increased collaboration between classroom teachers, librarians and coordinators of technology for learning (Hughes and Acedo 2016).

Educational institutions must adapt and embrace changing pedagogies and develop the curriculum accordingly (Tritz 2015). According to Heick (2019), schools need to explore not only how to use technology but also how it can open up new and different ways of learning. Curriculum shifts need to focus on various forms of active learning and flipped classrooms and scale up team-based and problem-based learning environments. Curricula need to be deeply redesigned on the dimensions knowledge, skills and character, summarized as Meta-learning Framework (Fadel et al. 2015). Learning objectives need to be defined as outcomes that are measurable.

The curriculum plays also a vital role as an articulator of STEM (Science, Technology, Engineering, and Mathematics) competences (Incheon Declaration 2015). It underscores the crucial role played by STEM in finding out innovative solutions in order to forge sustainable development and sustainable lifestyles. Emerging technologies support updates in curricula and learning material. From a curriculum design perspective, there is a critical need for more flexibility (Hassler et al. 2016).

UNESCO published a curriculum prototype which draws on the experience in a wide range of countries and regions. It outlines five stages for curriculum development: *Evidence Gathering—Preparation—Development—Implementation—Monitoring and Evaluation* (UNESCO 2017b). The curriculum should be adjusted to national needs and content and updated more frequently. Training activities to each stage are attached, requiring the completion of several tasks and subtasks, related to decision making or formulation of responses (ibid). A report of curriculum-guidelines of 10 countries provides insights in ongoing developments (Cox 2017).

The Ministry of Education in New Zealand has developed a draft vision of *Lifelong learners in a connected world.* It provides a snapshot on education in New

Zealand in 2025 as '*a highly connected, interdependent education system*' and provides additional resources for curriculum development. They are divided into four sections: state-of-the-art infrastructure, twenty-first-century teaching and learning, access to quality content and resources and equitable access (New Zealand 2016). Each section addresses policy makers, planners and curriculum developers to take care for schools and school libraries to provide students with access to digital technology for the development of digital literacy skills in order to support learning and development.

Affordances (selection, adapted from New Zealand MLP 2015).

- state-of-the-art information communication technology (ICT) infrastructure to ensure learning can occur anytime, anywhere,
- twenty-first-century teaching and learning through digitally literate teachers and students and innovative practices,
- easy and safe access to quality digital content, resources and tools,
- equitable access to digital technologies to enable every student to learn regardless of location, learning needs or family background.

Recommendations (ibid).

- commit to meeting the needs of twenty-first-century learners,
- achieve equitable access to digital devices for every learner,
- invest in people and innovation,
- create future-focused learning environments,
- invest in high-quality digital content and systems to make content easily accessible,
- build regional capability through collaboration,
- build a robust evidence base,
- implement a coordinated, system-wide effort to align curriculum, digital technologies, property, infrastructure, funding and legislation,
- design a coherent, flexible and robust funding structure to support twenty-first-century learning.

8.9 Teacher Education

Curriculum development needs to be considered in teacher education and professional development programs in context with approved and new evaluation methods. It has to be outlined how digital technologies can supplement pedagogical principles that are specific for using technology in instructional settings (Heick 2019). It includes how to embed digital skills into the curriculum and provide educators with the support they need to teach them.

The European Commission (Department Education and Training) published a series on the topic of teacher education. It claims more support for teachers, school leaders and teacher education, including career-long professional learning opportunities (ICF 2017). The EU working group has developed a ‚guidance for policymaker on quality assurance for school development to ensure a more effective, equitable and efficient governance of school education and to facilitate learner mobility.

Tondeur (2018) recommends effective strategies to support preservice teachers to adequately integrate ICT in teaching and learning activities. He puts the focus on the strategies included in the SQD (Synthesis of Qualitative Evidence) model (UNESCO 2018/Ed WS/43).

- Using teacher educators as role models,
- reflecting on the role of technology in education,
- learning how to use technology by design,
- collaboration with peers,
- scaffolding authentic technology experiences, and
- providing continuous feedback.

8.10 Discussion

Education and training stakeholders are the key players in making innovations mainstream. Emphasis in schools is often directed at technical digital skills, whereas soft skills, being just as important, are not as highly relevant recognized (Grand-Clement et al. 2017).

Mobile technology has potential to change the student–teacher dynamic for the better, though only if implemented correctly. There are different affordances in technology-enabled training (digital education) related to school levels. While some curricula already include many twenty-first-century competencies, the challenge lies in the need for systematic implementation of the curricula through alignment with appropriate pedagogy and assessment. This implies that in many cases there is also a need to refresh curricula to reflect the skills more explicitly. Shifting from *instructional design* to *experience design* and using *design thinking* is necessary.

Schools need to provide resources for teachers to feel comfortable when teaching in mobile technology formats. Teaching material must be redesigned in terms of mobile technology (Ally 2009). Higher engagement from K-12 students who use mobile technology is often recognized as a direct result of feeling of ownership on the part of the student.

OER requires a significant change in practice and the development of specific attributes, such as openness, connectedness, trust and innovation. Decreasing the cost of education for students becomes possible through OER use in classrooms (Bliss et al. 2013). Instructors need to be trained necessary skills to be able to create and/or use OER (Lynch 2017a). These attributes translate into open educational practices (Hegarty 2015).

Particularly in higher education technological change (adoption of new technologies for learning) is being driven by students' demand. Through a fusion or integration of informal and formal learning, students can consider teachers as co-learners and recognize learning as a partnership model (Henderson et al. 2015; Hall 2009; Dabbagh and Kitsantas 2012). It is important for a learner to make a smooth transition from formal to informal learning, promising the idea of 'continuity.'

When looking ahead to the future, institutions must encourage close collaboration between instructors and technology experts early in curriculum design (Tritz 2015). The use of technology in education should be fed back from educators to EdTech developers (Grand-Clement et al. 2017). Educational technology companies should provide more evidence of the technology's usefulness and better communicate the technology's value and importance. EdTech providers should explore the pedagogy behind the use of the technology. It is important to bridge the disconnection between EdTech producers/distributers and educators to improve technology, software and efficiency for learning.

While technology is transforming the future of education, outdated infrastructure for classroom technology can pose a distraction. Connection hassles and classroom delays when trying to link display systems and user devices can lead to decrease productivity and disengage students (UNESCO 2017b). Furthermore, young people can also be discouraged by low-level technologies used in schools, compared with the high-quality digital content that they are used to outside school.

Nagel (2013) refers to an assessment gap in how changes in curricula and new skill demands are implemented in education. He states that schools do not always make necessary adjustments in assessment practices as a consequence of these changes. In the light of learning in the digital age, it needs to consider new evaluation instruments for individual learning progress. Education should be measured in terms of skills and development, rather than in terms of content and learning outcomes. This needs a substantial rethinking of the examination system (Grand-Clement et al. 2017; Care et al. 2018).

8.11 Conclusion

The goal for students is to be able to learn and work safely and effectively in a digital environment, choosing the most appropriate tools for their tasks which are essential for quality learning. Learner's abilities for using knowledge and having problem-solving skills are associated with the quality of adopted and applied curriculum (Gencel and Saracaloğlu 2018). For students with special needs, modern technology can change their life by offering access to learning.

Improvement of formal education and lifelong learning builds on two main sets of skills: digital and technology skills and the so-called soft skills, which are increasingly important in order to participate in the digitally connected society.

With the rise of digital technology in the classroom, it becomes easier for teachers to personalize lessons, instructions and projects for each student or group (Russell 2017). Teachers must acquire (evolve) skills, attitudes and understanding to support students to develop the necessary information literacy skills together with technology skills and critical thinking. Progress can be achieved when motivated teachers are willing to explore new teaching methods with integration of (mobile) devices commonly owned and used by the students. Ongoing professional development is necessary for teachers to learn how to effectively use different types of educational technology as well as strategies to implement technology across content areas. Teachers can focus on the work of each student and provide feedback, grades and reports directly to students through online platforms. It offers opportunities for students to collaborate from a variety of places and peer-to-peer learning.

Further research is required to identify the skills needed today and to predict where skills gaps and shortages may emerge.

Glossary

Twenty-first-century skills Skills necessary for all children to succeed as citizens and workers in this century. These skills such as collaboration and team work, creativity and imagination, critical thinking, problem solving, digital literacy and citizenship (retrieved from The Glossary of Education Reform, http://edglossary.org/21st-century-skills/).

Adaptive learning is an approach to creating a personalized learning experience for students; it is a (sometimes nonlinear) approach to instruction and remediation, adjusted to a learner's interactions and demonstrated performance level, subsequently anticipating what types of content and resources learners need at a specific point in time to make progress. (Source: The Journal, https://thejournal.com/articles/2014/05/14/adaptive-learning-are-we-there-yet.aspx).

Blended learning Learning occurs online and in person augmenting and supporting teacher practice. It allows students to have some control over time, place, path or pace of learning. Source: National Educational Technology Plan, p. 8, http://tech.ed.gov/netp/.

Deeper learning means the students' ability to use higher-order cognitive skills to construct long-term understanding. It involves the critical analysis of new ideas linking them to already known concepts and principles so that this understanding can be used for problem solving in new unfamiliar contexts. (Source: Article www.julianhermida.com/algoma/law1scotldeeplearning.htm.

Digital citizenship refers to norms of appropriate and responsible behavior with regard to technology use. The Digital Citizenship Curriculum is free and available to schools from Common Sense Education's foundation at https://www.commonsense.org/education/digital-citizenship and https://www.commonsense.org/education/scope-and-sequence.

Digital learning environment is a place of learning that uses technology to expand the classroom into the local or global community. Students have the opportunity to develop both academic skills, and twenty-first-century skills are engaged in authentic tasks that have a connection to the real world.

Digital learning means any instructional practice that effectively uses technology to strengthen a student's learning experience and encompasses a wide spectrum of tools and practices,

Digital literacy refers to the ability to use digital technology, communication tools or networks to locate, evaluate, use and create information; to understand and use information in multiple formats from a wide range of sources; to perform tasks effectively in a digital environment. Literacy includes the ability to read and interpret media, to reproduce data and images through digital manipulation and to evaluate and apply new knowledge gained from digital environments. (Source: University Library, University of Illinois, www.library.illinois.edu/diglit/definition.html.

Educational technology encompasses the practice of using technology in instructional settings in support of teaching learning and academic achievement.

Game-based learning (GBL) Students learn through playing games. (Source: Teach thought, www.teachthought.com/technology/difference-gamification-game-based-learning/).

MOOCs are massive open online courses with open access and interactive participation by means of the Web designed for the participation of large numbers of geographically dispersed students. MOOCs provide participants with course materials that are normally used in a conventional education setting, e.g., examples, lectures, videos, study materials and problem sets. MOOCs offer interactive user forums, which are extremely useful in building a community for students and professors. Generally, MOOCs do not charge tuition fees or provide academic credit

Open Educational Resources (OER) are teaching: learning and research materials in any medium (digital or otherwise) that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions. https://en.unesco.org/themes/building-knowledge-societies/oer.

Personalization *or* personalized learning refers to an instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner. It includes learning objectives instructional approaches and instructional content, and it very based on learner needs, learning activities and are meaningful and relevant to learners, driven by their interests and often self-initiated.

Problem-based learning is a student-centered pedagogy in which students learn about a subject through the experience of solving an open-ended problem. (Source: www.Wikipedia.com).

Student-centered learning refers to a wide variety of educational programs learning, instructional approaches and academic-support strategies that are intended to address the distinct learning needs, interests, aspirations, or cultural backgrounds of individual students and groups of students. (Source: The Glossary of Education Reform, http://edglossary.org/student-centered-learning/).

IBE International Bureau of Education Blog.

ICT information communication technology.

IFLA International Federation of Library Associations and Institutions.

OECD Organization for Economic Cooperation and Development.
OPAL Open Education Quality Initiative.
SQD Synthesis of Qualitative Evidence model.
STEM is a curriculum based on the idea of educating students in four specific disciplines: Science, Technology, Engineering and Mathematics.
Items derived from https://www.nj.gov/education/techno/glossary/ and adapted.

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Margarete Grimus' scientific work is directed at integration of digital media, eLearning and mLearning to increase learning efficiency with regard to didactical aspects. Her research focusses on strategies for integration of mobile learning to increase educational standards in Sub Saharan Africa. Main aspects addressed are didactics for developing online learning material to build up informal learning competences, with a vision of decreasing the digital divide, and to foster talents by ability of using online educational resources. Research-projects were carried out in Nigeria, South Africa, Mozambique and Ghana, published in international journals and congress-proceedings. She was a lecturer at the University College of Teacher Education (prospective and advanced teacher training) in Vienna, Austria (full time) and in addition as lecturer of the University of Derby, UK (Master of Education, part time). Her cooperation in projects with European Universities about curriculum development and standards in Teacher Education continues, together with working as test-leader and external examiner of international studies (PISA, TIMSS, PIRLS).

Chapter 9
Considering Learning Styles When Designing for Emerging Learning Technologies

Lisa Poirier and Mohamed Ally

Abstract An examination of what learning styles really mean, where they came from, how they are used and their impact on the design and delivery of education is the focus of this chapter. Learning style theories have had a long history in the West and were born from a plethora of learning theories developed mostly in the early twentieth century. The definitions of learning styles have evolved since its inception in the late 1800 s with many opinions defining and redefining them. Criticism about the truthfulness and usefulness of learning styles for both pedagogical and learning practices has been and continues to be part of decades-long debates and discussions. How learning styles are identified, assigned and the subsequent meanings attached to them have historically guided research and educational practices, many say in the wrong direction. There is much literature that clearly negates the claims of one main learning style used for learning in all contexts, with evidence showing that several modalities work best for higher-level learning. Yet, even with such hard and clear evidence against the way learning styles theory is often interpreted and used, it has, and continues to have, great influence in both research and educational practices, why is this? Cultural implications around learning styles naturally need to be examined especially within this broad, digital world. As online and e-learning continue to take hold in the global classroom, it makes sense to examine what learning styles theory means for online learning for both teachers and students.

Keywords Emerging technologies · Learning styles · Learning preferences · Learning inventories · Multiple intelligence · Learning styles theory

9.1 Introduction

The theory of learning styles has been discussed and re-examined for decades with much of this research done in the classroom setting. This has generated much debate as to the pedagogical usefulness of learning styles as a productive method of teaching

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and learning. Ample literature has discredited the early claims of learning styles theory, showing that no scientific evidence supports the claims (Lethaby and Harries 2016; Martin 2010). Although seemingly unfounded, learning style theories still guide much educational research and practice, and even though largely discredited, learning style theories are still a part of teacher education training programs as well, thus remaining very influential (Lethaby and Harries 2016; Martin 2010). Howard-Jones (2014), showed that within five countries (UK, Netherlands, Turkey, Greece and China), teachers agreed that students learn better when they receive information tailored to their preferred learning style.

With online learning in higher education becoming a global phenomenon, considering learning styles in this new context of globalization with emerging technologies is important as well. Emerging technologies common in distance education today include massive open online courses (MOOCs), mobile and ubiquitous learning and virtual reality (VR). MOOCs can indeed be massive with its digital classroom's walls bulging to capacity from several hundred to several thousand students (Atiaja and Guerrero 2016). Although emerging technologies are found in almost every field imaginable, they are considered optional and not yet a requirement for learning; many have a futuristic feel that has not truly taken hold or is really still in its infancy (Emerging technologies in education n/d; Miller et al. 2005; Atiaja and Guerrero 2016). Miller et al. (2005) offer a clear explanation of emerging technology:

> A technology is still emerging if it is not yet a "must-have." For example, a few years ago email was an optional technology. In fact, it was limited in its effectiveness as a communication tool when only some people in an organization had regular access to it. Today, it is a must-have, must-use technology for most people in most organizations. In this sense a technology can be a standard expectation in the commercial or business world, while still being considered as "emerging" in the education sector. (p. 6)

Do learning styles therefore have a place in this new world of education? This chapter will examine the definition of learning styles, what they mean, where they came from, how they are used and their impact on education. Cultural implications will also be examined along with the biases of Western developed learning style tools and, most importantly, learning styles in the realm of online education or e-learning.

9.2 Description

9.2.1 What Are Learning Styles?

A learning style was initially described as a student's consistent way of responding to and using stimuli in the context of learning (Keefe 1979). Willingham et al. (2015) explain that although many learning style theories are varied, each holds that individuals learn in different ways (learning styles) and that learning is optimized if the instruction is tailored to an identified learning style. The definition has evolved through the years with later definitions offering a broader explanation. Keefe (1979) defines learning styles as the "composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment" (p. 4). Stewart and Felicetti (1992) define learning styles as those "educational conditions under which a student is most likely to learn" (p. 15). Learning styles are therefore not concerned with *what* learners learn, but rather *how* they prefer to learn.

Learning styles can therefore be better described as learning preferences, describing how students prefer to learn, not necessarily that they learn more or better through any such self-identified style. This more apt descriptor is still not quite how teachers tend to view learning styles. Many educators still think of learning styles as students learning better through their self-identified style. Topical literature shows us that learning preferences, combined with other methods, are the most optimal approach for higher-level learning (learning styles as a myth n/d). One alternative to understanding how students learn, although often confused as the same as learning styles, is multiple intelligence theory which focuses more on how students prefer to process information. Gardner (2017) describes the purpose of multiple intelligence theory (MI) that it "seeks to describe and encompass the range of human cognitive capacities. In challenging the concept of general intelligence, we can apply an MI perspective that may provide a more useful approach to cognitive differences within and across species" (p. 1).

9.2.2 History of Learning Styles

How people learn has been a subject of speculation and study since at least the 1800s. At that time, teachers began to look beyond just their role in teaching and look at the experiences of the children in the classroom, recognizing their individuality and interest in learning and this in turn began to influence teachers' pedagogical training and practices (Boone 1894). The term "learning style" has been with us a long time and first appeared in 1892; in 1954, it was applied in a study by Thelen to groups at work (Honey and Mumford in Fatt 2000). Jung developed a theory of personality types in the 1930s, and several theories from other theorists have been presented since. Learning style inventories come directly from these personality theories. One of the first learning style inventories offered in the West is by Betts and was published in 1909; over 70 instruments have been developed in the following years. There has been an abundance of learning styles described through the decades and are labelled by self-identifying instruments. The purpose of self-identification is best described by Kolb (2014) and is twofold: firstly, an understanding of the different ways in which students learn can enhance their own learning; secondly, teachers would have valuable information that would assist in the teaching and planning process resulting in enhanced educational performance.

Some of the most popular learning styles describe learning as happening through the senses: visual, auditory, read/write, kinetic, verbal, social, logical, emotional, field dependant, field independent, to name but a few. Each offers a preference for learning or places the individual on a continuum between two identifiers. Truong

(2016) discusses some of the most notable for the e-learning environment, beginning with Felder-Silverman's learning style theory. This theory divides learners based on their information input, information process, perception and understanding. The author also identifies Kolb's learning style inventory and Honey and Mumford's learning styles; both these styles describe the learning style based on the student's proposed learning cycle (concrete experience, reflective observation, abstract conceptualization and active experimentation). Even though learning style theories and inventories have enjoyed much popularity, there has been a considerable concern from the many nay-sayers.

Throughout much of the twentieth century, learning styles have been critiqued as having no scientific evidence to support its claims, and although this is the case, they continue to be a part of popular culture and in the educational setting. The implications of accepting the theory of learning styles are its entirety that if, for example, a "visual learning style" is reported, then all learning should take place more efficiently through this modality, yet evidence shows that this is not so. Learners can identify subjective or self-identified preferences for learning but this does not mean that deeper or more efficient learning is taking place when using this preference. While learning style still drives education research and pedagogy, it has been viewed as somewhat of a pseudoscience that continues to influence education (Goodwin and Hein 2017). Nonetheless, even with much doubt and lack of clear evidence, learning style theories have been driving educational research, practice and programming for decades (Parslow 2012).

9.2.3 Evolution of Learning Styles

Learning theory began early in the twentieth century with the mid-twentieth century seeing an increase in many learning theories. Learning theories produce ideas and with those ideas come instruments that permit some modification for application. The pedagogical piece accompanies these instruments, influencing how teachers view learners and how they organize, create and implement their learning materials. Each instrument created for each theory is, in essence, a "theory-in-action" measuring tool. The purpose of each tool is to help understand where on a continuum or which end of the binary an individual lies. Learning styles work to inform both the student and the instructor. Once the description of how a learner learns best is established, the reaction to this claim in the world of education is to tailor teaching to match the learning style of a student, and in this way, a student's learning is optimal. A plethora of learning styles have grown through the decades with each attempting to answer the question of "what is learning style"? With each identification follows a descriptor of how one learns and subsequent advice about how to create learning materials around the identified style.

Management organizations and education were and are great supporters of all things learning styles. Many teacher training programs explore learning theories and educational institutions have adopted particular learning style theories that seem to fit well into pedagogy or, seem to enlighten the learning process to ensure that students learning experiences are complete (Martin 2010). Martin (2010) goes on to say that "The use of instruments reporting individual learning or cognitive style is attractive for educators, especially within high-pressures to reach or improve upon high levels of student performance in public examinations and to promote individualized learning" (p. 1583). It is therefore understandable that learning styles remain a part of education with the heavy support they receive from educational institutions.

Concurrently, a vast number of researchers from varying disciplines, each focused within their research, can muddy the waters as each interprets evidence and theories aimed at and focused in their own fields. The commercial production and distribution of all these various instruments has a tremendous impact on education. The selling of instruments and sometimes training to interpret these instruments, along with books and other supporting information, can be quite financially lucrative. These instruments are developed accepting the assumptions, analyses and goals of the theorists, which are often as commercial as they are research orientated (Coffield et al. 2004).

9.2.4 Assignment of Learning Styles

Throughout most of the twentieth century, learning styles were assigned through self-identification inventories but technology can also assign learning styles. Learning style inventories have always been a popular activity and rely on students answering questionnaires; the choices then determine the most accurate and appropriate learning style for that individual. Li and Abdul Rahman (2018) explain these detections of learning styles in two distinct ways: (1) static detection, based on learning style inventories and (2) dynamic detection through the learning behaviour. Although self-identification is a common way to identify learning styles, in recent years, the application of machine learning and the accompanying computerized algorithm analyse online behaviours, creating a huge database of online learning preferences. McLean (2018) describes machine learning (ML) as "a discipline within artificial intelligence (AI), and is the science of getting computers to do something, without explicit programming" (p. 1). The use of technology to assign learning styles through learning behaviour is an interesting concept. The emerging technologies of today, such as MOOCs and VR, are becoming more and more familiar to students so technology-based instruments to measure or identify learning styles would seem relevant and in line with the technological experience.

Online behaviours include: participation in forums, chat boxes, emailing, accessing online journals, blogs and other articles, movement within a platform, amount of time spent in a platform, accessing links within a platform. Machine labelling has offered interesting results; the software examines online learning activities of students and then assigns learning styles/preferences based on said activities. This is an interesting way to examine learning preferences in the online learning environment. It takes the subjective perspective of student self-identifying away, focusing solely upon actions of students. As students become more engaged in emerging technologies, an understanding of learning preferences in these contexts can be proactive as it can guide pedagogical approaches.

9.2.5 Pros and Cons of Assigning Learning Styles

Knowing about individual learning preferences has many benefits for both the student and for the teacher. Knowledge about a student's own learning can offer a sense of confidence in learning which can be extremely motivating (Coffield et al. 2004; Truong 2016). Labelling a preference for learning can offer a place to begin new tasks. This knowing is often shared with teachers, or even implemented by teachers, and the discovery of learning styles can also help a teacher become more mindful of pedagogical practices and ensure that a variety of approaches will be explored when planning and subsequently implementing programming. Coffield et al. (2004) state that "A knowledge of learning styles can be used to increase the self-awareness of students and tutors about their strengths and weaknesses as learners. In other words, all the advantages claimed for metacognition (being aware of one's own thought and learning processes) can be gained by encouraging all learners to become knowledgeable about their own learning and that of others" (p. 43). This knowing can also offer disadvantages in the learning environment for both student and teacher as well.

A label can pigeonhole a learner which can have several drawbacks. A student's expectation about learning can limit not only the student's approach to learning but also the expectation of learning; a student may not attempt anything beyond the realm of what they believe is attainable through the preferred learning style only. Not only can a student be limited by a "one-size fits all" perspective with regard to approaching learning, a teacher's attitude can be impacted as well (Martin 2010).

A teacher with a limited view of how an individual can learn can narrow the pedagogical approach and expectations towards a student. Much of the literature concludes that approaching learning in just one way can inhibit "deep learning". One more negative about this way of thinking is that the onus for learning is shifted from the student and towards the teacher. Should the student fail to progress, it is then the teacher's fault for not directing teaching exactly towards a student's identified learning style. This may have particularly ominous consequences in jurisdictions that adjudicate teachers by their classroom scores on universal tests.

9.3 Literature Review

9.3.1 Critiques

Learning styles have had a volatile history during the last 100 years and has had, and continues to have, an impact on educational research and classroom pedagogy. As the brick and mortar institutions of learning give way or at least share the face-to-face classroom with the digital online classroom world, an exploration of learning styles in general, how they have developed and the impact of them in the realm of online learning and emerging technologies, is worth examining. Allport (1937) describes an individual's cognitive style as the typical and habitual mode of problem-solving, thinking, perceiving and remembering. Learning styles can be described as the application of this cognitive style in the learning environment (Riding and Cheema 1991). Many researchers conclude that the research around learning styles, what they mean and how they are used, has been somewhat misinterpreted.

The terms, learning styles and multiple intelligence, have been used interchangeably for decades. Both seem similar but are quite different. Gardner (2013) clarifies this confusion by explaining that learning styles are simply a hypothesis about how an individual will approach a range of materials, whereas multiple intelligence is about how the brain uses, stores and interprets this information. Gardner has identified nine multiple intelligences and everyone uses them all, some to differing degrees. Multiple intelligences represent different intellectual abilities and include: naturalist (nature smart), musical (sound smart), logical–mathematical (number/reasoning smart), existential (life smart), interpersonal (people smart), bodily–kinesthetic (body smart), linguistic (word smart), intra-personal (self-smart) and spatial (picture smart). Cherry (n.d.) claims that Gardner's theory is not without criticism either and has come under fire from both psychologists and educators. These critics reason that Gardner's definition of intelligence is too broad and that his nine different "intelligences" simply represent talents, personality traits, and abilities, not intelligence. It is also maintained by the Cherry (n.d.) that Gardner's theory also suffers from a lack of supporting empirical research; despite this, the theory of multiple intelligences still enjoys considerable popularity with educators.

Within education, there are many problems associated with the identification and subsequent pedagogical direction based on the results of any learning style instrument. Pashler et al. (2008) conclude that students do not necessarily learn better when using their preferred learning style but learn equally well using a variety of styles. Curry (1991) determines that identifying learning styles and the characteristics most relevant to learners in an educational environment is problematic. Confusion around terminology and definitions, along with issues in validity and reliability, adds to the problems of learning styles in education. Coffield et al. (2004) go on to say that "Yet beneath the apparently unproblematic appeal of learning styles lies a host of conceptual and empirical problems. To begin with, the learning styles field is not unified, but instead is divided into three linked areas of activity: theoretical, pedagogical and commercial" (p. 2).

Learning styles are born from the models forged under the psychology discipline yet are implemented and practised strongly in other disciplines. Much of the researches around learning styles have taken place in other domains, such as management, vocational training and education, to name just a few. Cassidy (2004) postulates that the reason that the topic has become so fragments and disputed is a direct result of each domain having its own research focus. Coffield et al. (2004) state that “Mainstream use has too often become separated from the research field. More problematically, it has also become isolated from deeper questions as to whether a particular inventory has a sufficient theoretical basis to warrant either the research industry which has grown around it, or the pedagogical uses to which it is currently put” (p. 2).

Supporters of learning style theory postulate that tailoring instruction around identified learning styles optimizes both instructor and subsequent learning for students (Parslow 2011). There have been many identifying instruments developed from the theories and the results offer useful information for placing or sorting individuals on a continuum, based on self-identified answers on the created instruments. The popularity of learning styles in popular culture and within education seems to not take the conclusions of the critics seriously. If learning styles are here to stay, then perhaps ensuring that students become aware of their “preferences” rather than focusing on one style and if teachers begin thinking this way as well, then perhaps we can lessen the negativity of this phenomena.

As previously discussed, the impact of learning styles on online learning for both students and teachers can be both positive and negative. Learning style theory is embedded in much teacher training (Lethaby and Harries 2016). Learning styles seem intuitive and commonsensical. There is much social influence in this area; there is a plethora of books, websites, experts and articles dedicated to uncovering learning styles which subsequently increases teacher efficiency (Willingham et al. 2015; Pashler et al. 2008). The claims seem reliable, we may, for example, not understand the science claims behind gravity but still accept it (Goodwin and Hein 2017). Widespread belief is the confusion between ability (which is multifaceted) and style or preference for learning, which hinges on one modality.

9.3.2 Emerging Technologies

Emerging technologies have essentially brought the world together through the digital classroom. This phenomenon has forced us to look at changes in pedagogy. Employing emerging technologies in distance education is described by Veletsianos (2010) who says that “to further educational goals may necessitate the development of different theories, pedagogies, and approaches to teaching, learning, assessment, and organization” (p. 18). The text goes on to say that although not likely well researched, as emerging technologies are relatively new, a true understanding of the relationships between pedagogies and technologies warrant analysis. Learning styles fall under this examination as well. Massive online learning classrooms (MOOCs) can have thousands of students from a barrage of different cultures and socio-economic backgrounds. It is the contentious view of this author that we, as educators, simply cannot continue to approach teaching as if all students are a homogenous group in a brick and mortar institution; this simply will not work. Cultural expectations are bound to influence how we present, monitor and facilitate the online learning classroom experience. A broader look at learning styles within this context is worth exploring. Emerging technologies are influencing the evolution of the digital classroom. Within this evolution, we must ensure that we respond with an aligned pedagogy. This examination will not only influence pedagogical practices but also enhance our understanding of the impact of emerging technologies on the design of the digital classroom and will also offer an innate understanding of its participants in this digital world as well.

9.3.3 Cross-Cultural Implications for Learning Styles

Cultural differences and preferences for learning can be quite different from the Western view of learning styles and preferences. Different cultures look differently upon learning and thinking. Gu et al. (2017) discuss the research in cultural psychology that has emerged identifying individual learning differences which have arisen from cultural factors. These individual differences are described in terms of motivation and processing, thinking styles and learning styles. Students from different cultures need to be considered in the online learning world as well. In the global digital world, these students' differences warrant a close and considered examination. Thus, online learning has meant a re-examination of learning styles and their potential contribution.

The growth and expanse of the global digital community means that students from all over the world have access to online learning from all over the world. Different cultures have different expectations about the roles of learner and student. In some cultures, it is disrespectful to ask the teacher any questions and it is frowned upon if females ask any questions. Other cultures dedicate weekends to family and prayer so teachers need to be cognizant of what expectations they have for assignments over weekends (Kumar and Bhattacharya 2007).

An awareness of culturally inclusive practices by the instructor may ensure that extra encouragement, modelling, consideration and clear directives are given to some students. Popov et al. (2013) noted that collaboration in culturally mixed groups is often challenging and may require extra facilitation. LaFever (2010) states that "The critical examination of standard teaching practices in North American schools were catalysed by the civil rights movement and the recognition that educational institutions were not serving society as a whole" (p. 1). Tran (2012) concludes that "students from CHC (Confucian -heritage-culture) may hold a different perspective on the appropriateness of behaviours and reactions in the classroom environment" (p. 64). The author goes on to say that for students to move to a more active learning environment, it takes time and that they will need help and guidance from instructors to recognize and handle the differences and adapt.

Understanding that we need to be aware of Western bias and embrace cultural differences when managing, creating and delivering content for online classes cannot be ignored. Instructors need to strive towards inclusiveness with these new global electronic classrooms. Alalshaikh (2015) reinforces the role that teachers and instructional designers need to take with culturally different students. "Teachers and instructional designers need to develop online course content this is culturally appropriate and culturally sensitive" (p. 74). The author goes on to say that this need to be culturally sensitive and to take this information into consideration when designing courses and programs, ensures inclusivity for different cultural groups. The goal always being that learning is enhanced.

Online learning can be different from the face-to-face classroom; considering those from different cultures and their differences in the online classroom is an important piece of culturally sensitive pedagogy. Alalshaikh (2015) identifies four categories in the online learning environment: perceptual learning styles; cognitive processing learning styles; social learning styles and problem-based learning styles. Each style is broad and encompasses a wide group of preferences. Perceptual learning styles describe learners who prefer textual information and may have strong auditory component to learning (reading and listening with their mind's ear). Cognitive processing learning styles discuss learners who prefer abstract concepts, learning through concrete examples. Also included in cognitive processing learning is the holistic or global style. Social learning styles are about social engagement. Students may want to study alone or with peers; they may also need guided learning. Finally, problem-based learning styles seem to combine the previous styles. Wheeler et al. (2005) say that problem-based learning promotes skills through "complex, real-life problems and motivates student to adopt deeper approaches to study" (p. 126).

Students from differing cultures have some culturally specific behaviours when participating in the online learning environment. Yu-Chih et al. (2013) reported on a study about many different cultural groups, and several interesting results were noted. Several ethnic groups in the study preferred learning that is kinesthetic, auditory and tactile except for Anglo students who preferred visual learning styles and did not like cooperative learning. It was noted too that Asian students are more visual than verbal learners. These are, of course, generalizations but some commonality should alert the instructor to take this information into consideration when planning and teaching (Alalshaikh 2015).

Popov et al. (2013) report that "collaboration in culturally mixed groups is less than optimal and may require extra facilitation" (p. 36). This implies that teachers need to ensure their course planning matches the cultural needs and differences of their students. Popev et al. (2013) go on to discuss that the "results reveal that cultural differences could be understood in terms of differences in thinking styles, and that these differences could affect the collaborative process" (p. 22). Cultural differences in the global world of online learning must be considered when planning. Popev et al. (2013) found that teachers assigning scripted roles according to cultural backgrounds may have value in assisting students who collaborate with others. Teachers who are considerate of their culturally different student population by planning activities and assignments accordingly can only help but enhance these learners. Thinking of learning preferences with different cultural populations within emerging technologies is an important consideration in terms of adjusting pedagogical practices as well.

9.4 Assessment

9.4.1 Informing Practice

The applicability and usefulness of the various theories and research clearly inform distance educational practices and has many practical applications for educators. Students benefit from different kinds of instruction because, ("*Learning styles and myths*" n.d.)

> learning requires complex, often uneven developmental steps like building on prior knowledge, forming conceptual structures slowly, and varieties of repetition, students benefit when instruction provides various ways to enter into learning. Alternating modes can serve different students' aptitude, level of self-awareness as a learner, and cultural background. (p. 4)

Cassidy (2004) laments that although research into learning styles has no real scientific evidence to back its claims, knowing about differing learning styles within individuals and within oneself can promote valuable insight into both learning and teaching in the educational setting. Teachers offer varied presentations when planning is best for students as they learn in a variety of ways.

9.4.2 Practical Application for Online Learning

There is an expectation for students in the online learning environment to manage their own learning (Alalshaikh 2015). We are well beyond distance learning of yesterday with packages arriving in the mail and learning taking place in isolation. Today, the online learning environment offers both real-time synchronous experience as well as asynchronous experience. Students do have a preferred way to learn, and some of these preferences have cultural influences; both need to be considered when planning and implementing programming. Important too, is the consideration of the specific and likely different needs of students when participating in and using emerging technologies, such as MOOCs and VR. It should also be noted that the learning preferences that students have identified or are aware of for face–to-face learning may be different during their online learning experience.

Within both synchronous and asynchronous learning, there are many practical applications one can implement that have been influenced by learning style theories meant to enhance learners' experiences. An understanding that students prefer to learn in a particular way, but they actually use many modalities for deep learning, encourages teachers to ensure that they are offering content in many ways.

Learners, in turn, experience content and participate in varying ways on the learning platform. Within synchronous environment, there are several suggestions to ensure that students remain engaged. All these suggestions can appeal to several learning preferences. Group discussions during class-time, with very clear directions, text with visuals with any supporting materials will appeal to those who prefer material presented visually. Synchronous group discussions can be challenging in the online classroom. Using clear, concrete language is important for individuals who need precise direction, often a need with some culturally diverse groups. Videos are useful for keeping students engaged. Articles to read during class can offer active engagement for students. Small group discussions are valuable as well, students remain engaged and can come back to the group with feedback; assigning roles is important as some students need this directive. Small group discussions also give the students a sense of belonging and participation. Giving time for forum discussions during class time helps keep students, who prefer this mode of participation, engaged. Online presentations also work well within a synchronous environment. It allows for active engagement and time for a thoughtful response. Removal of time constraints for students who experience test anxiety, etc.…is valuable as well (Oh and Lim 2005; El-Bishouty et al. 2014).

Asynchronous learning, although similar to synchronous learning with regard to types of activities, is different because there is no real-time interaction. It is important for the instructor to provide guidance and structure for forum discussions. Teacher moderation is important, especially for culturally different students who have an expectation about the roles of teacher and student. Emailing feature is also a great communication tool for both students and teachers in an asynchronous environment. Closed, small group forums allow students to discuss assigned (or unassigned) topics with small groups. This allows students who would not normally participate in a larger discussion group to participate. Responding to posted assignments and offering time to reflect on those assignments is useful too as well (El-Bishouty et al. 2014).

Suggestions about how learning styles can assist online learning are relevant and useful. Both asynchronous and synchronous learning can be improved upon by ensuring that student learning preferences are considered. As the machine-based identifier of learning preferences noted, students do have preference for how they participate in the online learning environment so ensuring that the activities, assignments and tools are made available to them is important for students continued participation and maximum learning.

9.5 Conclusion

Learning style theory has been with us for a very long time. It grew from learning theories, and although it has been criticized for several decades, it is still extremely influential in both research and education. The overall belief is that we learn a particular way, and this has been proven to be untrue. The literature shows that we all have learning preferences but we use several ways to learn information with parts of our brains working together, rather than in isolation and depending on the context, we learn differently. Inviting students to reflect on their learning (metacognition), rather than focus on "a" learning style, has shown to improve learning outcomes (Ambrose et al. 2010).

Instructional methods can vary across disciplines and course content. Cultural influences have an impact on learner preferences and need to be considered when planning and implementing programming. For optimum educational performance for both teacher and student, we need to understand and even embrace the ideas of learning preferences, multiple intelligences and cultural differences. All must be acknowledged and taken into consideration, in both the brick and mortar institutions and within the online environment. The shift towards emerging technologies and learning styles/preferences within these environments is an important part of the evolution of education. Most learning style research and instruments were developed before emerging technologies were introduced in education. Further research is required to determine learner preference when using emerging technologies. In addition, it may be advantageous for the learner to function in all of the dimensions of learning style so that they can maximize their learning. The challenge for education is how to develop the "whole person" with many learning preferences so that they can learn using any technology and delivery method.

Glossary of Terms

Asynchronous learning Delayed interaction with teachers and other students during the learning process.

Learning style An individual preference during the learning process and interacting with others.

Synchronous learning Simultaneous interaction with teachers and other students during the learning process.

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Chapter 10
3D Virtual Reality in K-12 Education: A Thematic Systematic Review

Rebecca Tilhou, Valerie Taylor and Helen Crompton

Abstract With progressive twenty-first-century 3D virtual technologies, the ability to blur the lines between material reality and digital worlds is proliferating in K-12 classrooms across the globe. A thematic systematic review was used to examine three-dimensional (3D) virtual reality (VR) in K-12 education from 2010 to 2019. Findings revealed specific features and capabilities of contemporary 3D VR technologies, how 3D VR technologies are being used in K-12 education, and how 3D VR supports learning experiences. In 3D virtual worlds, students are able to view peripherally through a virtual presence, experience weather, time, and different environments, and virtually touch and examine objects. The current research showed that 3D VR is commonly applied in middle and high school science classrooms and facilitates the pedagogic approach of inquiry-based learning (IBL), a branch of constructivism. The reviewed studies indicated that integrating 3D VR technologies leads to enhanced learning experiences, leading to increased achievement and motivation.

Keywords 3D virtual reality · Immersive environment · Inquiry-based learning · Virtual environment for learning · Virtual field trip

10.1 Introduction

Rapid advancements in technology are challenging humans to reconsider basic categories that make up reality (Brown and Green 2016; Choat 2018). The boundaries between the natural and the technological, human and non-human, and how life is defined are changing in response to human innovation (Choat 2018). A digital model of the material world allows for a reconceptualization of matter, agency (Choat 2018), and how students can learn by experiencing a real versus virtual material world. Children naturally engage in autotelic practices to learn about the world and nature around them (Rautio 2013). For example, the act of picking up and holding

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a stone, feeling its texture, temperature, and shape is both the activity and reward in itself. The learning about nature and matter is intrinsically motivated. Yet, what if this tangible "vibrancy of matter" (Bennett 2010; Tesar and Arndt 2016) could transcend how matter is defined, allowing children to virtually experience and touch stones miles away from where they sit within the walls of a classroom? With progressive twenty-first-century 3D virtual technologies, the ability to blur the lines between material reality and digital worlds is proliferating in K-12 classrooms across the globe (Brown and Green 2016).

Three-dimensional virtual reality (3D VR) is a digital representation of an environment where users can become fully immersed within it (Dalgarno and Lee 2010). In 3D VR environments, humans can create their own presence, move around and see in all directions, and interact with objects, giving students a strong sense of being in the simulated space (Mikropoulos and Natsis 2011; Pederson and Irby 2014). Educators are increasingly interested in incorporating 3D VR into pedagogical practices because of the learning benefits it offers students. Experiential learning opportunities that students may otherwise not be able to access, contextualized and exploratory learning, and increased motivation and engagement are all affordances granted by the use of 3D VR environments (Dalgarno and Lee 2010; Pederson and Irby 2014).

While a growing body of current empirical research reveals the positive impacts that 3D VR applications have on learning in K-12 classrooms (Grotzer et al. 2015; Pederson and Irby 2014; Sun et al. 2010; Tarng et al. 2012), scholars and educators need a more current, holistic understanding of contemporary 3D VR technologies due to its expeditious developments and educational affordances (Brown and Green 2016; Kavanaugh et al. 2017; Minocha et al. 2017).

The purpose of this thematic systematic review is to examine 3D VR technologies being used in K-12 education and how 3D VR supports students' learning experiences. This chapter begins with a brief overview of 3D VR and a synthesis of extant systematic reviews related to 3D VR's use in education. Following, a review of empirical studies illustrates current uses of 3D VR specific to K-12 education. This section will give special attention to types and features of 3D VR systems, learning contexts, participants, and outcomes of 3D VR integration. Next, descriptions of the most contemporary 3D VR technologies gained from reports, reviews, and teacher–practitioner articles are offered. Lastly, a conclusion will provide a summary of the findings and provide implications for future research.

10.2 Literature Review

10.2.1 Virtual Reality

Three-dimensional immersive technologies have become a basic component of modern computer games (Dalgarno and Lee 2010), such as with *World of Warcraft, Active Worlds,* and *Second Life* (Dalgarno and Lee 2010; Han 2011). *Second Life,* founded by the Linden Lab in 1999, became one of the most popular computer games in the first decade of the twenty-first century due to the use of 3D technology. In 2010, a reported 1,381,635 users signed into *Second Life* in just one month (Han 2011).

As 3D immersive technologies have gained momentum, so has their potential for uses in K-12 teaching and learning. Richer, more experiential engagement that was never before possible is now viable with the ability to virtually explore places and interact with objects and structures in those environments (Dalgarno and Lee 2010). Thus, with these advancements of 3D VR systems and their union with education, 3D VR has come to assume many sub-categories such as (a) 3D virtual field trip (VFT) (Argles et al. 2015; Tutwiler et al. 2012), (b) 3D virtual worlds (Hew and Cheung 2010), (c) 3D virtual learning environment (3DVLE) (Dalgarno and Lee 2010), (d) 3D virtual environment for learning (VEL) (Pederson and Irby 2014), and (e) 4D VR (Moorefield-Lang 2015). These 3D VR sub-categories include systems whose features range from life-like graphics on a screen without the use of a headset to the use of lightweight headsets that allow users to view 3D VR applications peripherally in more realistic ways. The growth of 3D VR in education is undeniable; however, VR technologies have yet to gain widespread inclusion into educational curricula (Kavanaugh et al. 2017) in the same way gaming 3D VR has infiltrated homes and children's leisure activities.

10.2.2 Extant Systematic Reviews

To date, few systematic reviews of 3D VR in education have been conducted. Hew and Cheung (2010) explored how 3D virtual worlds were being used in education and what research methods and topics were utilized. Mikropoulos and Natsis (2011) examined research with educational virtual environments (EVEs). Following these, Kavanaugh and colleagues (2017) examined 3D VR research in education. These reviews provide scholars with an examination across of empirical work across nearly two decades.

Hew and Cheung's (2010) systematic examination of 3D VRs in education covered research up to 2008. The authors found that 3D virtual worlds were used as communication spaces, simulations of a space, and experiential spaces where users could act on the environment. The majority of the studies reviewed utilized descriptive or experimental research approaches. Additionally, the majority of the samples came from polytechnic and university settings (69%), with secondary schools representing 19% and primary schools 12%. The disciplines where the research was carried out were typically in the arts, health, and environment fields and sought to examine participants' learning outcomes, affective domain, and social interactions (Hew and Cheung 2010).

Mikropoulos and Natsis (2011) sought to discover studies' educational contexts, characteristics of the 3D VR environments, and learning theories applied to 3D VR studies conducted. The review conducted by these authors covered research from 1999 to 2009 and found that 40 of the 53 reviewed articles conducted studies in the context of math and sciences. No specification of participant age and schooling level, other than stating that all of the studies ranged from elementary school pupils to university students and teachers, was provided. Specific characteristics of 3D VR found during this time period were immersion, multisensory interaction channels, and intuitive interactivity with visual representation being the predominate feature (Mikropoulos and Natsis 2011). The authors concluded that the overall features of 3D VR implied the principles of constructivism, which was used as a framework by the majority of studies reviewed. These features were experiential, contextual and collaborative learning, spatial representation, and engagement (Mikropoulos and Natsis 2011).

Kavanaugh and colleagues' (2017) review of research from 2010 to 2017 focused on understanding why, despite the decades-long existence of virtual reality, education has not integrated 3D VR more consistently. Through this analysis, the authors also examined the context in which implementation mostly occurs, as well as a few contemporary 3D VR technologies and systems currently available, such as *Oculus Rift*. Findings indicated that researchers typically employ virtual reality with the purpose of increasing learners' intrinsic motivation, and a framework of constructivist pedagogy, collaboration, and gamification emerged (Kavanaugh et al. 2017). Differing slightly from the previous review, this research indicated that 3D VR was used mainly in health and medicine fields, and 51% of the studies took place in higher education. Lastly, the authors found 3D VR's limitations included insufficient realism, cost and overhead, usability, usefulness, lack of engagement, and even motion sickness. These issues provided insight into why 3D VR has not been more widely embraced by education communities worldwide.

10.2.3 Purpose

These aforementioned reviews of existing empirical research of 3D VR in education provide valuable insights into the progress and future needs of this growing technology. However, little specific knowledge about K-12 populations is provided. While these reviews found that studies typically took place in math and the sciences, little detail was offered about other disciplines where 3D VR was used (Kavanaugh et al. 2017; Mikropoulos and Natsis 2011). Lastly, much is still unknown about the types of current 3D VR systems employed in education and their specific capabilities for teaching and learning (Hew and Cheung 2010; Kavanaugh et al. 2017; Mikropoulos and Natsis 2011).

The purpose of this thematic systematic review is to address these gaps in knowledge about 3D VR's use in K-12 education through examination of most current research (2010–2019). There will be a specific focus on: (a) features and capabilities of current educational 3D VR technologies; (b) disciplines where 3D VR is implemented and how it is applied; and (c) impacts on K-12 students' learning experiences. Thus, the research questions guiding this systematic review of extant research were:

1. What contemporary 3D VR technologies are being utilized in the K-12 educational setting?
2. How is 3D VR currently applied in the K-12 classroom?
3. What are the impacts of 3D VR on learning experiences in the K-12 educational setting?

10.2.4 Method

A thematic synthesis methodology (Gough et al. 2012) was applied to address the three research questions and develop a synthesized knowledge base specific to VR in K-12 education. A thematic synthesis unites findings from different types of research (Thomas and Harden 2008), as it allows for the analyzation of multidisciplinary datasets and creates a platform for common understanding across fields (Boyatzis 1998: xiii). A key activity of thematic synthesis is the translation between studies' results, which allows the researcher to analyze findings from different paradigms (Gough et al. 2012). Employing this method is essential in the case of this systematic review because research covering VR has emerged from a variety of research approaches and several disciplines such as educational technology, science, and mathematics. Additionally, current VR knowledge can be found from technology reviews, reports, and teacher–practitioner articles.

Search strategy. The search for literature took place through EBSCOhost *Academic Search Complete, Education Research Complete,* and *ERIC* databases. Results were limited to: (a) peer-reviewed journals and (b) date selection of 2010–2019. Search keywords were used in several phases. Phase one used the terms *virtual reality, education, elementary and secondary.* In subsequent phases, additional keywords were employed such as *virtual learning, elementary students, virtual environment,* and *affordances.* Articles were selected based on the following criteria: (a) studies involving K-12 students and (b) determination that a 3D VR was actually discussed and employed. In a final keyword search, specific VR technologies, such as *Google Expeditions* and *Google Cardboard*, discussed in a previously included article were used and resulted in additional articles providing current information about 3D VR technologies and their uses.

10.2.5 Findings

These searches yielded seven studies from peer-reviewed publications. Five of the seven's populations included middle or high school students and three populations included upper elementary students. All studies took place in science classrooms. Table 10.1 indicates some key components of these seven studies.

Table 10.1 Population, location, and subject area in relevant studies

Study	Population	Location	Subject area
Grotzer et al. (2015)	Fifth- and sixth-grade students	USA	Ecosystems Weather
Lin et al. (2011)	Tenth-grade students	Taiwan	Earth science Weather systems
Minocha et al. (2017)	Fourth–eleventh-grade students	UK	Geography
Pederson and Irby (2014)	Seventh-grade students	USA	Ecological impacts of natural disasters
Sun et al. (2010)	Fourth-grade students	Taiwan	Space systems
Tarng et al. (2012)	Third-grade students	Taiwan	Agriculture and plants
Tutwiler et al. (2012)	Tenth-grade students	Taiwan	Earth science Geography

The studies included in Table 10.1 were examined to address this review's three research questions. The upcoming sections answer those research questions which provides insights into contemporary 3D VR systems being used, disciplines and fields where 3D VR is commonly applied, and 3D VR's impact on learning experiences in K-12 classrooms. Following these sections will be the further description of the most contemporary 3D VR systems at the time of publication that are emerging in practitioner literature but have not yet been employed in a study.

10.2.6 Contemporary 3D VR Technologies Utilized in the K-12 Setting

Lin and colleagues' (2011) and Tutwiler and colleagues' (2013) subsequent study with Taiwanese students used the 3D virtual field trip (VFT) *Virtools*. *Virtools* is a virtual representation of Hsiaoyukeng Walking Area in Taiwan. Most of the 3D VFT is experienced from a first-person point of view, though there are third-person perspectives when users interact with computer-controlled people within the world. Students had the ability to investigate with classmates rather than in a solitary manner. Weather patterns within the virtual world fluctuate to mirror typical weather patterns of that real-world area. There is a visitor's center with signs pertaining to rock specimens that can be found in Hsiaoyukeng Walking Area. When these rocks are spotted by users, they can be picked up, moved, and viewed from every angle, as well as enlarged to see minute detail.

Minocha and colleagues (2017) integrated physical, real field experiences with *Google Expeditions* (GEs). GEs offer guided field trips on a smartphone using a viewer called *Google Cardboard*. *Google Cardboard,* shown in Fig. 10.1, is a small box equipped with lenses that fit into a smartphone. The GEs' application offers

Fig. 10.1 *Google Cardboard* viewer

more than 500 3D VFT expeditions that allow for 360° photospheres of locations all over the world. Like *Virtools* in Taiwan, GEs enable students to view places such as Great Barrier Reef or Tolbachik Volcano, which would be difficult to visit physically. Additionally, with GEs, students can take biological field trips to see systems such as the human heart, the process of respiration, or to look microscopically at organelles in a cell (Craddock 2018). However, in this particular research, GEs were used to visit a nature preserve.

Through Pederson and Irby's (2014) 3D virtual environment for learning (VEL), *Hurricane Hal,* students were able to traverse a realistic wetland in order to collect data using instruments available in the virtual world. Learners were able to take on the role of a research assistant named Sam who visits four different wetland environments impacted by a hurricane. Students were able to navigate the sites with a virtual airboat and laboratory where they could create and implement investigations. Data was collected most often by sighting and taking counts of animals in the environment.

Grotzer and colleagues' (2015) *EcoMuve* has similar properties to *Hurricane Hal*. Students could test the water quality and study animals living and dying in the environment. With an additional mobile 3D VR application employed, *EcoMOBILE*, students also visited a physical site with their mobile devices and viewed the site using the application, *Virtual Binoculars,* which offered an augmented reality where students could see the physical place along with water monitoring stations distally to gain information about water quality (Grotzer et al. 2015, p. 47).

Sun et al. (2010) utilized a 3D VR model *Sun and Moon System*, created by combining Microsoft Direct3D Library, C++ programming language, and Autodesk 3-D Max for model construction. The system allowed students to view simulation of the earth's movement and orbit, Earth's location, simulation of the moon's movement and phases, and the sun and moon positioning. Students were required to view these components, and the learning activities focused on the moon's phases and location.

The 3D virtual farm in Tarng and colleagues' (2012) study with third graders allowed students to navigate a detailed farm that included a pond, a garden, and buildings. The application allowed students to role play as farmers caring for their animals and crops. Animals moved and grew over time from the students' care.

Students could plant vegetables and observe their growth from seeds. The elementary children had to be actively engaged with the virtual farm's components and, over time, measure the growth of the animals and plants they cared for.

10.2.7 Current Educational Applications of 3D VR in K-12

The findings show that 3D VR was solely used in the sciences at the upper elementary, middle, and high school levels. In several of the studies, different 3D VR systems facilitated VFTs. Virtual field teaching improves accessibility in situations where it is difficult to physically go to an environment due to climate, terrain, or school resources (Tutwiler et al. 2012). Similarly, 3D VFTs introduce the "nature of fieldwork" in a unique way that engages students (Argles et al. 2015). Not only do 3D VFTs build familiarity of fieldwork with students, but with teachers as well, prompting teachers to facilitate physical field trips for their students (Argles et al. 2015; Tutwiler et al. 2012). However, Argles and colleagues (2015) argued that 3D VFTs should be used in conjunction with other resources for best learning.

The study of earth science and geography is among the topics that were paired with a variety of 3D VFTs employed in studies. For example, in Lin and colleagues' (2011) study and Tutwiler and colleagues' (2012) follow-up study with the same population and context, Taiwanese tenth graders used *Virtools* to virtually visit tough terrain at high altitudes to explore geological features of Hsiaoyukeng Walking Area within a remote national park in Taiwan. Students were able to review geological concepts and explore rocks and weather patterns through their virtual experience.

Pederson and Irby (2014) used a 3D virtual environment for learning (VEL) named *Hurricane Hal* and student-directed scientific inquiry, or inquiry-based learning (IBL), to explore the ecological impacts of a natural disaster on a wetland ecosystem. IBL, a component of constructivism (Fowler 2015), requires students to address real-world problems by collecting and interpreting data, and then synthesizing the evidence to come to conclusions, develop curiosity, and ask more questions related to specific learning goals (Minocha et al. 2017; Pederson and Irby 2014). Pederson and Irby's middle school students were given a task using the 3D VEL, prompted to ask questions, design their own investigation, collect and examine data, and report findings. Similarly, *EcoMuve* was employed in Grotzer and colleagues' (2015) study to allow fifth- and sixth-grade students to explore and collect data over time in an ecosystem that offered a pond along with neighborhoods and a golf course. This study's learning focus was on understanding the concepts of causation and change over time in a natural environment rather than explicit IBL, however, the pedagogy behind the exploration echoes inquiry.

Minocha and colleagues (2017) integrated geography, IBL, and the 3D VFT, *Google Expeditions* (GEs), with 4th through eleventh-grade students. The researchers and educators blended real experience with the virtual to teach geography and time-change concepts and also to explore the affordances of the GE's application. Minocha and colleagues took students to a physical field trip site—a nature reserve—to sensitize students to the concept of change in environments being caused by construction and tourism. In this case, a high-speed train track was being hypothetically built in the area. After the physical field trip, using a 3D VFT deepened students' inquiry because they had the physical experience as a foundation of background knowledge. The pairing of the real and virtual experiences stimulated questions they would not have previously known to ask (Minocha et al. 2017).

Sun et al. (2010) utilized a 3D VR model named *Sun and Moon System* to teach space systems to fourth-grade students. Sun and colleagues explicitly positioned their population's learning of space systems within constructivist theory, with a specific focus on using the 3D VR to correct misconceptions about spatial orientation of the planets, moon, and sun, and gain new conceptual understanding of space systems. In another study with elementary students, Tarng et al. (2012) integrated a 3D virtual farm into third-grade science lessons teaching about plants and animals. Students learned about common animals and plants, their features, parts, functions, and needs for living through the use of the 3D VR farm.

These findings indicate that constructivism, the foundation for inquiry learning, is a dominant pedagogic approach paired with 3D VR in K-12 education. Constructivism posits that humans develop knowledge and understanding through a constructive, active process (Dewey 1985; Kavanaugh et al. 2017). In a constructivist learning environment, students actively and iteratively form a personal, subjective model of reality from the fluid dynamic between experiences and ideas (Dewey 1985; Kavanaugh et al. 2017). Constructivist approaches to teaching and learning foster students' ability to access prior knowledge, examine existing ideas, and navigate related experiences in a supportive, interactive manner, allowing students to construct new ideas and apply those ideas to create deeper understanding and skills (Sun et al. 2010). The experimental and experiential are essential to learning (Dewey 1985), and 3D VR technologies in education facilitate constructivist qualities (Kavanaugh et al. 2017).

10.2.8 Affordances of 3D VR on Student Learning

The studies examined show that the use of 3D VR had a direct impact on students' learning experiences, notably, when used in conjunction with or to promote physical fieldwork. *Virtools*, the technology used to facilitate the 3D VFT with Taiwanese tenth graders, led students to increased achievement in content learning and positive attitudes toward the virtual field experience. Furthermore, students had greater engagement when they directed the 3D VFT rather than observing a teacher via projection on a classroom board (Lin et al. 2011). In a later report, Tutwiler et al. (2012) explored how students' ability to visit the national park site with classmates within the virtual realm increased desire to physically explore the site in the future. Other scholars have affirmed the value and importance of pairing 3D VR with real physical field experiences (Argles et al. 2015; Minocha et al. 2017). Field scientists have often criticized the use of 3D VR to teach concepts that need true field experiences because, in essence, it is not possible to replace the learning that happens in physical reality with a 3D VR (Argles et al. 2015). However, when 3D VFTs are implemented to support physical field courses, they supply further background knowledge and experience that promotes more strategic use of students' time while out in the field (Argles et al. 2015). Prior to physical fieldwork situations, 3D VFTs can allow students to practice scientific methods applicable to their field of study, making mistakes in a low-risk environment (Minocha et al. 2017). Furthermore, the nature of scientific fieldwork can be practiced in classroom settings, in an engaging format, which then builds familiarity with fieldwork for both students and teachers. 3D VFTs also provide post-physical fieldwork that reinforces learning, facilitates completion of tasks, and allows for additional observations (Argles et al. 2015; Minocha et al. 2017). The use of 3D VFTs can be a valuable aid in enhancing learning outcomes, motivation, and physical fieldwork at all curriculum levels, and it is best practice that educators use this type of 3D VR to support physical field experiences rather than replacing them.

Researchers and educators' strategic implementation of 3D VR technologies often has a focus on facilitating students' independent scientific inquiry through the IBL approach. The ability to collect and analyze data in the virtual environment promotes scientific inquiry, or IBL, in the classroom (Grotzer et al. 2015; Pederson and Irby 2014). IBL fosters students' development of investigation skills in subjects such as science, history, and geography, leaving plentiful space for problem-solving and critical thinking (Minocha et al. 2017; Pederson and Irby 2014). IBL was employed throughout several of the studies analyzed for this review.

In Pederson and Irby's (2014) study with middle school students, the authors collected data on students' engagement and self-directed inquiry and found that students' self-regulated interest in learning increased significantly, shown, for example, by how students specifically posed many questions at the beginning of the program and later spent much time synthesizing evidence from their collected data. The authors reported further that student engagement throughout the use of the 3D VEL steadily increased as students grew to understand the structure of IBL and the 3D VEL, which led to positive outcomes in learning.

Additionally, students using *EcoMuve* and *EcoMOBILE* showed increased understanding and reasoning about changes over time and the impacts of humans on ecosystems through an IBL approach (Grotzer et al. 2015). The researchers found when students visited the physical site after using *EcoMuve*, and upon viewing the real pond in nature, it was evident that the students were able to transfer aspects of the virtual experience to their observations at the real, material pond. The transfer of learning was apparent with the questions students posed, the information they sought, and how their attention was focused.

Sun et al.'s (2010) findings indicated that students who had access to *Sun and Moon System* 3D VR showed significantly higher learning achievement compared to the group who did not and expressed a willingness and interest to use the technology. The authors deduced that the 3D VR model significantly improved learning because it offered multiple perspectives about space system motion and moon phases rather than a textbook explanation. Additionally, a post-survey indicated that more than two-thirds of the students had desire to use *Sun and Moon System* 3D VR. Similarly, Tarng and colleagues' (2012) virtual farm study with third-grade students found increased learning achievement and willingness and interest in using the 3D VR technology. It is important to note, however, that even though more than two-thirds of Sun and colleagues' students indicated interest in the 3D VR, some students showed a preference to learning the scientific concepts in other ways. This finding supports the point that 3D VR educational technologies are most effective when combined with other resources and avenues of knowledge and experience.

10.2.9 Future Studies on Contemporary 3D VRs in Education

The findings identify a gap in scholarly understanding of various contemporary 3D VR. The following technologies were highlighted in the literature but have not yet been employed in empirical studies. Future research is needed on these 3D VR technologies as they may have the potential to further extend and enhance K-12 learning. Argles and colleagues (2015) presented the 3D VFT *Virtual Skiddaw* to teach geology. *Virtual Skiddaw*, shown in Fig. 10.2, can be accessed via any Web browser and it has a multiuser capability which allows for collaborative group work, even when users are geographically dispersed. Brown and Green (2016) detailed applications such as Google's *Street View* which allows the user to create and view others' photospheres and share them on the internet.

Other applications Brown and Green presented were Mattel's *View-Master*, which is similar to *Google Cardboard*; *Discovery VR* which allows viewers to enter Discovery channel's TV shows; and *VR Immersive Education* which allows users to

Fig. 10.2 *Virtual Skiddaw* 3D VR geology field trip (TheOpenScience Laboratory 2013)

Fig. 10.3 *Oculus Rift* headset (Oculus, n.d.)

create environments in history and science to deepen understanding. Moorefield-Lang (2015) described the most recent version of *Oculus Rift* which offers users an advanced headset and the ability to design 4D VR apps themselves. Users have a “beta share space” to support the sharing and testing of other user-created programs on their headset devices. The *Oculus Rift* headset is shown in Fig. 10.3.

While these descriptions of programs often refer to science teachers, Han (2011) explored how the use of the 3D VR application *Second Life* could be used with art students. As *Second Life* offers the ability to build one’s own 3D virtual environment, Han argued that art students could create 3D art in the virtual world in the same ways a sculptor would in physical reality. Han’s article shows possibility for alternative approaches with the use of 3D VR in education, leading users into subject areas outside the realm of the sciences and data collection. As Brown and Green’s (2016) description of *VR Immersive Education* implies, creating an environment in history could be a powerful tool in increasing students’ motivation to learn history and also understand what an environment in the past may have looked like. Grotzer and colleagues’ (2015) *EcoMuve*, which addressed the concept of time—past, present, future—implies further ability to create environments to simulate the past. Chintiadis et al. (2018) exhibited how environments representing places in the past can be created for educational use with their description of *Trials of the Acropolis*. This 3D VR aligned with third-grade Greek history and Greek mythology allows students to enter Ancient Greece with the purpose of fulfilling an ancient myth. Users engage with avatars, hear background music, and are able to have rich experience with characters and storytelling. These innovative, current 3D VR applications imply a wide range of uses for teaching and learning (Fig. 10.4).

Scholars posit that 3D VR technologies can be beneficial in K-12 teaching and learning; however, further examination of specific 3D VR technologies with empirical methods is needed. It appears from these findings that more research is needed in different K-12 subject areas, such as mathematics, social studies, and literacy. Furthermore, many of the extant studies are in middle and high school and further exploration is needed with younger students.

Fig. 10.4 *VR Immersive Education's* "Apollo 11" represents the historic 1969 NASA space journey (VR Education Holdings 2019)

10.3 Conclusion

The current research examined in this systematic review conveyed the rapid advancements of 3D VR technologies in K-12 education. Educators and learners have options available on the market to use a multitude of realistic applications on mobile devices and laptops/desktops. Some of the VR applications are screen-based and others connect with a variety of headsets that allow users to experience virtual worlds with peripheral vision. It appears from the findings of this thematic systematic review that the grade levels and disciplines where 3D VR is most often applied are middle and high school classrooms narrowed to branches of science. The studies reviewed indicated that 3D VR facilitates the pedagogic approach of constructivism, with a specific focus on inquiry-based learning (IBL) in the sciences. While other systematic reviews identified constructivist learning theory in previous empirical research, this review's findings reveal a specific focus on the iterative process of inquiry to build knowledge and understanding in K-12 settings. This approach conjoined with 3D VR technologies has been found to enhance learning experiences, leading to increased achievement and motivation. More empirical research is needed to explore the affordances of the most contemporary 3D VR systems and how they enhance learning.

With the lack of empirical research exploring the use of 3D VR technologies in disciplines other than the sciences and these findings suggesting that 3D VR enhances students' learning and motivation, there is a further need to examine the affordances of 3D VR in other subject areas. Craddock (2018) argued that using GEs in her library biology lesson-assisted English language learners in better understanding scientific concepts because the visual experience created association with the scientific language. If entering 3D virtual worlds assists students with understanding scientific language, then what could a 3D VR to teach reading or writing add to this preliminary knowledge related to language acquisition? Additionally, using a 3D VR for students to not only enter an environment, but a community of people in a place and time, could offer powerful social and historical learning experiences. In the arts and engineering, affordances of 3D VRs could allow students to build objects and images in an environment. These implications leave much to be explored.

Lastly, this review reveals there is a dearth of research with primary students. Bruner (1960/1977) argued that every child at any stage of development can be effectively taught any subject in an intellectually honest form. Teaching with advanced technologies is no exception to Bruner's philosophy. Though teaching and learning certainly gain complexity as student's age, elementary students, like those in Sun and colleagues' (2010) study, are exposed to intricate concepts that require understanding of a physical, visual, dynamic world. As scholars continue to conduct research in K-12 education utilizing contemporary 3D VR systems, educators and students at a variety of levels and disciplines will be able to experience new, virtual notions of what objects and environment, experience and inquiry can be.

Glossary of Terms

3D VR A digital representation of an environment where users can create their own presence move around and see peripherally, and interact with objects.

Constructivism A learning theory that suggests humans develop knowledge and understanding when in a supportive environment that allows them to construct new ideas and apply those ideas to create deeper understanding and skills.

Google Cardboard A small box equipped with lenses that fits into a smartphone to be paired with 3D VR technology, Google Expeditions.

Google Expeditions A 3D VR technology that offers more than 500 3-D virtual field trip expeditions that allow for 360-degree photospheres of locations all over the world.

Immersive Environment A realistic three-dimensional virtual environment where users have a presence they can control and use to interact with matter in the environment.

Inquiry-Based Learning A component of constructivism that requires students to address real-world problems by developing curiosity through questioning collecting and interpreting data, and synthesizing evidence to come to conclusions.

Virtual Environment for Learning A 3D virtual environment that represents realistic natural environments where users have the ability to interact with objects in the environment collect data, and see change over time.

Virtual Field Trips A 3D virtual environment that can represent real-world locations. Users have the ability to interact with objects in the environment collect data, and collaborate with other users within the environment.

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Chapter 11
Personalized Learning for Adults: An Emerging Andragogy

Kathryn Wozniak

Abstract Recent research has revealed benefits to using technology to personalize and adapt a learning experience to the learner's preferences, habits, and developing expertise (Cardona et al. in 2013 IEEE Colombian conference on communications and computing (COLCOM), pp. 1–6, 2013; Johnson and Samora in Glob Educ J 2016; Murray and Pérez in Informing Sci: Int J Emerg Transdiscipline 18, 2015; Yang et al. in Educ Technol Soc 16, 2013). Personalized learning can give each learner the opportunity to learn effectively and efficiently based on his or her own assets of skills, knowledge, and abilities, supporting a student-centered pedagogy. It also can provide the opportunity for wide-scale access to quality learning and teaching where public or open education has fallen short due to limited resources (Dockterman in npj Sci Learn 3:15, 2018). While there are a number of studies of personalized learning design and implementation, most of these studies were conducted in K-12 classroom environments, where the approach to teaching and learning is different than the approach for adult learners in workplace or informal learning environments. Adult learners have various types and amounts of reasons, access, time, motivation, and resources for learning, which would affect the way a tailored or individualized experience would be designed for them as compared to children (Knowles et al. in The adult learner, 2012). This chapter will review existing research on personalized learning and will define andragogy, which is teaching and learning designed for adult learners. Recommendations for designing personalized learning experiences and technologies will be explored, such as designing proper diagnostics, scaffolds, and features for higher-order thinking skills development. Based on this literature review and outline of recommended practices, the author will delineate next steps and considerations for future research on personalized learning for adults.

Keywords Personalized learning · Andragogy · Adult learning · Learning design

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11.1 Introduction

Personalized learning is similar to a personalized online shopping experience. For example, if a learner wants to study biology, the personalized learning technology with which he or she interacts should have initial diagnostics to determine prior interests, skills, abilities, and knowledge. Based on these initial diagnostics, the personalized learning technology should automatically individualize a program of study to fit the learner's needs with a balance of challenge and engagement. Varied resources, stepwise assessments, and individualized activities must be ready for deployment to meet a broad range of scenarios that each learner interacting with the system will require.

Recent research on personalized learning has revealed benefits to using technology to adapt the learning experience to learners' preferences, habits, and developing expertise (Johnson and Samora 2016; Yang et al. 2013). The majority of recently developed adaptive learning software uses algorithms to identify individuals' learning styles and analyze their behavior when engaging with learning artifacts in the system, which then directs the system to automatically present customized content such as readings, activities, and assessments based on those results (Tseng et al. 2008). Many of these tools are structured to allow for Bloom's mastery method of "re-teaching" or "differentiating" with new activities or other resources for learning when the student does not meet a certain threshold of achievement.

The idea of differentiating learning experiences and analyzing learning styles to determine best methods of teaching and learning is not new, but the use of computers to automate this process is. While there is data that shows students are "satisfied" with their experience with some personalized learning approaches and systems, there is limited research on whether and how the approaches and systems are improving their learning or the learning process (Cardona et al. 2013; Murray and Pérez 2015). Despite concerns with the validity of these tools for learning, new personalized learning technologies are coming on the market each day and show promise in both K-12, higher education, and workplace training environments. Thus, it is critical that instructional designers and educators familiarize themselves with the tools as well as with the processes involved in designing "good" learning experiences using these approaches and tools, with the expectation that there needs to be good content, scaffolding, and alignment to learning goals, regardless of the validity of the tool used.

However, most of the literature focuses on the development of the tools used for personalized learning, not on the design of the learning experience that happens via these tools. There is limited guidance for instructional and web designers on how designing a personalized online learning experience may be different than designing a non-personalized online learning experience. Backward design is one of the most frequently applied models in the instructional design process that focuses on desired results, evidence, and a learning plan—all working backwards from specific learning goals and key evidence and artifacts (Wiggins and McTighe 2011).

Additionally, while there are a number of studies of personalized learning tools, most of these studies were conducted in K-12 classroom environments, where the approach to teaching and learning is different than the approach for adult learners in workplace or informal learning environments. Adult learners have various types and amounts of reasons, access, time, motivation, and resources for learning, which would affect the way a tailored or individualized experience would be designed for them as compared to children (Knowles et al. 2012). To date, there are few studies that discuss design requirements for personalized learning experiences and technologies as they pertain to adult learners as well as if and how they differ from designing for adult learners in non-personalized learning contexts.

Considering this gap, it is critical to better understand the role of instructional design when it comes to personalized learning experiences and technologies for adult learners, such as those in higher education and workplace training settings. Personalized learning systems are increasing in popularity, so it is imperative to develop best practices for designers and practitioners who are working with personalized learning systems and structures. What should educators, trainers, and instructional designers consider as they develop a personalized learning experience in higher education and for workplace training? What are the challenges and opportunities?

11.2 Why Adult Learners?

Personalized learning and its usefulness in the multiple contexts in which adults learn are often not directly or intentionally explored with adult learners—those who are beyond traditional undergraduate college age—in educational settings or in informal or workplace learning environments. While pedagogical practices and learning technologies have been developed to support personalized learning, most research has focused on grades K-12 and developmental scenarios. Very few studies have examined returning adult learners in post-secondary settings or workplace settings, where they need continued support in developing and transferring knowledge and skills for success (Veenman et al. 2006).

It is also important for instructional designers and educators to better understand adult learners' needs when it comes to personalized learning because adults are a significant portion of the college student population. According to a recent study, 60% of the US undergraduate student population is made up of post-traditional adult learners: "meaning they were older than 24, worked full time, were financially independent, or were a current, former, or spouse of a member in the military" (American Council on Education 2017). Additionally, the frontal lobe of the adult brain, which controls self-regulating and metacognitive skills related to judgment, critical thinking, and decision making, does not fully develop until the mid-20s, so the goal of understanding and supporting adult learners as a separate entity from K-12 learners makes sense (Powell 2006). Instructional design principles have been developed for broad-scale learning design, but, again, most research and resources have gone toward designing learning experiences for children and teenagers, not adult learners.

Furthermore, we know that more and more adults are learning and training in online environments (i.e., e-learning); in fact, the average age of an online learner is 33 years old (Kolowich 2012). However, we are still trying to understand their learning practices or strategies while learning or training online or how to support them in these environments. A 2013 Sloan study of online education growth reports that "over 6.7 million students were taking at least one online course during the fall 2011 term, an increase of 570,000 students over the previous year" and "thirty-two percent of higher education students now take at least one course online." However, the study also reports that retention, students' lack of discipline, and unfavorable views of online learning by employers were barriers to the success of online programs and courses (Allen and Searman 2013). Contributing to the retention and discipline issue is the fact that adults, while strong in metacognitive awareness, often lack the metacognitive regulation skills, such as time management, planning, and strategizing for learning, that are needed to succeed in online learning environments (Artino and Stephens 2009; Michinov et al. 2011). While some of these studies look at traditional-aged undergraduates (18–22), they also look at graduate students who fall in the 24 and older age range that is under investigation in this research. Graduate students tended to do better with metacognitive awareness and knowledge of cognition than undergraduates, but still lacked transfer and regulation skills.

In the e-learning landscape, researchers have also found that success in online environments is due to "high levels of participation, a supportive facilitator style, and ample opportunities for metacognitive reflection" (Cacciamani et al. 2012). Educators, designers, and researchers have made strides in recent years to scaffold this type of learning within and beyond the classroom. Learning systems and technologies have been developed to support learners in participating in and integrating authentic and personally meaningful learning experiences and gaining adaptive expertise (Bransford et al. 2000; Herrington et al. 2014; Land et al. 2014). Additionally, research on learners and learning in digital environments has shown that participation in digital learning environments supports metacognition because of the opportunity for learners to connect with each other via social networks and construct representations of their identities and knowledge so they can then critically reflect on them (Akyol and Garrison 2011; Cambridge 2008). These studies support the notion that technological interventions should draw from educational practices concerned with social constructionist learning theory and a learner-centered design framework.

Yet, many of the technologies and practices that claim to support learning and cognitive development tend to perpetuate teacher/teaching-centered rather than learner/learning-centered principles and tools, for example, learning management systems (Dalsgaard 2006; Dohn 2009; Wegener and Leimeister 2012). For personalized learning, several technologies have been tested on grade school, high-school, and college-aged students (18–24 years old), and they are primarily for assisting learners in particular domains that require structured problem-solving rather than across multiple contexts (e.g., Dabbagh and Kitsantas 2012; Roberts-Mahoney et al.

2016; Kara and Sevim 2013). The research on technologies and e-learning systems that specifically support adult learners and their personalized learning experience is limited.

Due to the increasing opportunities for adults to learn online, more attention has been paid to developing tools and practices that support adult learning in online environments and draw from established principles of adult learning and teaching (or "andragogy"). When considering ways to support personalized learning for adults, it is necessary to review these principles and recent research on how adult learners learn online.

11.3 Andragogy and Personalized Learning

The conversation around learning and education for adults in particular, also known as "andragogy," is not a new one. One key thinker in this conversation is Malcolm Knowles. Knowles and others have argued that teaching adults is different from teaching children, and that there is a "continuum of learning," where a learner with more experiences to draw upon will have more independence and self-direction when it comes to learning. Henschke and Cooper (2006) conducted a review of the literature to support the foundation for andragogy. They found several practice-based empirical studies in andragogy that demonstrate how adults' independence, understanding of self, and previous experience are common factors in andragogy. Based on this previous research as well as his own studies, Knowles states that adult learners can be characterized according to the following due to their higher exposure to more situations and experiences than children and teenagers (Knowles et al. 2012):

1. Need to know: adults want to know why they need to learn something or have a real-life experience that has resulted in their need to know
2. Self-concept: adults are responsible for their lives and appreciate the opportunity to be self-directed with regard to their learning
3. Prior experience: adults come to learning situations with a variety of prior life experiences on which they draw and make meaning
4. Readiness to learn: adults are ready to learn what is most relevant to them at a given time
5. Learning orientation: adults learn best in real-life, authentic contexts
6. Motivation to learn: adults may be externally or internally motivated to learn, but the most influential motivation tends to be intrinsic (Knowles et al. 2012).

In the 1980s, when computer-aided learning was rapidly growing, Knowles applied some of these adult learning principles to a computer-aided learning context for adults:

1. Explain the reasons specific things are being taught (e.g., certain commands, functions, operations, etc.).
2. Instruction should be task-oriented instead of memorization—learning activities should be in the context of common tasks to be performed by the others.
3. Instruction should take into account the wide range of different backgrounds of learners; learning materials and activities should allow for different levels/types of previous experience.
4. Since adults are self-directed, instruction should allow learners to discover things for themselves, providing guidance and help when mistakes are made. (Knowles et al. 2012).

These principles have also been applied to instructional design for adult learners in twenty-first-century online environments. Cercone (2008) and Blondy (2007) in their reviews of the adult learning literature note that instructional designers need to be attentive to an adult learner's independence, self-directedness, prior experience, and need for respect as an expert and as mature individuals with a great number of external responsibilities and limited time and resources. This means that there should be intentional goal toward facilitation rather than instruction or "banking" of knowledge—the teacher, educator, or collaborator should not tell the learner what to do and how to do it. Instead, adult learners should be provided with space to transform and have control over their own learning with ample opportunities to seek support if they require it (Knowles et al. 2012). Learning design should also be process-based, interactive, and collaborative. Cercone (2008) states that for adult learners,

> [...] the learning process is more than the organized acquisition and storage of new information. The learning process involves learning about oneself and transforming not just what one learns, but also the way in which one learns. It is also about sensing, visualizing, perceiving, and learning informally with others. Interaction and collaboration should occur in the learning environment to facilitate adult learning. (pp. 151–152)

Finally, while the greater number of adult learners in online education has increased interest in online and blended learning, motivating students to persist and complete experiences such as self-paced online trainings, college courses, and massive open online courses (MOOCs) has been a challenge (Shapiro et al. 2017; Lee et al. 2013). Many students of MOOCs have found they lose interest and self-motivation due to either the lack of, or the overwhelming amount of, discussion posts from other students participating in the MOOC. Sifting through this information to make meaning and find opportunities for engagement can be daunting. Again, making the content and activities of the learning experience relevant to and easy for adults and providing the support they need when they need it are key to their persistence (Shapiro et al. 2017; Loizzo et al. 2017).

Knowing more about adult learners' characteristics both in terms of personalized learning will inform the decisions made when designing learning experiences and personalized learning tools for them. Adult learners require personalized interventions that provide opportunities for self-direction, collaboration, authenticity, and relevance.

11.4 Designing Personalized Learning Experiences for Adults

When considering an andragogical approach to personalized learning, it is important to keep Knowles' principles of andragogy in mind. Below are some suggestions for aligning personalized learning with those principles.

11.5 Prompt the Adult Learner to Identify Their Expertise, Preferences, and Interests

The word "personalized" in personalized learning suggests that each learner is unique and comes to the learning situation with a variety of different experiences, preferences, and interests. While adults and children are both unique in these respects, adult learners have a higher level of metacognition than children, as well as greater experience in different aspects of life more broadly, giving them a stronger ability to self-analyze and be self-directed when in learning situations (Salles et al. 2016). This means that when asked "what do you know," "what is best for you," "why are you doing this," and "what do you prefer in situation X," adults will likely have more in-depth and potentially more accurate responses than children. This difference is apparent in the andragogy principles of self-concept, prior learning, and motivation to learn:

> 2. Self-concept: adults are responsible for their lives and appreciate the opportunity to be self-directed with regard to their learning
>
> 3. Prior experience: adults come to learning situations with a variety of prior life experiences on which they draw and make meaning
>
> 6. Motivation to learn: adults may be externally or internally motivated to learn, but the most influential motivation tends to be intrinsic. (Knowles et al. 2012)

For this reason, personalized learning systems for adult learners should prompt the learners for their expertise, preferences, and interests directly, rather than letting the system make those assumptions based on usage alone. Many technologies that attempt to personalize an experience personalize it based on choices the users are making within the system and do not use any diagnostics of previous learning. Here is an example in the commercial world. Amazon.com will base its recommendations for you according to what you recently bought or reviewed, as well as other demographic information they obtain when you set up your account, but they do not regularly ask "what do you think of this?" or "how are we doing at personalizing this experience for you?".

To follow these three principles, personalized learning experiences and systems should start (and continue) with what the adult learner already knows and can do, as well as what they prefer, like, or dislike. A series of diagnostics and self-reports can be offered before, during, and after each learning experience. For example, if an adult learner needs to demonstrate workplace safety compliance, they should be offered a pre-test or other type of assessment to determine what they remember from the last time they were evaluated for compliance as well as a quick survey to ask them how they would like to learn new information about workplace safety: video, slides, texts, audio, or some combination of both. Other personalized multimedia modality preferences could be offered as well, such as whether the learner is able to skip through a video to key points, whether they can choose to view cartoons instead of videos of actors, and whether they want to interact or collaborate with other employees or work independently in order to learn new material. They could also be asked about their preferences for other personalized aspects of a learning experience, such as quiz question format, pace, or subject matter for examples (e.g., do they want to see examples with characters and settings of their own choosing?).

A word of caution when prompting learners about their expertise and preferences: there are times when an individual may be unsure about these aspects. It is also possible that the diagnostics used to determine these aspects are not in line with the learner's understanding of them. For example, if the learner says they like to learn with video, this may only be the case when learning complex material like physics theories, but not for simple procedural tasks, like baking a cake. It is therefore critical that self-reports and diagnostics are triangulated with other data such as usage patterns and assessment scores. For example, usage patterns may show that learners skip through video to charts and summaries, so video may not actually be the *best* mode of communicating content to them. Assessment scores may show that while the learner stated they prefer learning by listening to podcasts and working with other students, they are not remembering key concepts or do not apply what they have learned in effective ways. Thus, while it is recommended to prompt learners for their prior knowledge and preferences, this should be analyzed along with other learner data.

11.6 Align Learning Objectives to Learning Tasks, Activities, and Resources

The andragogy principles suggest that adult learners' have a need to know and a readiness to learn, and they appreciate having a learning orientation:

> 1. Need to know: adults want to know why they need to learn something or have a real-life experience that has resulted in their need to know
>
> 4. Readiness to learn: adults are ready to learn what is most relevant to them at a given time
>
> 5. Learning orientation: adults learn best in real-life, authentic contexts. (Knowles et al. 2012)

Adults are learning because they need to know something and want to see the value of their learning in the real world. How did the learner get to this point in their learning and do they know why they're here?

To address these three principles of andragogy, it makes sense to align all learning tasks and learning objects in any personalized learning experience to learning objectives and standards. In many evidence- and performance-based learning environments, educators and trainers are required to align students' acquisition of content, knowledge, and skills to predetermined standards. These standards are often established by accrediting bodies or professional associations. Seemingly, this type of alignment would be easily done in a personalized learning environment. All content, activities, and assessments would be aligned to a standard, thus ensuring that upon reading, replying, evaluating, or completion of some other learning task, students are meeting all of the standards required in the learning experience.

One way of making this alignment clear in a personalized learning environment would be to offer an interactive list of learning outcomes or standards that apply to that particular learning situation. Since learning objectives serve as the ways students demonstrate their ability to operationalize the standards, this would a way to systematically align or link learning objectives to content. A drop-down menu of standards could be provided to instructional designers and with which to align text, video, quiz and test questions, activities, projects, and all other course content. Anytime a learner is interacting with a learning task or object, they should be able to find or see the objective or standard for that particular task, activity, or resource (Meyers and Nulty 2009).

Aligning learning tasks and learning objects with standards and objectives in this granular way would also help to make it clear to both the teacher and the learner which standards or objectives an adult learner needs to work on or improve. For example, if a teacher or the learning system identifies that John is not demonstrating Learning Standard X based on interactions with the content he has been exposed to so far during a learning experience, the teacher or system can re-teach and provide additional resources that match the learning objective the student fails to grasp. One opportunity for designing this personalization into the learning experience is through rubrics. Rubrics could be linked and aligned to learning objectives, which are aligned to the standards. By identifying areas of misunderstanding, misinterpretation, and/or misapplication of core concepts in the grading rubric, instructors articulate specific deficiencies in the learning objectives that the student should address. Personalized tools could allow students to click on the specific criterion in the rubric with which they are having trouble and receive help on that issue through supplemental texts, video, or other teaching materials. A rubric feature would allow students to click on criteria on which they did not meet expectations and to be given additional material directly relevant to their needs. Any additional text, video, or other content chosen by the instructor, student, or system would allow John another opportunity to meet the standard and objectives.

An opportunity for assessment of what the student knows and can do with this content is critical to ensure that learning happens, but also that the adult learner is fully aware of what they are learning, why they are learning it, and what is most relevant to meet a particular learning standard. Content, tasks, and activities should be aligned with the learning objectives, and this should always be visible and clear to the adult learner.

11.7 Offer an Array of Resources and Assessment Options

Traditional learning experiences typically have one set of required resources and assessments or activities. Occasionally there are recommended resources, but these are rarely integrated into key assessments and activities, so learners rarely review them. Regarding a specific learning experience (computer skills), Knowles et al. (2012) stated that:

> 3. Instruction should take into account the wide range of different backgrounds of learners; learning materials and activities should allow for different levels/types of previous experience.
>
> 4. Since adults are self-directed, instruction should allow learners to discover things for themselves, providing guidance and help when mistakes are made.

That said, personalized learning for adults should offer an array of resources and assessment options, especially those that focus on the higher levels of thinking and learning. This array would foster an environment where students could master key concepts through self-selected or recommended resources and assessments.

In a personalized learning experience or system, learners would be offered multiple resources that cover the same or similar content. If these are all aligned with the objectives and standards as stated earlier, then the learners should be able to successfully complete assessments and provide evidence of their learning regardless of which resource they select. A personalized learning system could automate this process by pulling relevant resources from the web or an established resource bank as needed, such as those that are open educational resources (OERs). An instructional designer, course instructor, and students for a particular course or learning objective could curate and rate the resources from the OERs so that a database for the course could be tailored even more as time goes on.

Assessments could also be varied and give adult learners options to demonstrate their learning. While some quiz and test software is smart enough to identify key terms from a document or website in order to provide multiple choice questions with distractors (e.g., Liang et al. 2018), it has not yet reached the level where it can generate high-level questions appropriate for more advanced subjects and topics. Future software would be able to pull out key concepts from the text and other materials provided by the instructor or instructional designer to develop content questions, and possibly even offer projects and activity ideas. The tool would be able to develop knowledge and comprehension questions from the supplied text and video, resulting in the student's' ability to receive immediate results from the assessment and identification of areas where additional learning was necessary.

Giving adult learners the opportunity to not only select the resources they feel would support them best but also select the assessments and activities that appeal to them would undoubtedly follow the principles of andragogy outlined earlier. Future research would need to look further into whether this type of personalization does indeed lead to more effective and efficient learning for adults.

11.8 Conclusion and Next Steps

While it is important to think about the ways that a personalized learning approach could improve upon learning in the K-12 classroom, it is equally important to think about how it aligns with adult learning or andragogy and can improve adults learning experiences as well. Adults are going back to school in great numbers, and many have found that they need to keep up with their professional development more frequently as the job market shifts. Thinking about the most effective and efficient ways for adults to stay current in their professions or even to simply explore new skills and knowledge is critical in the twenty-first century. Aligning a personalized learning approach with andragogy principles is a good first step.

The first step in designing personalized learning experiences for adults is to recognize that adults learn in different ways and for different reasons than children. Acknowledging this fact will help developers and designers hone in on methods and principles of design for motivating adults to learn while interacting in online environments.

The second step is to design with established adult learning principles in mind such as those written by Knowles et al. (2012). It is also important to remain critical and recognize the limitations of adult learning principles and best practices when it comes to personalized learning environment design, especially since many were developed with an assumption of face-to-face and other traditional learning situations. For example, while a personalized experience or system that prompts adult learners to identify their own interests and preferences supports the principles of adults' self-concept and readiness to learn, perhaps their interests and preferences may change over time or in certain circumstances. It would be necessary in this case to revisit andragogically based design choices in iterative and reflective manner.

Lastly, the recommendations for features and aspects of a personalized learning experience or system for adults presented here is just the tip of the iceberg. Many have already incorporated similar features and functions in their designs, but many have not and continue to teach and train adults in very monotonous, tedious, and inefficient ways. A big part of this problem could be the lack of resources to re-create old curriculum so it allows for a personalized experience. Perhaps the introduction of automated analytics and assessment for online learning and the growing sophistication of natural language generators will help educators and instructional designers make the leap into better learning for all learners.

Professional development and continuing education will continue to be an important factor in maintaining a strong workforce and a satisfied society in the twenty-first century. Personalized learning will serve the needs of adult learners as they grow in their careers and pursue various interests. Educators, human resources leaders, instructional designers, and software engineers will play a pivotal role in ensuring that personalized learning experiences align with what we know about adult learners.

Glossary of Terms

Andragogy teaching and learning strategies aimed at adult learners as opposed to children.

Personalized Learning an approach to the design of learning experiences and activities that caters to the individulized needs and preferences of the learner.

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Chapter 12
Learning Cell: Intelligent Technologies and Resources in Curriculum Development

Wang Qi

Abstract Curriculum design and development is important for online learning and it could affect the learners' learning efficiency. However, learners have different demands for curriculums and current curriculum design relies much on the experts' intelligence and experiences, which make it difficult to adapt to different learners. The development of intelligent technologies has made it possible to analyze the learners' personalized information and demands more accurately. As an intelligent online learning platform, Learning Cell has involved many of the current prevalent technologies and used them to help instructors and learners develop personalized online curriculum. This chapter introduces the processes and practices of how the Learning Cell is used in curriculum design and development. This chapter will give a new insight for other researchers to implement and conduct research.

Keywords Intelligent technology · Curriculum design and development · Learning Cell

12.1 Introduction

Curriculum plays an important role in providing high-quality learning and adapting the learning based on the learner's needs. So design and development of high-quality curriculum for different learners is important in education. However, there are some problems in how curriculum is designed and developed. There are mainly two kinds of curriculums, the ones developed by the experts and the ones developed by teachers. For the curriculums developed by the experts, they are usually the exemplary courses which are of higher quality. Many learners will enroll in this kind of curriculum. The other type of curriculums are developed by the instructors and targeted to specific learners in the teacher's class. The content of the curriculum is more targeted while the quality is not guaranteed compared to the expert developed curriculum.

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With the development of the Internet and mobile technologies, much information are created every day. For this reason, learners are faced with much more information influx and if they want to adapt to the need of the society, online curriculum becomes a good choice and support. However, different learners have different learning requirements and learning style. Under this condition, even if different learners want to learn the same curriculum, the content and organization of the curriculum should be different. However, as mentioned before, there are two kinds of curriculum and they both have limitations. So how to design and develop high quality personalized learning contents for each learner is a difficult and meaningful problem to be solved. On the one hand, it needs a lot of work, and on the other, the designed curriculum should adapt to the learners' capacity and knowledge level to provide high-quality service.

Recently, the progress of intelligent technologies in news generation, image generation and video generation reveals possibility to solve this kind of problem automatically. In this area, the researchers firstly extract the mode or rules for specific object. Using the rules, the expert could define some model or algorithm for object generation. During this process, the most important thing to do is to conduct analysis of the workflow for specific work and collect all factors that play important roles in the workflow. Then one can extract the factors and generate some rules for realizing the workflow. Similarly in curriculum design and development, there are also operable workflows or rules. This provides great potential to design and develop curriculum with intelligent technologies automatically.

This chapter will explore the intelligent technologies and theories that support the development of personalized curriculum.

12.2 Intelligent Technologies Which Can Be Used in Curriculum Development

Usually, most curriculum developers design and develop the courses based on their intuition, this results in the gap between the practice and the curriculum theory (Hungerford et al. 1978). Some researchers conducted research for medical education curriculum development and defined the six steps including problem identification, needs assessment, goals and objectives, educational strategies, implementation and evaluation (Kern et al. 2010). To realize this work, some intelligent technologies should be involved.

12.2.1 Neural Network

Neural network has been proposed and used for several decades. Its core algorithm is the backward propagation and has solved many problems in different areas, such

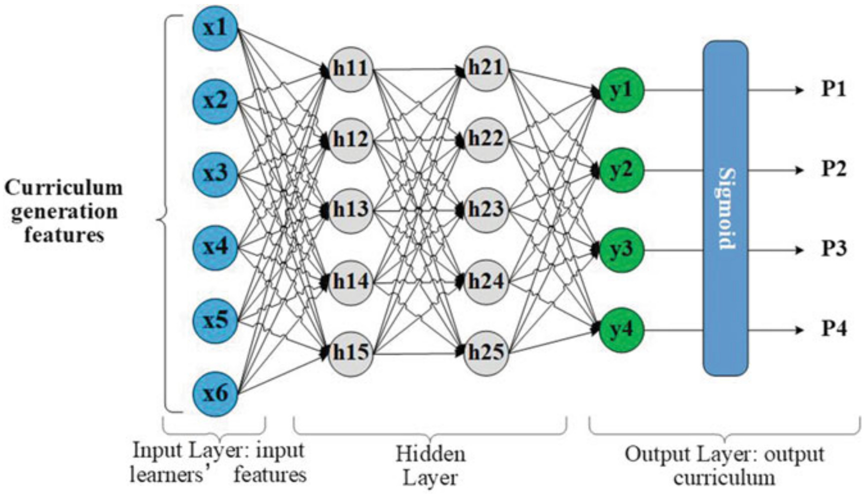

Fig. 12.1 Neural network for curriculum generation

as face recognition (Cottrell 1991; Lawrence et al. 1997), hand writing recognition (LeCun et al. 2014; Zamora-Martínez et al. 2014) and voice recognition (Lang et al. 1990; Wu et al. 1996). During this process, the neural network is used to find features in different areas which might be difficult to recognize by human. So in curriculum design and development, neural network could also be used for finding potential rules. These rules could be trained and represented by the input layer, the hidden layer and the output layer in the neural network. After the network has been constructed, the learners could get the curriculum they need by inputting their learning needs and profile. Figure 12.1 shows the process of curriculum generation. Firstly, the curriculum feature data are extracted and input through the input layer. Secondly, the data were processed through the hidden layer in order to acquire the weights among different nodes. After all the parameters in these layers are decided, the network should use the output result to update all the above parameters which is called backward propagation. At last, if new data comes into this network, it will conduct prediction and generate new curriculum automatically.

12.2.2 Knowledge Graph or Semantic Technologies

Knowledge graph is derived from the research of ontology or semantic technologies. Ontology was originally proposed in the philosophy area and has been used in computer science area in the 1980s (Chandrasekaran et al. 1999). In many research projects, ontology is used to represent the concept model of specific domain and as an engine for the reasoning behind recommendation systems (Shanks et al. 2003). After 2012, Google proposed the knowledge graph based on several data sources and

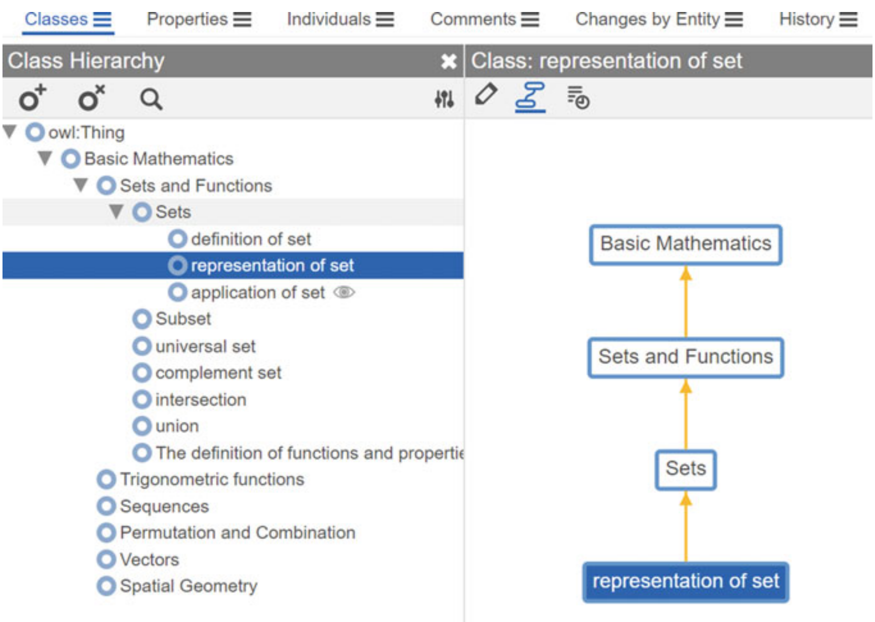

Fig. 12.2 Knowledge graph in specific subject

then the technology of knowledge graph has been used to solve difficult problems in multiple area based on the concepts and relations (Singhal 2012). In education area, concept is the basic unit for learning and there is complex relationship among different concepts. Under this circumstance, knowledge graph can be used to organize the components and knowledge in education area. Therefore, the knowledge graph can be used to support curriculum design and development. Generally, the knowledge graph is constructed by the experts from the curriculum standard and can be expanded by crowdsourcing capacity during the real learning context. The structure of the knowledge graph could be divided into four levels and each level represents knowledge points of different granularity (Fig. 12.2). As to each concept in the knowledge graph, some links could be constructed which could represent the logical relations among these concepts. With these relations, if a learner has something wrong with one concept, the related concept or resources could be provided.

12.2.3 Cognitive Map for Learners

Knowledge graph could represent the concepts and their relations. It is defined from the aspect of objective knowledge and learning content. However, learning could be influenced by multiple factors including the learners' cognition, behavior, the outside environment and the social interactions (Axelrod 2015). With the inter effect

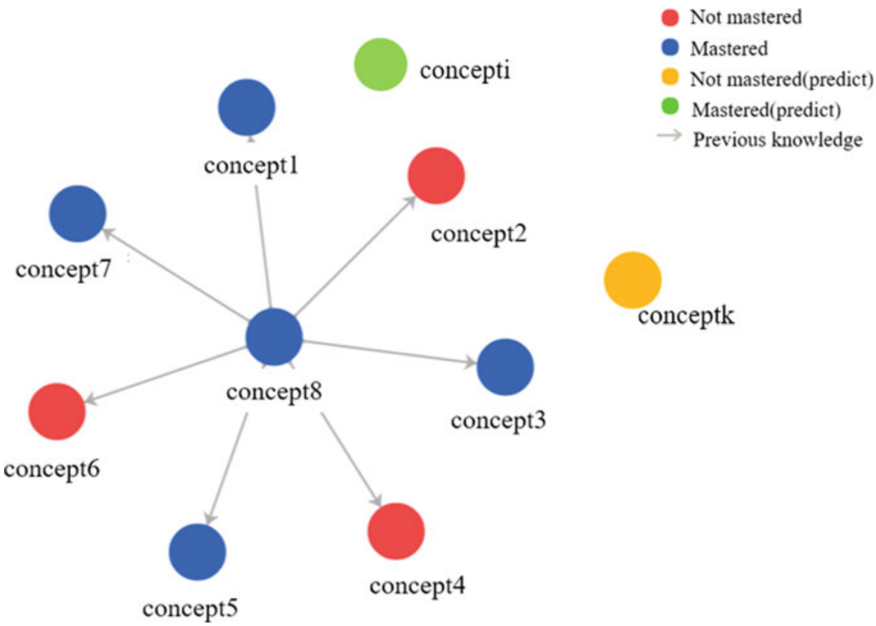

Fig. 12.3 Cognitive map

of these factors, learners' learning state on different knowledge could be different (Mei et al. 2014). So in curriculum design and development, a method should be proposed not only to represent the knowledge itself but also the learners' cognition state. Cognitive map is built based on the curriculum knowledge graph. Moreover, it is different among learners as each learner's learning state is added onto the knowledge graph. After all, the cognitive map could reflect the learner's knowledge stage and the learner's learning path (Fig. 12.3). This could be a better guidance during the learning process for online learners.

12.2.4 Visualization Technologies

Visualization is a method which could make abstract things easy to understand by using graphs to represent the process or result. It has been used in different fields to help workers improve their cognition while completing tasks in the workplace. In the education area, learner's learning progress is a dynamic state related to many different factors and it is changing all the time. If the process and their learning result could be visualized, it will help both the learners and the instructors promote the learning or instruction efficiency. Accordingly, there are mainly two kinds of visualization in education area. One is the visualization of the learning environment and process and the other is the visualization of the result. The first is to help learners visualize the

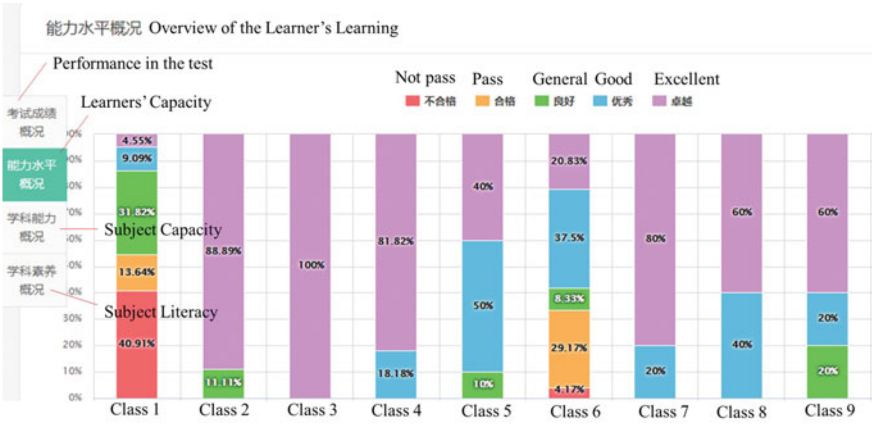

Fig. 12.4 Visualization of the learning result

cognition process by using interactive 2-D or 3-D technologies (Macdougall et al. 2016; Shoufan et al. 2015) such as the virtual reality (VR)/augmented reality (AR). For example, the magnetic field is one of the most important part in physics subject and it is usually invisible. The visualization systems could simulate the magnetic field and make its changes visible for learners during the learning process (Matsutomo et al. 2012). This will reduce the learners' cognitive load as well as instructors' load in explaining the process. Another visualization system is used to visualize the learners' participation so as to explicate their behavior and promote learning (Janssen et al. 2007). During this process, the relationships between knowledge state and the learners' behavior should be established and then be represented by the system. Also, the second visualization targeted to the evaluation of the learners' progress or difficulty by presenting the graphs, tables or dashboards (Mejia et al. 2017) and this will make the learners' progress explicit (Fig. 12.4). During this process, there should be a data analysis framework which could give a diagnosis of the learners' problems and capacity. All these visualization technologies are based on the data mining and analysis model. If used properly, it will be a great promotion for curriculum design and development.

12.2.5 Social Knowledge Network (SKN)

Learning is not just to deliver information to learners. It is a social process involving both knowledge and person. Knowledge and person are all nodes in the learning space. To learn is to establish connections among these nodes (Goldie 2016). If a learner could construct a more complex and higher level relation network which contains different level knowledge and person, it means that the learner may have

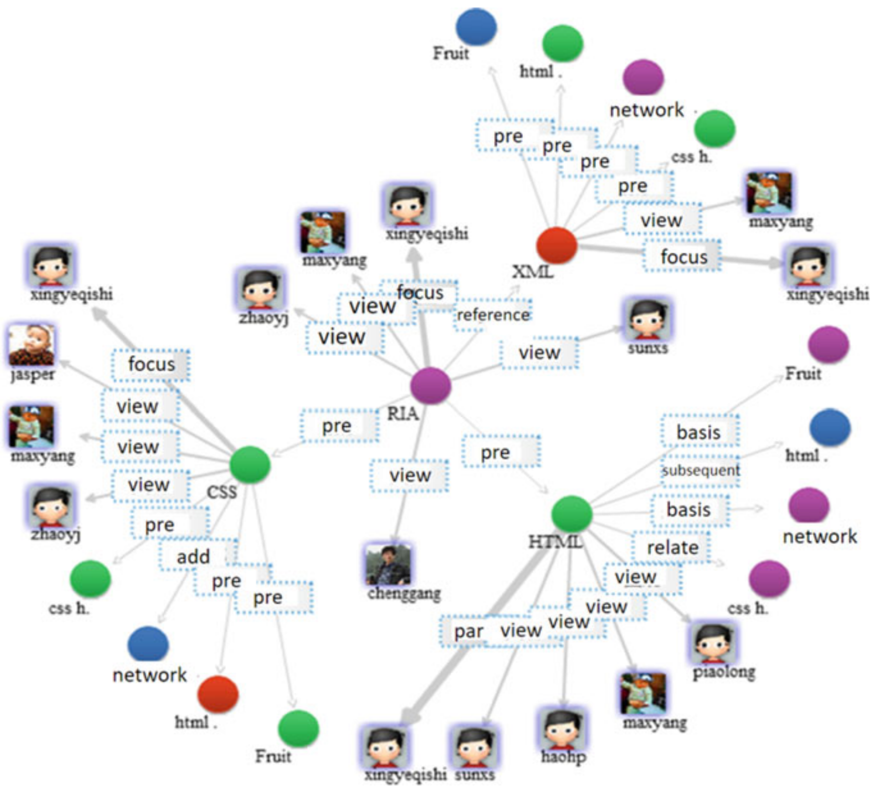

Fig. 12.5 Social Knowledge Network (SKN)

engaged deeper in learning. So the network of person and knowledge is a representation of the learners' learning process. Also, the network could help the learner expand his/her learning by interacting deeper through the network and connecting more nodes. The network is defined as Social Knowledge Network (SKN). In curriculum design and development, SKN could be used to provide adaptive services for different learners (Duan et al. 2019). On the one hand, the service could provide the learners with specific knowledge and resource. On the other hand, when the learner has something difficult to solve, the service could provide access to experts or peers for knowledge improvement (Fig. 12.5).

12.2.6 Educational Data Mining and Analysis

Educational data mining and analysis plays an important role as the engine in curriculum development. Educational data is usually complex and it could reflect the

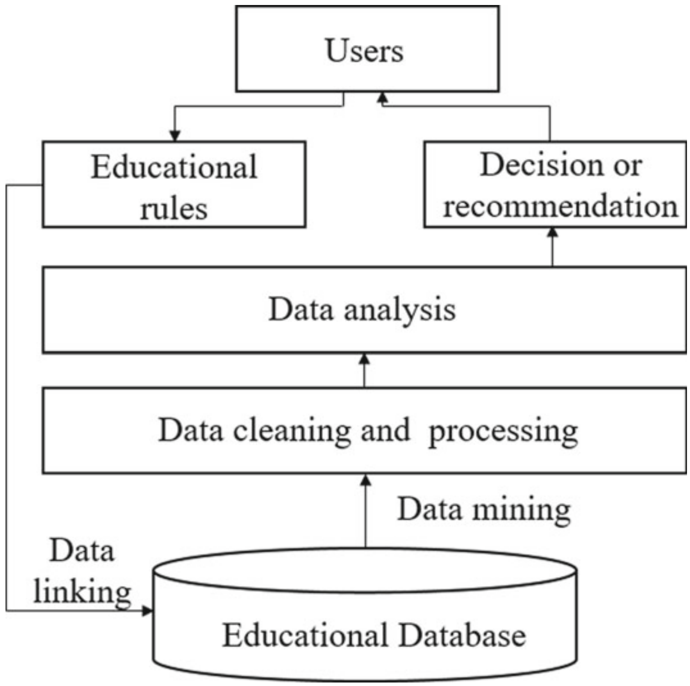

Fig. 12.6 Educational data mining and analysis

nature or rules of education (EIAtia et al. 2016). For example, by collecting and analyzing learners' behavior and performance in class or out of class, the system could establish the norm of learners in different dimensions, such as knowledge, literacy and capacity. Furthermore, by comparing with the norm, the system could discover specific learner's learning problem by collecting his/her learning data and analyzing his/her learning pattern. This process could be of great help for learners to find their potential problems and promote their learning. Finally, it would improve the learners' learning efficiency. So in curriculum design, data mining and analysis module could be an essential part both in finding the learning demands and diagnosing learning problems (Costa et al. 2017). The main process for data mining and analysis is as follows: establish data mining rules and required data set, data linking which could link the learners' needs and the data in database, data mining by designed algorithm, data cleaning, data analysis and decision making or recommendation (Fig. 12.6).

12.2.7 Natural Language Processing

Natural language processing is a method which helps to explain what the human is communicating with the computer. It contains several processing parts: grammatical analysis, semantic analysis and linguistic understanding. These processes are based on some basic works such as: Markov models, probabilistic grammars, supervised and unsupervised classification and the vector-space model (Manning 1999). After these processes, the computer could understand what the human communicated and accordingly search for relative resource or services for the human. In curriculum design and development, as the learners' needs could arise at anytime and anywhere, it is necessary for the computer to master knowledge of what the learners really need. The main task in curriculum design and development is to analyze the learner's real requirements using semantic analysis. The process includes: extract the learners' natural language, word segmentation, linguistic understanding based on semantic reasoning or similarity computing and output. One example of this is the AI tutor (Fig. 12.7).

12.3 Design and Development of Curriculum Based on Intelligent Technologies

In this chapter, we mainly introduce the design and development process of curriculum based on the Learning Cell Knowledge Community (Learning Cell). It is a ubiquitous learning platform and could support online learners' personalized curriculum generation (Yu et al. 2015; Yang and Yu 2015). Learning Cell contains six modules: Learning Cell, Knowledge Cluster, Community, Personal Space, Learning Tools and Knowledge Cloud. Learning Cell represents a dynamically structured-resource targeting to realize specific learning objective including the content, activity and evaluation about one topic. Knowledge Cluster is the whole curriculum consisted by a collection of related Learning Cells. Community is where the learners with similar interest could communicate about one curriculum while the Personal Space is where the learner could manage his/her learning. The Knowledge Cloud consists of a collection of curriculum of similar topics. The Learning Tool contains all tools or scaffoldings that could help the learners in online learning. In this section, the components of curriculum in Learning Cell will be introduced in detail how the curriculum are designed and developed based on intelligent technologies.

12.3.1 Components of Curriculum in Learning Cell

In the Learning Cell Knowledge Community, the curriculum is displayed with the form of Knowledge Cluster. In the Knowledge Cluster, there are a list of Learning Cells of related topic which could make the curriculum a complete sequence. Thus, the learner could have an overview of the curriculum. Under the support of Knowledge Cluster and Learning Cell, curriculum in Learning Cell Knowledge Community should contain a collection of Learning Cells and there should be a knowledge graph

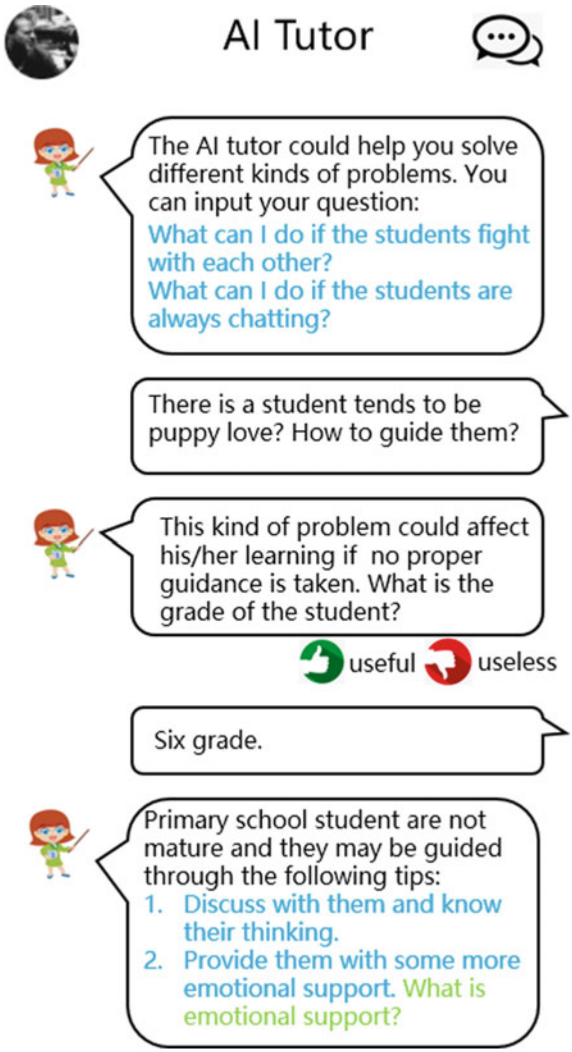

Fig. 12.7 AI tutor

and evaluation for these Learning Cells. In each Learning Cell, the following components should be involved: context information, semantic networks, learning objective, learning content, learning activity, learning tools, evaluation, generative information, SKN and exhibition (Fig. 12.8). Context information determines the features of the curriculum such as the physical context, learning style and so on. Semantic network determines the semantic property of the Learning Cell. Learning objective determines the expected knowledge level of the learner after learning. Learning content, learning activity and learning tools are the main part of Learning Cell and could support the learners' learning. Evaluation is to assess the learners' performance. Generative information reflects the information the learners and instructors contribute. SKN

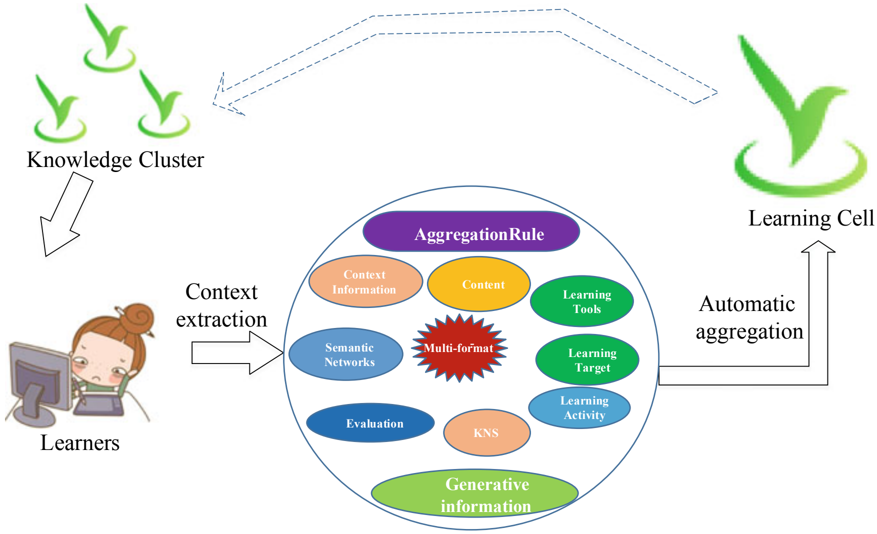

Fig. 12.8 Components of curriculum in learning cell

contains the related resources and person of the topic. Exhibition is the format the curriculum is presented to learners on different devices and under different contexts.

12.3.2 Procedures of Curriculum Design and Development in Learning Cell

This section will introduce how to conduct curriculum design and development based on the Learning Cell Knowledge Community. The framework for curriculum generation includes five layers: data storage layer, data processing layer, curriculum generation layer, service layer and exhibition layer (Fig. 12.9).

Data Storage Layer: Data storage layer is the basis of the curriculum generation framework and it stores all the data that could be used for analyzing learners' context, capacity and curriculum needs. The data includes interactive data, performance data, knowledge and rule data and curriculum elements data. The interactive data could be used to determine the learners' context, learning style and preference. The performance data could be used to decide the learners' knowledge level. The knowledge and rule data reflect the knowledge graph in specific area and the relations contains in the knowledge graph. The curriculum element data could provide the components which is used to generate the curriculum, such as the resource, person, tools and activities.

Data Processing Layer: Data processing layer could extract the data from the storage layer and conduct data analysis. The target of this layer is to determine

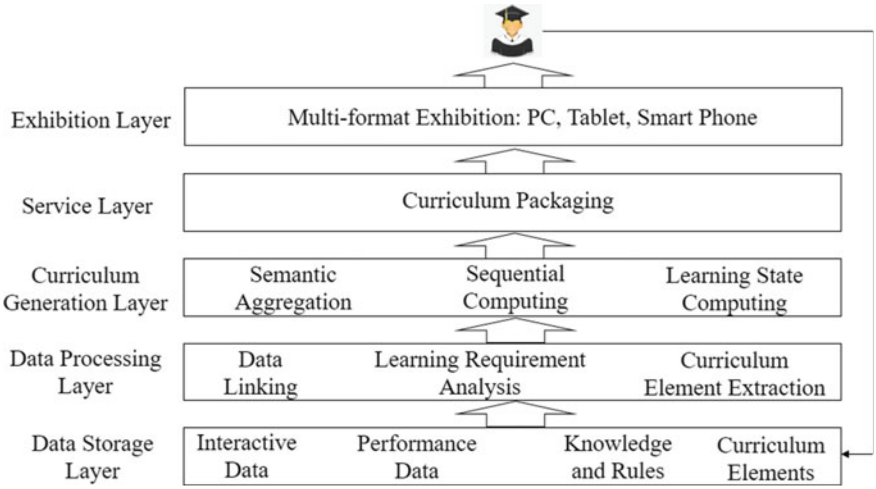

Fig. 12.9 Curriculum generation framework

the learners' contexts and real needs in order to provide them with adaptive curriculum. During the data analysis process, data linking, requirement analysis and element extraction could be used. Data linking could relate the learners' interactive and performance data with specific knowledge. With these links the system could diagnose the learners' problem as well as the reason. Requirement analysis could use the interactive data and performance data to determine what content the learner need under the current context. During this process educational data mining and analysis is the most important technology. Moreover, sometimes the system needs to understand some human interactive language with the help of natural language processing (NLP) technology. Also, in order to conduct better decision, neural network technology could be used. After the requirements are determined, the curriculum components should be extracted by the element extraction method. The analysis result and extracted elements are transferred to the curriculum generation layer for curriculum generation.

Curriculum Generation Layer: This layer is the most important module in curriculum generation framework. It receives the learners' needs and elements for curriculum generation. Then it will analyze the relations of the received elements based on semantic technology. After this process, all semantically related resources or curriculum components are aggregated, such as the learning content, learning activity, evaluation and SKN. After this process, the knowledge organization rules should be used to determine the sequence of the aggregated components and organize the components with a learner-friendly form. At last, in order to make the learners' learning state explicit, knowledge graph and cognitive map are integrated to represent the learners' cognitive level. After these three steps, a curriculum package will be transferred to the service layer.

Service Layer: The service layer receives the curriculum package from the generation layer and then extracts the context information and learner feature from it. After the contexts and learner feature are determined, this layer could reorganize the elements and transfer them to the exhibition layer. All the elements should be adaptive to the specific context and learner.

Exhibition Layer: The exhibition layer will first detect the device and visualize the received elements based on the device and context. This layer is the core part for the generated curriculum to realize multi-format exhibition. Visualization technologies are used to guarantee the friendliness of the curriculum that is exported to the learner.

With the above five layers, the Learning Cell Knowledge Community could realize curriculum design and development automatically. The procedure is as follows:

(1) Detect the learners' learning context and analyze their history data. During analysis, NLP and neural network are used to determine the learner's context, learning style and other features which are helpful for personalized curriculum development.
(2) According to the features and needs, the Learning Cell Knowledge Community should collect elements from the data set for curriculum packaging and reorganizing.
(3) Using semantic technologies, sequence computing technologies and cognitive state computing technologies to organize extracted elements and make them a well-organized curriculum structure.
(4) Output the packaged curriculum according to the devices and context of the learners. After this process, the learners could conduct personalized learning and give feedback to the generated curriculum. These feedbacks would be helpful for further curriculum design and development.

12.4 Conclusion

Curriculum design and development are quite important for online learning, and providing personalized curriculum is the main assignment for educational researchers. However, with the increase of learners' needs, it is difficult for experts to provide personalized curriculum for all. This requires the development of a method for automatic curriculum design and development. This chapter provided the initial view of the method for automatic curriculum design and development.

Recently emerging technologies provide the possibility and support for automatic curriculum design and development including neural network, knowledge graph or semantic technologies, cognitive map for learners, visualization technologies, SKN, educational data mining and analysis, and natural language processing. On the one hand, these technologies could collect data which reflect the learners' whole learning process, and data analysis could be conducted for learners based on the collected data. On the other hand, the learners' learning process and learning state could be visualized and this is quite important for regulating and evaluating the learners' performance. Moreover, from what have been analyzed, the online system could design and develop adaptive curriculum which could be adaptive for different learners based on the rules and relations established by the semantic technologies. This is the whole process of automatic curriculum design and development in Learning Cell.

In the future, in order to make this method more effective, an adaptive learning system should be provided to support learners' learning. During this process, higher-efficient algorithm and rules should be designed. Also, more complete knowledge graph should be developed to support curriculum development.

Glossary of Terms

Learning Cell learning resource with collections of content items, activity items, service items and their semantic descriptions based on a single learning objective.

Neural Network a network composed of several layers which contain many nodes and edges with parameters and hyper-parameters. This network could realize complex computing.

Knowledge Graph a graph composed of nodes and edges in which the nodes represent concepts in specific area. The edges represent the relations between different concepts.

Cognitive Map a graph composed of nodes and edges. It is similar to the knowledge graph. The main difference between them is that the cognitive map reflects different learners' learning state. So each nodes represent the concept as well as the state of the concept and the edge represent the logical relations among different nodes such as A is prior to B.

KNS Knowledge network for social services (KNS) is a network composed of person and knowledge. With this network the learners could find related person and resources easily and thus promote their learning.

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Chapter 13
The Holographic Academic: Rethinking Telepresence in Higher Education

Dominic Pates

Abstract Using holographic projection technologies at an event titled 'Women in Tech', Imperial College Business School launched in November 2018 what it claimed to be the 'world's first holographic event at a university'. This form of teaching via telepresence has the potential for a significant disruption of the lecture format and also raises profound questions around the pedagogy of giving lectures in this way. This chapter asks some of those questions as well as attempting possible answers to them and is therefore intended as a set of practical considerations for teachers, technologists, and policy makers that might wish to investigate holographic delivery for their own institutions.

Keywords Education 4.0 · Haptics · Holographic · Holography · Holograms · Mixed Reality · Telepresence · Blended synchronous learning · SAMR model · Web conferencing · Webinars · Imperial College · Distance learning

13.1 Introduction: Imperilled Princesses and Resurrected Rappers

The old man told his younger companion a tale of the near extinction of an ancient order of knights, and described a ubiquitous power once channelled by those knights, known as The Force. He ambled over to a nearby robot and pressed a button on the top of the metallic device. A holographic message then appeared in the room, displaying an imperilled Princess that had a message to pass on to the old man about the dangers she was under.

> Help me, Obi-Wan Kenobi. You're my only hope. (Princess Leia, in 'Star Wars: Episode IV—A New Hope', 1977)

Once delivered, the message flickered out with a white noise flourish. Information imparted, the R2 droid unit that Leia had entrusted to deliver her message shut off

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its laser beam and the faraway Princess disappeared. Although the older Obi-Wan had been introducing the young Luke Skywalker to the ways of The Force prior to playing the message, Skywalker's thoughts, no doubt, turned instead to ones of rescuing princesses.

While projecting a holographic image without the required physical plates was technically impossible at the time of 1970s cinema (Johnston 2011) and the likes of Leia holographic rescue plea might have set unrealistically high expectations of the capabilities of holography (Holography 2019), this cinematic moment was nevertheless pivotal for a new generation to conceive of the potential of holograms. The seeming use of live holograms of actual people has become noticeable in recent times. British model Kate Moss made a 'ghostly' holographic appearance as the finale to Alexander McQueen's 2006 Paris fashion show (Williams 2015). Dead rapper Tupac Shakur was brought 'back to life' to appear alongside Snoop Dogg at the 2012 Coachella Valley Music and Arts Festival (Holography 2019). In the same year as Tupac's resurrection, Indian Prime Minister Narendra Modi simultaneously addressed voters at campaign events across several different locations, using holographic technologies to broadcast the recorded speeches via a satellite link (Kalansooriya et al. 2015).

Describing these 3D moving images of people as holograms is not strictly speaking accurate. They are often an example of or comparable to the deployment of '*an old conjuror's trick*' (Johnston 2011) commonly known as the Pepper's Ghost illusion. This has traditionally involved the utilisation of a hidden offset mirror to reflect an image seemingly in real space, while many of the modern variants are created via rear projection onto semi-transparent screens (Holography 2019). The technologies and techniques used to produce such illusions have been referred to as *fauxlography* (Gordon 2017), given that they are not '*actual recordings of interference patterns*'. They are nevertheless often commonly referred to as holograms, despite technically being imposters within the medium.

Four decades on from Leia's holographic plea, London's Imperial College Business School launched an event in November 2018 that it claimed to be the '*world's first holographic event at a university*' (IB Women in Tech 2018). The technology used in this initiative, provided by a company called ARHT Media, connected guest speakers based in video studios in other global locations—in this case, Los Angeles and New York—with students seated in an Imperial lecture theatre in London. The speakers appeared in real-time, as life-sized 3D holographic entities, with interaction possible between both audience and speaker. This takes today's appearance of a remote guest speaker in a live lecture or seminar as typically conducted using standard consumer web conferencing tools to a different level, and arguably closer towards the realm of Arthur C. Clarke's renowned adage that "*any sufficiently advanced technology is indistinguishable from magic*" (2018). It also raises profound questions for the pedagogy of giving lectures in the not-too-distant future and could serve to significantly disrupt an educational format that has remained relatively unchanged for hundreds of years.

This chapter investigates the notion of holographic lecturing. It looks at considerations of live teaching at a distance via telepresence tools, the wider uses of holography in education, and the potential implications for the curriculum, as well as possible ethical dimensions of this new approach. It attempts to draw out what it might be like to teach in this way and is thus intended as a set of practical considerations for teachers, technologists, and policy makers who might wish to investigate holographic delivery for their own institutions. It is also intended as a means to ask what is hoped are the right questions to be asked of this medium ahead of any possible wider adoption, in support of whether or not it becomes more widely adopted in educational contexts, and specifically within the higher educational curriculum.

13.2 Breaking the Lecture Mould

Opening the event (IB Women in Tech 2018), Imperial's Business School Dean refers to the technology that they are going to use as '*not about replacing people, it's about enabling a connectivity that is not possible to do without…but in doing so, that's possible to do so with a sense of presence*'. Following a digital transition reminiscent of Leia's white noise departure, the first speaker appears on stage. She asks the audience whether they can see or hear her, clearly needing a commonplace affirmation as she steps into a brave new world of futuristic presentational delivery. She makes reference to the apparent historic nature of the moment throughout her talk, in an address peppered with a meta-narrative on the use of holography in the moment. There's a little audience interaction to start with, as she asks people to raise their hands on a series of choices, then she delivers her talk. After taking one question from the audience, she disappears, and the next speaker arrives via the same transition effect. In another demonstration of the capabilities of this new technology, the second speaker appears in pre-recorded format. The finale of the event comes with a panel talk that comprises two live guest speakers and a facilitator flanking either side of the stage in London, with two other guests that take centre stage, live from New York.

With more complexity in a mixed panel setup comes a little more uncertainty, at least at first. The first guest asks the audience '*Can you hear us OK?*', then states '*We'll get through it. We're holograms. It's really cool*'. Most of the panel discussion flows smoothly, to the extent that it is easy to forget that not all speakers are physically present in the same place. As with the first speaker, the panel incorporates a holography meta-narrative, laughing about the layout of the panel and the ability to see everyone. Natural body language is typically replicated throughout the panel session, although there is a moment where the speakers in New York are being addressed by one of the ones on the London stage, on screen, they are looking in the opposite direction. There's space again for a question from the audience at the end, and the audience member is encouraged to stand up so that the remote speakers can see them, who wave in response.

From an educational perspective, this event points the way to a few probabilities and raises questions too. The technology itself takes a video image of a speaker standing on a platform in a *capture room* and sends it over the Internet to be back-projected onto the gossamer screen positioned on the audience's stage. Given both the novelty of this technology and the unique nature of the format, it is possible to conclude from this performance that reference to the technology, or specifically to holograms, is likely to be a feature of future educational uses of it. This can have the effect of both distracting from the main purpose of the gathering of people in the particular context and of highlighting the affordances of the technology, thus making it more apparent what it has made possible.

Despite the seamlessness of the experience and the novelty of the event, there were some clear differences that distinguished the speakers. During the panel, it was easier to make a comparison between remote and present speakers, given that they were literally lined up next to each other. The remote speakers had a certain 2D quality when lined up next to the 3D live speakers. While there was a good audio balance between speaker microphones, there were moments when there were noticeable differences in volume between remote and present speakers. This must be challenging for a sound engineer to get right, as they will typically tend to work with balancing a mix of audio inputs from within their proximity rather than between different locations. An equitable mix between both speaker types will be an integral part of maintaining the illusion.

How an audience member's voice is picked up when asking a spoken question is an important consideration for maintaining a sense of seamlessness at events such as these, whether one of the presenters is appearing via hologram, is live on stage, or is elsewhere in the room. Humans in face-to-face contexts, which holographic telepresence aims to simulate, naturally communicate with each other verbally, so enabling verbal interaction is important here, and difficult to achieve well. The speakers on the Imperial panel all appeared of comparable or equivalent height (accounting for actual individual variations within that). Ensuring that relative equivalence of height is clearly another necessary factor to consider, whether with a single speaker or a combination of telepresent and physically present speakers. If a hologram looks too tall or too short to appear as if at natural height, then their impact is further diminished.

The Imperial event also raised other logistical questions. Both the remote panel speakers were clearly next to each other in the same space. Could a third speaker be brought in from a different location? Due to the need for a frame around the projection screen and the black stage curtain to mask that framing, are such events are always likely to feel a little dark, and what impact would such a low-lit experience have on learning? Given that the facilitator did make reference at the end to the lighting, how an educational event that features holographic telepresence is lit is clearly another factor that requires consideration. Finally, the screen that the holograms appeared on felt a little 'flat' after a while. How might this technology develop further in future, as it is further refined? With greater bandwidth and connectivity options, would a next stage of telepresent guest speaker be recreated live, with lasers?

13.3 Holography and Education

Let us next paint a slightly wider picture and establish a little more background to the medium, before we go any further. A hologram is, essentially, a photographic-like recording of a light field that depicts a three-dimensional image of the recorded subject and which does not require any specialist optical equipment to be viewed. Holography records the light waves that are diffracted from that subject (Tahara et al. 2018) in order to make holograms. It can be understood via a comparison to photography, despite being a different process (Exon 2010). Where photography records the intensity of light waves that reflect off an object, holography captures both the intensity and the direction of light, and this gives a hologram the spatial quality that is missing from a photograph.

In 1971, Hungarian-British physicist Dennis Gabor was awarded the Nobel Prize for Physics '*for his invention and development of the holographic method*' (The Nobel Prize in Physics 1971 n.d.) which emerged from his attempts to improve the imaging qualities of early electron microscopes. Gabor coined the term *hologram* to mean *whole drawing*, taking its etymology from Greek roots (Johnston 2011). Although often considered as the originator of the hologram, his work naturally built on prior explorations in other fields, including Lippmann's investigations into colour photography in the 1890s, Zernike's work in phase-contrast microscopy, and several studies undertaken in the 1940s into optics (Johnston 2011). In an ironic twist for the inspiration of this chapter, Gabor himself joined London's Imperial College in 1948 and now has a hall of residence in South Kensington named in his honour (Gabor Hall n.d.).

Holography stepped out of science and into the arts during the late 1960s, when a handful of artists in the US, UK and elsewhere began to explore the aesthetic potential of the form (Johnston 2011), and exhibited their works in public galleries. By the 1980s, low-quality holograms could be easily mass-produced, and found their way into a wide variety of uses, including on record and book covers, on packaging, and as anticounterfeiting devices (Johnston 2011), such of those commonly found on credit cards.

Today, digital holography allows for recorded object wavefronts to be reconstructed using a computer (Tahara et al. 2018), taking the form into the present day. Microsoft (Microsoft HoloLens n.d.) uses the term *mixed reality* to identify the HoloLens, which it describes as a '*self-contained holographic computer, enabling you to…interact with holograms in the world around you*'. The HoloLens is an untethered, head-mounted display that overlays digital holographic content over a user's perceptions of real-world images and also accounts for a user's movement within a physical space, adjusting the virtual holographic image accordingly (Leonard and Fitzgerald 2018). As the user has to wear specialist equipment to view HoloLens content, it could arguably be bracketed with Pepper's Ghost technologies as another example of fauxlography, given that the HoloLens is clearly quite distinct from classical holograms. With the profusion of uses of the term, however, perhaps it is appropriate to accept that holograms are used as much a concept that tend to have distinct characteristics rather than just strictly speaking being a fixed medium, preserved in Gaborian aspic. Some researchers (Plesniak and Pappu n.d.; Page 2013) have attempted to combine haptics and holography. Page considered medical and surgical training as one use for his haptic holograms, suggesting that the importance of touch as a sensory experience means that its inclusion in the holographic experience might go some way to address the general criticism of holograms as static, non-interactive objects.

Haptic holography for training surgeons leads us on to consider the use of holograms in education. Unsurprisingly, literature on the use of holograms as an educational technology or for enhancing the learning experience is seemingly very limited. Schooled, perhaps, in the potential of them as depicted in Leia's plea to Obi-Wan or in the immersive environments of the Star Trek holodeck, many writers look to the possibilities that they imagine holographic technologies can bring to their particular context, rather than describing any actual deployments. These imaginings seem to fall into two broad categories—the perceived impact that holography can have on distance learning, and a rather more nebulous form of 'virtual academic', represented in holographic form.

Jefferson and Moore (1990) pointed out that distance-education systems typically work with one or two sense modalities. They envisaged that holographic features would, sooner or later, start becoming incorporated into visual presentations, thus enhancing at least one of the sense modalities. Norman and Scadden (2004) envisaged a virtual holographic tutor '*packed with loads of AI*' that could cater to individual students' learning needs. Portugal (2006) anticipated a future for distance learning where virtual holographic individuals would be pre-programmed for answering student questions, delivering lecture material, and anticipating other student inquiries. Eaton et al. (2008) saw dental education happening via holographic videoconferencing in environments similar to Second Life. Raj and Al-Alawneh (2010) imagined newer models of online learning that might appear to supplant the perceived inadequacies of text-based, asynchronous distance learning courses that combined rich Internet applications with holographic projection systems, and which might help to change perceptions of online learning impacted by the absence of direct, face-to-face communication. Gregory et al. (2013) anticipated the evolution of virtual worlds, where holographic projections would come off the computer screen and provide greater dimensions to the learning experience.

All of the above looked to possible futures where holography might be deployed in support of learning and teaching. Kalansooriya et al. (2015) took these speculations a step further and asked field experts to assess how applicable 3D holographic technologies could be used as enhanced tools for supporting distance learning. Leonard and Fitzgerald (2018) co-facilitated an actual trial use of Microsoft's HoloLens in an Australian secondary school. These two studies give us slightly more than speculation in terms of teacher or learner perspectives.

Kalansooriya et al. (2015) reached out to university academics and IT professionals, asking them to consider teaching environment factors that might impact on the learning experience, and barriers and difficulties to implementing a hologram-based classroom. The environmental factors they listed included interactive teaching methods, effective communication, and diversity in methods of presentation. The major barriers included lack of and initial high cost of infrastructure, limitations in bandwidth, and reluctance to adopt new technologies. All the subjects of their study shared the idea that holographic technologies would be a considerable improvement on video-based tools for supporting distance education, but there were no clear conclusions drawn about either cost-effectiveness or student involvement in such a classroom. The academics interviewed seemed to consider holograms as more likely a novelty than a core tool with real-world applications.

Leonard and Fitzgerald (2018) collaborated on some design workshops with an app publishing company, then trialed these initial designs in various subjects, including chemistry, physics, music and health. Their research showed that the technology was seen as broadly engaging, that teachers could see great potential, but that there were inevitable implementation issues. However, they were surprised by their conclusions, which found that the teachers and students involved seemed to consider this new technology as applicable only within existing teaching and learning practices. This had the effect of restricting the capacity to consider the new ways of doing teaching and learning that were afforded by the tool, particularly around mobility and sensory-motor engagement with the real world. It also suggested that under the context of current practice-based transformation frameworks such as the SAMR model (Substitution, Augmentation, Modification, Redefinition), innovative technologies such as the HoloLens do not in themselves automatically lead to redefinitions of classrooms practices. Their investigation concluded with asking how learning design and research could support teachers and students to engage more deeply with a tool such as the HoloLens, in order to support an educational focus that went beyond merely meeting pre-defined learning outcomes.

13.4 Teaching from Elsewhere

In an early conversation I had with an academic at City, University of London (City), I was asked about bringing an expert guest speaker into a class remotely. She was used to holding discussions with peers and colleagues in the sector via technologies such as Skype and wanted to be able to recreate this approach in class with her students. I considered the cumbersome barriers that I could imagine this would entail, such as spending class time on cabling, camera angles and students having to step out of their seats and approach a microphone just to be able to ask a question, and pondered how these barriers might be sufficiently removed to the extent that it would feel as if the guest speaker was there in the room. I imagined a future scenario, when the technology was sufficiently advanced, where holograms could take the place of a wall-mounted web conferencing system, it would feel as if the guest were actually in the room, and the final barrier of distance would appear as if fully removed.

Exon (2010) looked at video conferencing and telepresence as lenses for considering enhancements to Online Dispute Resolution (ODR) in virtual courtrooms. She suggested that video conferencing would enable disputants to hear frustration or concern in tone of voice, or be able to see the body language displayed when an opposing party begins not to tell the truth, so video conferencing seemed at first glance to afford the unique qualities that face-to-face dispute resolution can have. However, there are certain technical limitations that might limit the medium too, and which are just as relevant for educational contexts. Compression of audio or video signals that cause delays or disconnections, limited transmission of images, incompatibility between different conferencing products being able to connect to each other, and particularly lack of user familiarity with the technology can all impact negatively to participation in a video conference meeting. Furthermore, and perhaps most importantly, participants can struggle to develop trust or rapport in such settings, needing to modify themselves to fit within the video boundaries when they might even feel uncomfortable looking into a camera to speak at all.

Exon (2010) then referred to telepresence as attempting to overcome some of these hurdles presented by video conferencing. She identified key features for such a telepresence conferencing/collaboration system if one is attempting to replicate the in-person experience as much as is possible. When incorporated into a conferencing context, features would include elements like immersive or mirrored environments for participants to feel that they are in the same location, the perceived absence of the facilitating technology, participants being true-to-life-sized, video, lighting and acoustics of studio quality, and finessed details like true eye contact and precise skin tones. The International Society for Presence Research (2000; ISPR) goes further towards defining telepresence—which it shortens to *presence*—describing it as

> …a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience.

ISPR distinguishes between a *first-order mediated experience*—that which is mediated by human senses and perceptual processes and a *second-order mediated experience*, which is also mediated by human-made technology but is perceived as a first-order mediated experience. Bringing this back to teaching and learning, Themeli and Bougia (2016) identified the term *tele-proximity* through investigating synchronous video communication as an option within distance education. They used the term to describe the use of tele-operations to support the need for embodied human-to-human interaction in online courses, for promoting learning objectives and improving communication in such contexts, and for bridging transactional distances. They suggested that greater use of the tele-proximity model could be made by educators and instructional designers to enrich curricula by adding more synchronous activities, allowing the flow of group interactions to positively impact on efficiency and productivity.

Would holography finally remove the barriers between co-located and distant or would it lead to new barriers between educator and learner? As we have seen in this chapter, pseudo-holographic technologies are no longer the stuff of science fiction that they have been for educational dreamers for decades. They can have a great impact on learning contexts, and can certainly give the impression of ‘being there’. We haven’t discussed the ARHT Media infrastructure behind the Imperial event, however, and the additional skills needed to be on hand in order for such an event to look as smooth as it does. Neither have we discussed the planning and co-ordination needed to go into such events.

Holography, then, may both remove barriers in telepresence-facilitated education and add new ones. There are other considerations to factor in too. Yuen et al. (2011) looked to beyond the short term of mixed reality-type tools, past merely addressing the shortcomings of video conferencing, to potential long-term consequences for learning, teaching, and the institutions that education happens in. They found the implications to be profound and seemingly left them with more questions than answers. If the barriers to poor web conferencing experiences are finally removed, they suggested, and live distance learning is no longer viewed as less desirable than face-to-face instruction, does this not, therefore, raise profound questions for the ongoing viability of bricks and mortar schools and universities? Would market forces not ultimately lead to an end of the physical classroom in the face of superior alternatives?

Future forecasting in education is often ridden with hyperbole about the scale of coming transformations that never quite seen to fully transpire as imagined. Given that the lecture and tutorial format of higher education, as has been around for centuries, has proved resistant to change enough to the point of still being here today in formats that would have been recognisable to the medieval scholars of yore, I suspect that holography would not be the straw that broke the camel’s back. According to Leonard and Fitzgerald (2018), higher education will certainly need to imagine beyond existing formats of delivery, though, if it is to take advantage of the full affordances of this emerging technology.

13.5 Conclusion: Thinking Ahead

To conclude, we will look ahead with some remaining thoughts and questions on the use of live holograms in the curriculum.

In an era of transformative change driven by a whole raft of established and emerging technologies—artificial intelligence, the Internet of Things, robotics, Big Data—there is, perhaps naturally, talk of the impact that these things will have on education. Writers refer to Education 4.0 (Feldman 2018; Hussin 2018; Welsh 2018; What is Education 4.0? 2018) as a means of defining the educational transformations that they feel will inevitably run in lockstep with the wider socio-economic changes being wrought as the twenty-first Century moves into its third decade. Following innovations like the HoloLens and Imperial’s move into holographic lecturing, it seems reasonable to assume that the technology is now sufficiently advanced for holography (actual or otherwise) to begin moving out of the imagination and into the classroom. Given the pace of developments in mobile technologies and of mobile connectivity, it might not even be too far-fetched to see holography becoming a personalised experience, and thus find its way into learner hands too, in the not-too-distant future. Edholm's Law Of Bandwidth (Cherry 2004) states that telecommunications data rates are as predictable as Moore's Law and increase in capacity equally as exponentially, widening mobile bandwidth for all. The UK's first 'live holographic call' has already been demonstrated by Vodafone (Davies 2018) to showcase 5G connectivity, seemingly within weeks of the accompanying landmark educational event.

We have already seen through the Imperial example that holography can have a potentially disruptive impact on the lecture format. In this case, it is now technically possible to bring a guest speaker into a live lecture from, effectively, anywhere in the world and make it appear almost as if they are actually there in the room. In the short term, this could lead to those institutions with sufficient resources being able to bring top speakers from industry into their business lectures, high ranking lawyers dropping in on legal education, and the most-renowned surgeons dipping into health seminars in between operations. While this could make for a tantalising addition to the student experience, it is equally not too far-fetched to imagine that this could widen any existing gaps between the more elite institutions and those that are less well resourced. What then of the impact on the use of casual labour in academia, of over-reliance on limited contracts than on tenure? If one academic could be easily and simultaneously 'beamed' into several lecture theatres at the same time, could that not only reduce the number of academics an institution chooses to employ but actually devalue the physical lecture itself?

Another perspective, going against the grain of the concerns that Yuen et al. (2011) expressed for the ongoing viability of bricks and mortar institutions, is that bringing the best guest speakers in from around the world to lectures could be a sure-fire way to *boost* the value of the flagging lecture format itself, for those that question its endurance. After all, if a lecturer could bring a pseudo-live version of actual field experts into the rooms where their students are already concentrated, and to able to facilitate interaction between that expert and their learners, surely this would have a far more profound impact on learning resources and student engagement than better designed PowerPoint slides and a live quiz with instant feedback at the end? That factor alone could be a highly tantalising prospect for the very reach and potential of contemporary higher education. New global networks could emerge where academic knowledge is pooled for ever-wider audiences, greater opportunities for collaboration and interdisciplinarity can happen across more borders, higher education can reach into more remote places, and the wider spread of knowledge can be encouraged across our information societies.

As Leonard and Fitzgerald (2018) showed, there is every possibility that the holographic academic would be incorporated into the curriculum, yet there may be limited progress made towards actually redefining the educational offer itself and have full advantage taken of the affordances of the technology. This, perhaps, leads to a role for educational technologists and developers to continue to work closely with their academic colleagues and student bodies in order to support them in imagining what those new affordances might be, and to help facilitate the means for these new technologies to be brought into the curriculum in positive ways than genuinely enhance the educational experience, rather than being just another gimmick or a tool that ends up as contentious as something like lecture capture has turned out to be within academia.

In harmony with the principles of the movement around decolonising the curriculum, it is incumbent of any of us advocating for the holographic academic to join the academy that this new form is more broadly representative of a polyphony of voices than the increasingly outmoded tone of the stereotypical *sage on the stage*. If live digital holography is to avoid seeing with a *coded gaze* (defined as the '*embedded views by those who have the power to code systems*' by Buolamwini in Bermudez-Silverman 2018), then matters of equity need to be incorporated into trials and pilots of this emerging technology from the offset. Imperial's use of their novel platform to address the issue of gender imbalance in the technology sector is, at least, an encouraging step in a positive direction.

What does the holographic academic mean for the practices of teaching and learning? Delivering webinars require finding different ways to engage students in the learning process when they could so easily become distracted by whatever else might be happening on their computers or in the environments that they are in and which the educator is not physically present. In much the same way, for holography as a means of delivering distance education to be able to move beyond the gimmick, new pedagogies will need to emerge. Teaching in this way will be different from just giving a face-to-face presentation. In the case of the tool used by Imperial, the remote lecturer would see their student audience on a small tilted confidence monitor in front of them rather than mere feet away in the front row. How to establish rapport in that context, or respond to difficult questions? How could they compensate for not being able to move amongst their students in order to monitor progress when setting a task, support the struggling, or assert authority with disruptive sections of their class? What will professional bodies or training programmes make of those who want or even need to teach in this way?

In a lecture theatre, space has been specifically architected around the paradigm of a single speaker addressing a large group audience that faces them directly, and who usually speak uninterrupted for a notable length of time. The format is renowned for the challenge it sets for a static audience to keep themselves engaged over the duration of the talk, so the lecturer that wishes for an engaged audience might move around on the stage rather than remain at a fixed point throughout. With holographic lectures delivered in this way, that would be much harder to do, given that the speaker has to stay within the pickup field of the video camera in order to remain on the screen at the other end, equivalent to a fixed podium in an actual lecture theatre. The panel speakers at the Imperial event instinctively wanted to use certain conventions of body language to communicate with their panel peers as if they were co-present, such as looking at each other or holding outstretched palms in the direction of another person to indicate a turn to speak. Given the particular nature of this format, where interaction between speaker and audience or speaker and other speakers is a key distinguishing factor from an audience merely watching a video recording, would new conventions or literacies around interpersonal communication need to emergence for adoption of this holographic format to take hold?

For students, holographic academics might give them access to the world's best or most knowledgeable, but after the magic has disappeared in an animated flourish, those with the lingering questions may no longer have the chance to approach the lectern at the end of the session and ask the burning question they were too shy to ask while all their peers were watching. Conversely, such features in lectures could see significant upturns in overall attendance. Most British universities have student cohorts that are made up of a blend of domestic/European Economic Area students with international students from a multiplicity of other different countries. How readily would lectures being delivered via hologram be accepted across such diverse bodies? One final unrelated study gives us a possible clue.

Yokoyama et al. (2004) compared the differing reactions that Japanese and Swiss children had to ownership of robot pets. The Japanese children, who had all grown up in highly technologised societies where fictional robots were often a feature of the prevailing culture, were found to bond quickly with their robot companions but grew disaffected with them just as rapidly. The Swiss children had grown up in far less technologised societies and had had much less general exposure to robot characters within their culture, were initially quite reluctant to make any evident connections with their own robots. They did, however, become more used to them over time and ultimately formed stronger bonds with these mechanical creatures.

While robot pets and holographic academics are self-evidently worlds apart, perhaps this study acts as a cautionary tale, all the same, suggesting that some students will take to these new kinds of lecturers very quickly but soon drift their attention elsewhere, whereas others will struggle at first with this new paradigm, but ultimately gain something meaningful from the experience. As with any sufficiently advanced new technology, there are no easy answers. To paraphrase Princess Leia, we may well need to ask the holographic academic for their help, but to also ensure that they are not our only hope.

Glossary of Terms

5G The fifth generation of mobile phone network technology, providing broadband access

AI Artificial Intelligence

Bandwidth The maximum rate of data transfer across a communications channel

Capture room A facility that includes a stage or platform technical equipment for recording a relaying a digital image of the presenter on the stage, and video monitor(s) placed in front of the stage to relay images of the remote audience to the presenter

Confidence monitor Screen that carries content such as the text of a presentation (or in the ARHT Media example, a video feed of a remote audience) that is traditionally meant as a tool to support presenters and make them appear as if they are looking directly at the audience when speaking

Diffracted In the context of light, description of light waves that have become bent or broken up

Digital transition A multimedia device to indicate a move from one piece of digital content to another

Disputants A person in a legal case that disputes a charge levelled against them

Education 4.0 Label given to the potential application of 'fourth industrial revolution' technologies (AI, robotics, big data, Internet of Things, etc) to education

Fauxlography The practice of creating artefacts that appear holographic, but which are not created using traditional methods

Haptic holograms A type of hologram that can convey the impression of tactility, or appear as if they can be touched

Haptics The use of a sense of touch for interacting with digital objects

Holodeck A fictional plot device from the television series Star Trek that presented a staging environment where various virtual reality environments could be engaged with by participants

Holographic lecturing The act of delivering a lecture via holographic-like delivery tools

Holographic telepresence A form of telepresence driven by holographic-type technologies

Holography The science and practice of making holograms

Light waves The means by which light travels

Meta-narrative A wider narrative related to a general context, as opposed to the specific details of the main narrative itself; an overarching storyline that provides broader meaning

Microsoft HoloLens A mixed/augmented reality head-mounted display developed and manufactured by Microsoft

Mixed reality A hybridised form of reality that merges both real and virtual worlds, typically via immersive technology

Moore's Law The observation of a historical trend, named after Intel co-founder Gordon Moore, that the number of transistors in integrated circuits doubles roughly every two years, thus driving significant advancements in digital electronics

Online Dispute Resolution (ODR) A form of dispute resolution where the resolution of disputes between parties is facilitated via digital technologies

Polyphony A type of musical texture where aspects of a composition are combined to shape the work's overall sound and quality

Recorded object wavefronts The stored manifestation of the distribution of light waves

Remote speakers Event speakers, such as university guest lecturers, that are speaking or presenting to a live audience from a remote location

Sage on the stage An educator that imparts knowledge from a platform by lecturing to an audience; sometimes intended as a derogatory term

SAMR model A model developed by Dr. Ruben Puentedura for integrating technology into teaching

Sense modalities A means of sensing a stimulus, such as via the visual or auditory systems

Sensory-motor engagement Engagement with the real world via sensory systems and physical movement

Virtual courtrooms A courtroom configured solely via internet technologies

Web conferencing An online tool or service for holding live meetings, conferences or presentations, typically over a TCP/IP connection

Webinars A form of presentation, workshop, lecture or seminar transmitted over the web via video conferencing software

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With a specialism in innovations in learning spaces, he has contributed to the design of key recent space developments at City, including a flagship lecture theatre, a suite of collaborative PC labs, and a bespoke space for teaching Artificial Intelligence. Dominic led the introduction of wireless collaboration technologies to City, enabling academics to wirelessly display content from a mobile device in specialist Engineering labs, and is co-managing an initiative to incorporate this functionality into all of City's learning spaces. His interest in holographic telepresence stems from investigations into bringing remote expert speakers into live classes. He is a regular speaker at educational technology events and conferences.

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Chapter 14
Computational Thinking and Coding Across Content Areas to Develop Digital Skills

Valerie Taylor, Rebecca Tilhou and Helen Crompton

Abstract Educational technology skills and practices are becoming increasingly prominent in schools around the world as the integration of computer science strands, such as computational thinking and coding, are being introduced into curricula. Educational leaders and teachers should integrate computational thinking and digital skills into activities in all disciplines spanning grades K-12. Students who learn coding and computational thinking skills are better equipped to apply problem-solving skills to analyzing data, recognize patterns, and make connections between what they already know and the problems they face. This chapter supports practitioners, policymakers, researchers and funders by examining the definitions of computational thinking and coding and their relationship to project-based and inquiry-based learning, as well as the ways in which computational thinking and coding are currently employed across the content areas. Concrete resources are provided as support for educators of all ages and disciplines looking to incorporate coding and computational thinking skills into their lesson plans.

Keywords Coding · Computational thinking · Computer science · Decomposition · Problem-based learning

14.1 Introduction

Educational technology skills and practices are becoming increasingly prominent in primary and secondary schools worldwide as computer science standards, such as computational thinking and coding, are being integrated into curricula (García-Peñalvo et al. 2016). Countries such as England and Finland have policies for computer science integration already in place (Williams 2017). The United Kingdom, for example, now requires every student learn to code beginning at age five. By the age of 11 years old, students need to be able to demonstrate knowledge of at least

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two programming languages (Vickory 2016). Similarly, in the United States, government leaders in various states are signing legislation making computer science a core academic requirement for all grades. As the demand grows for computational thinking as a twenty-first century skill, educators need to be prepared to incorporate computer science standards into their daily teaching.

The goal of computer science education is to build a detailed understanding of the study of computers and how they work, algorithmic processes, problem decomposition, and data analysis (Next Generation Science Standards 2018; Vickory 2016; Williams 2017). Integral components of computer science curricula also include hardware and software designs, applications, and the impact computer science has on society in the twenty-first century (Virginia Department of Education 2018; Vickory 2016).

There is increased pressure for educators to integrate digital skills and computer science strands into school curricula to help them understand the tools needed to thrive in the digital world. The widely-adopted Common Core Standards (CCSSI 2019) and Next Generation Science Standards (2018) emphasize technology through creative integration and performance tasks. As a result, classroom teachers are being tasked with understanding newly introduced computer science standards while facing the challenge of strategically integrating computational thinking and coding into K-12 settings (Williams 2017). For many educators, this is an area that they feel underprepared to incorporate in meaningful ways. This chapter supports practitioners, policymakers, researchers and funders by examining (a) the definitions of computational thinking and coding and their relationship to project-based and inquiry-based learning, (b) how computational thinking and coding is currently employed across the content areas, and (c) resources available to help teachers and students better understand coding and computational thinking skills.

14.2 Digital Skills

Digital skills, such as learning to code and computational thinking, contribute to the learning processes and construction of knowledge in today's students (Kolb 2017). These skills promote students' ability to develop solutions to situations in their daily lives while fostering competence for collaboration with and without technology (García-Peñalvo et al. 2016). Classroom teachers may find that computing and the use of technology to create artifacts can be a fun and creative way to reach students and teach content across the disciplines (Mishra et al. 2013). Digital technology changes how readers and writers interact with material, which increases the need to learn new skills that will enable students to engage with continually evolving forms of text (Coiro et al. 2008).

14.2.1 Computational Thinking

Computational thinking is defined as a “thought process involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent” (Wing 2006, p. 1). Computational thinkers solve open-ended problems and make connections with other content areas through the use of skills such as sequencing and logic (ISTE 2018). Students who engage in computational thinking make connections between what they already know and the problem they face (Strawhacker et al. 2017). The process of computational thinking uses computers or other digital tools to formulate and solve problems through algorithmic thinking—the planning, design, and implementation of a sequential procedure that will lead to what the algorithm can do (Lockwood et al. 2016). Furthermore, computational thinking organizes, analyzes, and represents data through abstractions such as models and simulations, and uses efficient and effective steps to reach goals in a wide variety of situations (CSTA and ISTE 2011).

Students who practice computational thinking learn to reason with creativity and expression in innovative ways that demonstrate mathematical processes and content knowledge (ISTE 2018). Indeed, students who are taught computational thinking are better prepared to keep up with evolving trends seen in the professional world (Weintrop et al. 2015). Computational thinking is not only essential to the development of computer applications, but it can be used across all disciplines. From math and science to the humanities, computational thinking not only helps students make connections between disciplines, but also in their daily lives (Gallup Inc. 2016).

14.2.2 Coding

Many schools are redesigning curricula to meet the changing needs of their students and are focusing on coding as a literacy (Freeman et al. 2017). Coding is defined as:

> a list of rules, written in one of numerous programming languages, that instruct a computer to do what a user wants it to do: perform a sequence of instructions, repeat a sequence of instructions a prescribed number of times, and test whether a sequence was performed correctly. (Freeman et al. 2017, p. 11)

In this chapter, the terms coding and programming are used interchangeably, although coding differs from the broader term of “programming” where one creates things, develops logic, and analyzes a problem. Writing code is just one aspect of computer programming, but they are often used synonymously among educators (Khillar 2018).

Coding aligns with constructionist and constructivist learning theories. Seymour Papert’s developmental learning theory of constructionism has influenced the way educational tools, such as coding, are used today. Constructionism can be applied to digital environments that allow the child-directed construction of skills and artifacts (Blikstein 2013). Inquiry-based processes facilitate the creation of artifacts and/or experiences that build on prior knowledge. Inquiry enhances learning and promotes cognitive growth, supporting a constructionist approach to education (Kurti et al. 2014; Piaget 2013). When students are able to design their own solutions to real-world challenges or problems, they feel invested in what they are doing.

The inclusion of coding across the disciplines encourages students to create and experiment. Pedagogically, this supports Mishra and Koehler's (2006) Technological Pedagogical and Content Knowledge (TPACK) model. The TPACK model aims to effectively implement technology into students' learning processes through the appropriate melding of technology, pedagogy, and content knowledge (Freeman et al., 2017; Mishra and Koehler 2006). The model's framework facilitates the creation of cohesively designed learning activities, where pedagogical strategies, materials, and software teach content in an innovative and effective way. The integration of coding is much more than plugging a software or application into a lesson, rather it can be a fundamental component for teaching content at deeper levels (ISTE 2018).

14.3 Computational Thinking in Content Areas

Computational thinking in education helps build problem-solving skills that can be used in all disciplines (Lockwood and Mooney 2018). With computational thinking, students develop and understand the practices and attitudes needed to find and understand information for real-world issues (Strawhacker et al. 2017). Computational ideas should not just be taught in computer science classes (Barr and Stephenson 2011). While STEM education and computer science requirements for K-12 students are more easily aligned, integration into all disciplines is essential for learning valuable twenty-first-century skills (National Science Foundation n.d.). Educators at every level, from every discipline must have a basic understanding of computational thinking in order to fully implement pedagogical strategies that teach these skills.

Computational thinking is a fundamental, cross-curricular skill that helps students develop the tools necessary to formulate and solve a problem (Blikstein 2013; Wing 2006). Computational thinking is the ability to (a) think about a problem or process in terms of its parts; (b) create steps to solve a problem and confirm its solution fits the purpose; (c) make a problem seem simpler without losing its complexity; and (d) apply prior knowledge and experience to new problems in other areas (Curzon et al. 2014). Those who practice and develop the skill can employ computational concepts and ideas across disciplines and in all aspects of their lives (Brennan et al. 2018). Computational thinking helps support students' knowledge of society and the impact that computing has on it (ISTE 2018) while developing students' digital literacy skills, or the ability to find, understand, create, and share content (García-Peñalvo et al. 2016). Although computational thinking does not always need to involve the use of digital tools, students who engage in computational thinking develop the skills needed to work digitally. These skills include gathering and analyzing data needed to solve problems, which promotes students' deeper understanding of the world around them (Weintrop et al. 2015).

Educators wanting to add computational thinking practices into their daily instruction may find that they are already utilizing many of the same strategies that they use when incorporating problem-based learning (PBL). PBL is one of the most widely-used instructional methods today. It is a valuable tool that helps students learns the necessary skills to solve real-life problems (Hmelo-Silver 2004). This pedagogical approach is effective with a wide range of populations and allows students to develop self-directed and problem-solving skills that can be used in an effective manner (Hung et al. 2008). With ties to inquiry-based learning where students develop their own questions to answer (Wolpert-Gawron 2016), PBL's student-centered approach poses important, contextualized, real-world problems while providing guidance, resources, and opportunities for reflection to students. PBL allows students to simultaneously develop content knowledge and problem-solving skills throughout the process (Hoffman and Ritchie 1997, p. 97). Congruent to computational thinking, students who participate in problem-based pedagogies learn through facilitated problem-solving that focuses on issues that do not have a definite answer and require set steps to solve (Hmelo-Silver 2004). Students who engage in computational thinking and PBL work both individually and collaboratively to identify resources needed to solve the problem, reflect on what was learned, and effectively communicate solutions (Hmelo-Silver 2004).

Educators across content areas may be surprised to see that students are already engaging in computational thinking in many ways. Recent research from the computer science community found that students at every level can engage in computational thinking across disciplines (Barr and Stephenson 2011; Weintrop et al. 2015). Core computational thinking concepts and capabilities may be demonstrated in the classroom as a written outline for a story, the order of operations in a math problem, a reenactment of a book or historical situation, a simulation of the solar system's movement, or a depiction of peoples' migration patterns (Barr and Stephenson 2011).

Likewise, analyzing patterns and developing appropriate steps used to solve problems, or algorithmic thinking, is an aspect of computational thinking that can be easily integrated in K-12 classrooms spanning the disciplines (Houseal et al. 2016). Cross-curricular connections supported by the Next Generation Science Standards, for example, can be made by looking at the content, unifying themes, and scientific processes (NGSS 2018). Teachers who embrace this method of thinking, encourage students in all areas to ask questions, develop models, evaluate information, and find patterns within information provided. They encourage their students to draw conclusions, reflect on the process used, and reiteratively critique and revise their work (Williams 2017).

Creative thinking and the ability to work in cooperative groups support computational thinking that can be introduced at an early age in all content areas (DeSchryver and Yadav 2015; Doleck et al. 2017). Engaging students to be active, social learners through specific pedagogical practices helps students make positive educational gains (Kolb 2017). Similarly, co-use or co-engagement with digital tools can be used in creative, cross-curricular ways (Darling-Hammond et al. 2008). Examples include having students work together to engage in reading and writing practices through multimodal texts or using Google Docs to collect, assess, and organize data as a group. In the same manner, creative thinking may also be used to introduce collaborative problem-solving in classroom coding environments or networking systems (Doleck et al. 2017). The process of computational thinking starts before any coding can occur and should be taught with the same importance as reading and math (ISTE 2018; Wing 2006).

14.4 Coding in the Content Areas

Computer science is not only the exploration of computer design but also how computers can be used to create sequential instructions that direct the computer to do specific tasks. Computer programming, or coding, is a way to create software, apps, websites, electronics, and games, and it is used to manage large databases of information (Gallup Inc. 2016, p. 12). Educational programming environments make the teaching of computational thinking practical at every grade level and in every discipline. For the youngest students, computer science education may simply mean learning how to use a computer. However, coding at this age may be taught through easy to use software and graphics (Israel et al. 2015).

Computational thinking is a key element when teaching students to code. Coding helps students see their computational thinking skills in action and get immediate feedback (Williams 2017). The addition of coding in the sciences and humanities helps students develop problem-solving skills, encourages collaboration, and engages students through its link to gaming, robotics, and animation. Benefits of coding include the creation of steps and visual representations, the ability to be creative without worrying about making mistakes, and collaboration and communication skills (Williams 2017). This student-centered, PBL approach to learning helps students connect their thoughts with real-world issues to develop a deeper understanding, becoming a driving force behind student success (Freeman et al. 2017; Hu 2011). It is critical that students start coding in elementary grades.

Recent research in the area of computer science education has found that teachers in every grade level are successfully integrating coding into their daily lessons to help teach digital skills and discipline-specific content (Strawhacker et al. 2017). Many consider computer programming an important competence for the development of higher-order thinking skills in students as young as kindergarten when it is easier to learn languages since learning to code is similar to learning a language (Fessakis et al. 2013; García-Peñalvo et al. 2016). The Scratch Jr. programming environment, for example, is used in primary classrooms across the United States in several ways. Teachers may use Scratch Jr "Solve It" assessments to identify student understanding about programming using basic coding skills outlined in computer science standards (Strawhacker et al. 2017). Other teachers may use Scratch, Scratch Jr. or other visual block programming languages to teach spelling patterns or the life cycle of a plant using algorithms (Williams 2017).

Students who engaged in coding and computer programming benefit from being able to put their thoughts down, see the results in real time, and reflect on the outcomes to make improvements (Fessakis et al. 2013; Williams 2017). The implementation of whole-group coding activities on an interactive white board (IWB) can be used to facilitate the development of algorithmic reasoning and problem-solving skills in students as young as kindergarten (Fessakis et al. 2013). These activities teach necessary communication, collaboration, and digital skills, as well as specific content skills (Fessakis et al. 2013). In addition, students who continually see and hear teacher's model computational thinking and coding language are better able to understand and make applications to different areas (Hunsaker n.d.).

The cross-curricular integration of coding in all grades through appropriately designed learning activities, pedagogical strategies, materials, and software is an effective way to teach content (Strawhacker et al. 2017; Williams 2017). In fact, the inclusion of coding in English language arts middle school classrooms has proven to be a successful (Barr and Stephenson 2011). Studies have been conducted looking for the overlap between programming and writing/storytelling with middle school students to help expand literacies across the curricula (Burke 2012). The focus of one such study was to set up an environment where the traditional Writer's Workshop model was used in conjunction with coding using Scratch programming to teach a digital composition. Using existing language arts content and pedagogy, computer science was integrated to facilitate the production of students' writing at every stage of composition (prewriting to publishing). Results showed that the addition of coding to existing standards and pedagogy created an effective framework for teaching digital composition, as well as a connection between the processes of coding and writing (Burke 2012).

14.5 Practical Ideas for the K-12 Classroom

Student understanding of technology should go deeper than basic skills such as typing and exploring websites. Students need to understand digital environments and how to create and share content with others. They must develop the knowledge needed to gather data and recognize and analyze patterns in order to be successful in the future (Freeman et al. 2017). Instructional benefits for students who have had exposure to computer science programs include building high-order thinking skills and experience, increased collaboration, and positive attitudes about computer science. Computer science programs also help students understand how to apply mathematical concepts to solve real-world problems (Israel et al. 2015). The integration of technology and digital skills, however, must be strategic, taking into account the interconnected system of teaching and learning. Teacher training, access, and technical support are essential components for effective integration of technology (Crompton 2017).

With formal training and technical support not always readily available, there are user-friendly resources that teachers can access independently, many of which are free of cost. These resources, such as Scratch, promote the idea that all students should have the opportunity to learn coding and provide information and lessons

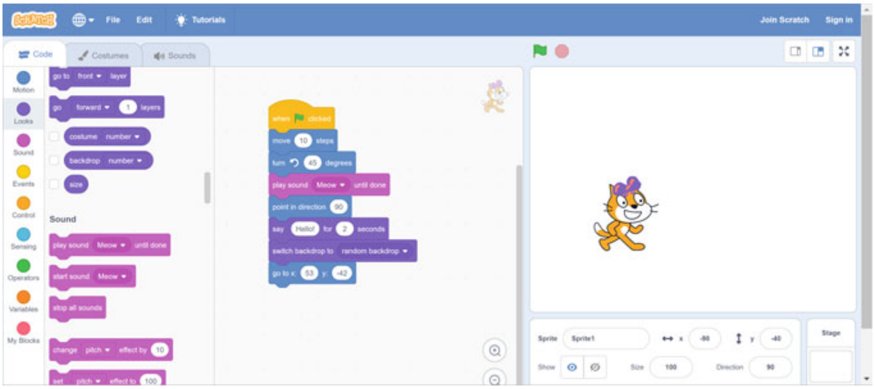

Fig. 14.1 Scratch programming "Getting Started" basic programming screen

to both teachers and students (Brennan et al. 2018). Scratch is an online programming environment launched in 2007 that helps students learns basic programming concepts. This program is unique because it allows users to share their own digital media through commands of block code stacked together to create coding scripts (Burke 2012). Students as young as elementary school may use Scratch programming to learn skills associated with understanding patterns and algorithms (Lye and Koh 2018). Scratch not only helps students understand concepts that can be transferred from one discipline to another, but may also help teachers identify the best ways to plan lessons on programming and coding (Fig. 14.1).

In conjunction with Scratch, Creative Computing applies a computational thinking framework utilizing the Scratch online programming environment. Creative Computing was developed by educators at Harvard University to help foster student computational thinking and coding skills (Computational Thinking with Scratch n.d.). Educators wishing to expand student knowledge and engagement with coding are even able to start a program for students outside of the classroom. This resource is free to download and can be used in K-12 settings.

Educators interested in learning more about computational thinking and coding may also explore free, user-friendly websites for information. One such site is Code.org, a nonprofit industry in the United States that works to teach computer science skills to K-12 students and educators with a focus on providing free lessons and resources to underrepresented populations. Code.org was founded on the belief that everyone can and should learn to code. Educator training and student resources are provided digitally on their website in over 50 languages and in person at different locations around the world. Another free coding resources is Club Code International (2018). This resource for educators of nine to 13-year-olds provides resources, project ideas, and online training for those willing to join. This resource has more than 12,000 active clubs and can be used to foster collaboration and creativity with peers around the globe.

Resources also include tutorials for teachers, such as with "Computational Thinking for Educators" (CTE). This user-friendly course is broken down into five units including Exploring Algorithms and Finding Patterns. CTE aims to help educators gain a better understanding of computational thinking and offers ways to integrate digital skills into their lessons. The program is self-paced and geared toward educators in a content area (CTE n.d.). Those who feel ready to integrate these skills into their curriculum but are not sure where to begin may also consult sites such as CAS Barefoot's Computational Thinking page, Wonder Workshop's Code to Learn Lesson Library, and ISTE's CT Vocabulary and Progression Chart for lesson plan ideas broken down by age, grade level, and discipline (Hunsaker n.d.). Each of these resources is specially geared to assist teachers with successful implementation of computational thinking and coding in their K-12 classrooms.

14.6 Conclusion

Students worldwide are studying the components of coding and computational thinking as schools are increasingly including elements of computer science into the curricula. The International Society for Technology in Education (ISTE) (2018) explains:

> Coding goes beyond websites and software—it's an essential component in finding solutions to everyday problems. Computational thinking has many applications beyond the computer lab or math class—it teaches reasoning, creativity and expression, and is an innovative way to demonstrate content knowledge and see mathematical processes in action.

Students who learn coding and computational thinking develop the understanding that there are multiple ways to solve problems and there is flexibility in answers and solutions. Educational leaders and teachers should integrate computational thinking skills and digital tools into activities in all disciplines spanning grades K-12 because it is cross-disciplinary in nature (Deschryver and Yadav 2015).

All subjects at this level blend together in one learning environment conducive to teaching these critical skills (Hunsaker n.d.). Classroom teachers can engage students in a multitude of ways that encourage exploration, creativity, collaboration, and reflection as they work to solve problems and make connections between computing and their own lives outside of school (Israel et al. 2015). Computational thinking and coding resources are accessible to every twenty-first-century teacher and learner in the form of free, web-based classes, frameworks, guides, and activities. This chapter provides information to support those unfamiliar with computational thinking and/or coding, and who may lack experience implementing these computer science skills to teach disciplinary content and digital skills.

As new knowledge and resources contribute to the teaching and learning of educational technology skills and practices in K-12 education, the next generation of students will be prepared to be leaders of computational thinking and coding in a digital age.

Glossary of Terms

Abstractions The process of ignoring or hiding complicated details that are not needed to focus on the ones that are needed

Algorithmic thinking The process of getting to a solution through the use of clear, thought-out steps

Coding The computer language used to develop apps and software; the initial steps of computer programming

Computational thinking A problem-solving process that encourages learners to think logically and identify, analyze, and represent data in a manner that can be applied to a variety of situations

Computer science Technology and the skills and process associated with it and their impact on society

Constructionism A learning theory that advocates student-centered and discovery learning where the student creates knowledge through play, testing, and exploration

Problem decomposition The breaking down of complex problems into smaller, more manageable problems

Problem-based learning A learning method that promotes the use of real-world problems to teach learning concepts and principles such as critical thinking, problem-solving, collaboration, and communication

Programming The creation of representations for solutions using a computer language so that the solution can be carried out by a computer

Inquiry-based learning A form of active learning that triggers curiosity and problem-solving to create knowledge

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Chapter 15
Augmented Strategies for Mobile and Ubiquitous Learning Technologies

Abdelwahed Elsafi

Abstract Today's students are growing up in a world where technologies are becoming a natural part of their life. Continuing advances in emerging technologies such as mobile devices, give students more control to access digital learning contents and sharing knowledge. A mobile device such as smartphones is considered a great tool to be used for learning, it provides learners a new opportunity for interaction with peers, teachers, and tutors, and improve learning environments for more creativity and engagements. Additionally, wireless learning devices can be used to help students learn and develop twenty-first-century skills (e.g., critical thinking, collaboration, communication, social skills, and leadership, etc.). Each one of these reported skills has always been necessary to be acquired for helping students to keep up with unprecedented global changes to enable them to participate actively in a rapidly changing society. However, the integration of mobile devices into the learning process is becoming more important than ever. On the other hand, the growing rapid globalized changing conditions have made a huge paradigm shift in school systems face-to-face classroom to more convenient and seamless learning, where learning could be accessible at any time and anywhere. Thus, school systems globally have additional burdens that require them to work under increasing pressure for preparing the younger generation to become active and contribute better in their future careers. In particular, school's responsibility is to work for cultivating desired skills which enable students to succeed and sustaining success in modern work environments as well as overcoming challenges that expected to encounter in digital societies. These changing conditions have been encouraged researchers to investigate effective learning strategies to leverage ubiquitous and mobile technologies for increasing student's motivation and promote their levels of attention and engagement. Moreover, precisely researchers have focused to examine the impact of implementing strategies supplemented with technology tools in scenario-based learning environment on students learning and performance, which is embedded multiple stages including guidance, technique and train students to perform learning activities under specific environmental conditions. The aim of this chapter is to discuss effective

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learning approaches based mobile devices that have been implemented inside the classroom and beyond, regardless of subjects area. This chapter investigates a variety of studies in the light of more recent innovative and best practices of augmented learner-centered strategies using for creating knowledge in mobile and ubiquitous learning events. The chapter offers to understand the popular feature of core aspects of wireless communication technology facilitating teaching and learning practice, affordances of mobile and ubiquitous technologies that benefit a variety of learning aspects, and what teachers do when using these latest emerging technologies for teaching. Considering the impact of emerging technology is changing the way teacher teach and the student learns, lead to think of new pedagogy; however, the chapter draws attention to the challenges of determining appropriate pedagogy to align with rapidly emerging technologies. Suggestions and main ideas that conclude with current issues for future research are provided.

Keywords Mobile learning · Ubiquitous learning · Wireless technologies · Learning strategies · Technology adoption

15.1 Introduction

With the rapid growth of emerging learning technologies such as Information and Communication Technologies (ICTs), E-learning, Virtual Reality (VR), Augmented Reality (AR) mobile devices and Internet of Things (IoT), etc., great opportunities are coming to truly enhance education experiences (Dávideková et al. 2017; Qi et al. 2017; Wu et al. 2013). Digital learning technologies are used to access information, open up new ways of learning and widen opportunities for communication, collaboration, participation and knowledge acquisition (Elsafi 2018).

In particular, mobile and ubiquitous learning have become pervasive and widely used to deliver education for individuals, communities, and regions without any constraints surrounding distance or separation (Ally et al. 2014). Educators, however, have opportunities to utilize the potentials of mobile devices and integrate them into teaching and learning practices and therefore to enhance students learning. In addition, mobile devices embedded wireless communication and sensing technologies such as Radio Frequency Identification (RFID), a Global Positioning System (GPS), and a Quick Response (QR) code have been made a huge paradigm shift from the traditional face-to-face classroom with limited resources and teacher-centered approach to more seamless learning, where learning could happen any time anywhere. Specifically, sensing and wireless communication technologies have also made a contribution to learning by offering guidance to the location-based learning, detect user information and provide convenient access to the digital learning content (Hwang et al. 2008). However, the benefits can be tailored to different learning contexts to enrich learning environments, meet the different needs of students, and provide meaningful learning experiences. Furthermore, with affordances of mobile technologies learners have gained tangible benefits to work with a flexible and interactive learning environment combines real-world and digital resources, so that, it becomes possible for educators, or instructional designers to provide and deliver learners educational content accessed by mobile devices regardless of the time and location (Ally and Prieto-Blázquez 2014).

While mobile and ubiquitous learning is still a growing research area, aspects of incorporating augmented learning methods or innovation new learning approaches to more fully leverage the potentials of these technologies in different subject areas by integration of sensing and wireless communication are becoming a more important and critical issue for educators (Geer et al. 2015). Therefore, eliciting an appropriate existing pedagogy to cope up with embedded features of mobile devices or innovative new approaches to accomplish desired learning tasks can offer seamless integration of learning technologies to power learners in different kinds of activities (Chen et al. 2015).

In this sense, the learner has to be encouraged to use learning technology tools that can promote new experiences and develop individuals and collaboration skills (Sampaio and Almeida 2015). In such conditions, the intended learning subject should be focused to harness affordances of mobile learning technologies on the practical uses of existing resources in an experimental way through effective learning scenario that quietly promote learner's interaction and increase motivation. Subsequently, educators being aware of strategically and efficiency incorporate augmented learning approaches based mobile and ubiquitous learning technologies in a variety of learning environments have gained highly significant (Chen et al. 2015). These circumstances have been lead to reach the ultimate benefits of mobile technology for learning purposes by harnessing its features to guide learners to a more effective, convenient, and successful learning experience (Mac Callum et al. 2014).

This chapter provides an overview of the core aspects of mobile and ubiquitous learning and its affordances to facilitate the teaching and learning practice. The author also emphasizes to examine some of empirical studies of mobile and ubiquitous learning incorporated different strategies to benefit students learning in a variety of subject area. Followed by a brief summary of key challenges overcome the adoption of learning technology into teaching practice as well as the conclusion of main ideas with current issues and future direction of emerging technology.

15.2 Core Aspects of Mobile and Ubiquitous Learning

Recently, researchers have made a lot of discourse about ubiquitous learning as one of the latest emerging learning technologies and the necessity for developing appropriate and effective pedagogical approaches to leverage its potentials, in which methods could incorporate to facilitate practice and lead to improve students critical thinking, problem-solving and collaboration skills (Jagušt et al. 2018; Suárez et al. 2018). Chiang et al. (2014) emphasized, students need to encourage using mobile learning tools to improve performance, develop intellectual skills and increase achievement in different subject areas.

Its obvious that the most important issue educators and practitioners should take it into consideration is traditional learning methods to the design and transfer of learning are being challenged and may no longer be appropriate to meet the modern school styles and younger generation needs, expectations, and diversities. Therefore, developing and incorporating new pedagogical approaches to align with wireless learning devices are needed. Specifically to reach optimal benefits of mobile and ubiquitous learning technologies to help students make progress in a different learning context.

The crucial features of ubiquitous learning technologies to effectively assist in blurring the gap between formal and informal learning and developing students learning in a variety of aspects have realized from the positive impact of wireless communication technology in different subject areas combined digital and authentic environments. For example, Hwang et al. (2010) asserted, the phenomenon of wireless technology enables learners to seamlessly utilize huge amounts and various kinds of "functional objects" anytime and anywhere through network connections.

It implies a ubiquitous technology-equipped system could supply users or learners with timely information and relevant services by automatically sensing their environment and various context data, then the system smartly generates proper results to provide appropriate services (Mottus et al. 2018). Thus, unique features to distinguish ubiquitous learning technologies from other old learning technologies were the wireless communication objects which embedded with sensors technologies (e.g., RFID, GPS, and a QR code) could detect users preferences and a surrounding environment to provide personalized services. Furthermore, these functions make learning more ubiquity, because of the distribution of resources and activities across time and space. Hwang et al. (2010) emphasize, for better beneficial from wireless and sensing technologies, the system can build into the other things, for example, objects placed around a learning environment and allow learners to interact with them. The interactive learning environment supported by (Smartphones, tablets, PDA, etc.) and embedded wireless technologies can provide learners with digital content accessed by mobile devices to learn in an authentic learning context. In ubiquitous learning technologies, the learning device candidates to be more useful to support teaching and learning practices is the smartphones because of its popularity and mobility (Chen et al. 2015). Such learning devices are deemed great educational tools with technological affordances to support daily teaching and learning activities and truly can facilitate students learning and prepare them beyond twenty-first-century skills. However, utilizing the potentials of mobile learning technologies students can easily access the digital learning content to learn and interact with peers and tutors.

15.3 Affordances of Mobile and Ubiquitous Learning

Mobile and ubiquitous learning technologies have unprecedented affordances to provide learners support into a variety of learning activities take place in multiple learning environments and without being restricted by space and time. In general, the potentials of mobile and ubiquitous learning have the capacity to enhance, enrich and facilitate accessing people in disadvantaged socioeconomic areas, people in places isolated because of natural disasters (e.g., flood, earth shake) and those who had tribal conflicts or civil wars (Ally 2004). The experts in the mobile learning field such as (Ally 2004; Traxler 2016) have summarized and listed several affordances of mobile and ubiquitous learning in the following points:

Contingent teaching and learning: To contingent teaching, teachers are utilizing several functions of mobile learning (e.g., access to online resources) to support the processes of teaching practice. Additionally, the system (sensing technologies of mobile devices) will help to determine and being responsive to the current level of the student, so that the teachers could adopt a strategy in the light of students learning situations. In this sense, both teachers and learners can react positively and respond to learning environments, however, they can utilize several benefits from using mobile devices to achieve teaching and learning purposes.

Authentic learning: Mobile devices have potentials to help students learning and solve-problem from a real-life situation. Also, the devices can assist to engage in a series of learning activities combine real word and digital learning resources. Furthermore, mobile devices offer students the possibility to discuss, explore, share ideas and construct their own knowledge from a real learning environment, therefore, students can experience meaningful learning. This will give students an opportunity to practice skills and create actual knowledge relevant to the workplace situation.

Situated learning: Situated learning is a matter of enabling students to create meaning from activities takes place in multiple learning environments of daily living. In this case, students can have an opportunity to be situated in a real learning environment, then the mobile learning system or tools will provide them guidance into the learning objects. Examples of such learning environments are including, (workplace, museum, zoo, field trip, etc.). Additionally, students can utilize several functions embedded with mobile devices (Camera, video, GPS, QR code) to support the achievement of learning tasks. Therefore, learners can have the opportunity to learn from a real interactive learning situation. This situation will help to actively participate in unfamiliar learning environments, practice several learning events in which students involved in real-world activities which replicate actual work settings to make sense of meaningful learning (Catalano 2015).

Augmented reality of mobile learning: Augmented Reality (AR) technology is providing users with the possibility to combine real life sensory with digital environments. In a mobile AR, the technology integrates digital data into the real environment to provide users with an immersive sensory experience. Therefore, mobile AR offers educators to integrate digital data into the real environment to provide learners with an immersive sensory experience for making deep and meaningful learning by comprises a real-world environment (Ibáñez and Delgado-Kloos 2018).

Context-aware and personalized learning: In addition to make learning accessible anywhere and any time with mobile devices, the devices embedded wireless communication and technologies sensors have functions to recognize, perceive and being aware to the context of the real world and that will support the intended context-aware learning environment. Using sensing technologies such as GPS the location of learners and information can be aware and combined with learners' profiles, learning styles and learners' level of knowledge. Indeed the QR code and RFID helped to identify the real-life objects to support learning activities related to the learning environment. Thus, mobile devices have full capabilities of being aware of learners' location. Once the location has well known, mobile wireless communication or sensors could detect environments and however, provide learners learning based on their characteristics, preferences, interests, and diversities.

Collaborative learning: The mobility of wireless learning devices brings new opportunities for learning by utilizing numerous functions of these devices to support collaborative learning.

The mobile device has capabilities to connect learners and support learning activities via social interaction and develops a relationship and enhances motivation and discussion. Therefore, learners can work together and engage in meaningful tasks.

Informal learning: In addition to a variety of mobile and ubiquitous learning applications, the features of wireless and sensing technology have affordances to support informal learning that occurs away from structured learning. Wireless communication technologies such as GPS, QR code and RFID have the capability to detect learners and locate learning environments. Therefore, this will help to take learning activities out of organized and structured learning.

Recommended system: Recommended system is becoming available with using mobile learning. The systems can serve in a variety of aspects to support learners. For example, the system can produce a list of recommendations based on learners' behaviors, then it will detect their preferences, interests and provides them with an appropriate learning style.

Educate all age groups: One of the major advantages of mobile learning is that devices can be used to educate all age groups (younger's, adults, matures). In such conditions, learners at both formal and informal educational institutions including; schools, colleges, universities, workplaces can provide a digital learning content accessed by their mobile devices.

15.4 Augmented Strategies for Mobile and Ubiquitous Learning

To reach the optimal success in students learning achievements, motivation, and increase performance, educators need to efficiently incorporate student-centered learning approaches combined with affordances of mobile technologies. The researches have demonstrated mobile-based learning strategy can be tailored and appropriately incorporate to fit the desired learning goals in different subject areas. Therefore, educators should encourage students to strategically and successfully use mobile learning to promote new experiences (Sampaio and Almeida 2015). For better success, a specific subject area should emphasize on the practical uses of mobile technologies to benefit from existing digital resources in an experimental way based on a particular learning strategy to promote students' interaction and collaboration. This section of the chapter analyzes empirical students that provided evidence to effective learning approaches incorporated in a variety of ubiquitous and mobile learning environments.

15.5 Inquiry-Based Learning

Inquiry-based learning (IBL) referred to the process of learning which allows a student to experience a particular subject presented in a specific learning situation. It is deemed as teaching approach requires both educators and students to take responsibility for learning, instead of traditional-centered approaches require the educator to tell or inform students and provide them with what they need to succeed in learning. In IBL, the educator provides students with questions, ideas, and observation to objects learning placed in the intended learning environment then students require to engage collaboratively in which way that builds their knowledge through investigation and explanation (Stockdale et al. 2018).

In the context of mobile-influenced IBL, empirical studies have proven a variety of scenario-based mobile and ubiquitous learning environments. The findings have shown tangible benefits include the use of mobile learning technology to support IBL activities could enhance autonomous learning, motivation, performance, knowledge acquisition, develop multi-strategies use for problem-solving and increase outcomes (Suárez et al. 2018; Hwang et al. 2010). For example, Chiang et al. (2014) developed an augmented reality-based mobile learning approach and examined how the combined functions of AR and features of mobile devices such as (AR display, chat room, portfolio, image editing, GPS, Camera, etc.) could use in learning processes to support students inquiry-based learning activities when learning about a natural science subject. The study focused on examining the impact of the system on students learning achievements and motivation. The learning scenario based on Bruce and Bishop (2002) five-stages (ask, investigate, create, discuss and reflect) of the IBL method. The instructor provides students with background knowledge about the learning target (a unit on aquatic animals and plants) followed by a pre-test, then students engaged to conduct activities at the authentic learning environment. To verify the effectiveness of AR mobile inquiry-based learning approach, the researchers conducted learning activities in which the experimental group used the new approach with AR functions and the control group used conventional mobile IBL without AR functions to investigate the issues of the targeted unit. For example, water hyacinth is one of the unit sections, the instructor presents a film about characteristics of water hyacinth and then asks students to examine those characteristics based on information presented in the film and record their answer in mobile devices. After exploring relevant characteristics, the instructor allows them to discuss concepts of water hyacinth to relate ideas. After the basic concepts and characteristics of water hyacinth have understood, the instructor permits students to present other plants that are similar to water hyacinth in characteristics. The results yielded, the participants in the experimental group outperformed those in the control group in the learning achievement and motivation. Therefore, AR supplemented mobile IBL could promote students' motivation and increase learning outcomes. With the combination of AR functions and mobile technologies features, educators can incorporate the IBL approach to allow students to learn authentically through a series of inquiry-activities to create their own knowledge using AR-based mobile learning. Experienced digital technologies—influence IBL activities are also crucial for students to keep engaged in processes of solving a complex problem and cultivate skills of dependent learning.

Chang et al. (2016) examined the students' learning motivation and achievement in English as a Foreign Language subject through the processes of mobile inquiry-based learning activities. It permits students' active participation to engage in learning the culture of the Taiwan Confucius Temple and its architectural features through multiple modes of facilitating English Foreign Language communication (Chang et al. 2016). Therefore, students could learn about the (vocabulary and grammar) of Confucius culture by using a QR code to access the learning content in the authentic learning environment which facilitates English language knowledge acquisition. To provide evidence to the effectiveness of the inquiry-based mobile learning approach on learning achievement and motivation, students recruited to an equal two groups (the experimental group was supported with immediate feedback during an inquiry activity and the control group without). This learning approach allows students in the experimental group to increase their learning outcomes and develop a deep understanding. Furthermore, students can improve the ability to investigate the implication issues surrounding the Confucius cultural Temple.

15.6 Peer-to-Peer Learning

Peer-to-Peer (P2P) learning is students teaching other students, it considered an effective learning approach to promote students learning and achieve better learning outcome (Andrews and Manning 2016). Many benefits of P2P learning have reported, Slavin (2011), such as students feel more confident and comfortable when they are interacting with peers, the similar level of discussion provides students great understanding and develop communication, it is also considered a way for supporting individualized learning and more important is learners could share similar experiences and knowledge. Thus, it seems that P2P learning is an efficient way of sustaining students' interaction and motivation. Moreover, students in P2P learning are expected to take responsibility of their own learning and engage in discussion and debate to solve a problem, the teachers play the role of facilitator and provide students theme for discussion with a simple strategy.

With the proliferation of ubiquitous learning technology and its potentials that have proven to support student learning in a wide range, the issue of coping with effective learning strategies is likely to be more urgent and becoming ultimate goal of educators. Therefore, using mobile devices as educational tools to enhance instructional activities with adequate learning strategies is widely acknowledged (Hung et al. 2014a, b).

Lin et al. (2016) voiced the explanation processes of the system developed for fostering students' self-regulated learning in the blended learning environment by implemented P2P learning strategy. The learning system called (Self-Regulated Learning with Group Awareness and Peer Assistance—SRL-GAPA). The main features of the system are, therefore, students aware of their peers in term of learning activities are going to conduct, students allow to see other group work, seeking help to overcomes learning barriers as well as to motivate each other. However, students can learn collaboratively from computer course through computer-supported collaborative learning environments that support SRL via peer assistance. To verify the effects of the developed system on students SRL behaviors and learning achievements, Lin et al. (2016) divided student for two groups in which the experimental group used Self-Regulated Learning with Group Awareness and Peer Assistance—SRL-GAPA and the control group used Self-Regulated Learning without Group Awareness and Peer Assistance. The results have shown, the system not only fostered students SRL behaviors and learning achievements of the experimental group but also can offer them pedagogical strategy used for developing skills of SRL in different learning environments (Lin et al. 2016).

15.7 Problem-Based Learning

Problem-Based Learning (PBL) deemed as one of twenty-first-century learning competencies, and it helps to evaluate and interpret information (Kapur 2015). For learners to be more active and creative, successful PBL emphasizes effective participation, problem-solving, and critical-thinking skills to solve an authentic PBL environment (Smits et al. 2003). The increasing use of ubiquitous learning technologies and wireless communication in learning processes are opening up the doors for educators to innovate new approaches. The combination of real-world objects and digital resources has expanded opportunities for implementing ubiquitous technology-enhanced PBL activities. Incorporating strategies for problem-based mobile learning can benefit in a variety of learning aspects and develop student twenty-first-century learning skills including; technology literacy, creativity and innovation, complex problem solving and cultivating skills of independent learning (Smits et al. 2003).

An example of a problem-based ubiquitous learning environment is an empirical study involved to improve students questioning abilities (Hung et al. 2014a, b). The study investigated among experienced and novice groups to determine students' ability for raising questions about the learning content and activities which were designed and supported with ubiquitous problem-based learning system (UPBLS). A total of 43 students participated in the study and divided into experienced and novice groups. The learning activities took place in the field observation supported with an online discussion over a long period of time (seven months) to evaluate the changes in students questioning ability. To support the inquiry learning activity, the design of the system included three main functions; online discussion for sharing ideas and experiences, E-library to offers students relevant digital materials, and web-based visualized tools to enable the student to summarize their information from the observed learning field. The UPBLS could support three stages of PBL, (a) raising questions from the field observation, (b) rising questions through the discussion and (c) observation and raising scientific questions from analyzing results and solving problems. Therefore, during learning activities learners are engaged in field observation learning, gathering data, raising questions, discussing with peers and sharing outcomes. To evaluate students questioning abilities, a specific rubric was designed for this purpose. Hung et al. (2014a, b) have said UPBLS was a powerful learning platform because it helps experienced and novice groups of students in progress of raising questions, particularly participants in the experienced group. This learning approach supported with UPBLS can be applied for different levels of students so that it can make meaningful learning by developing student's ability to raise questions.

15.8 Collaborative Learning

Collaborative learning is one of the most active approaches to present learning as a social process takes place through interaction and communication (Erkens and Bodemer 2019). Two prerequisites are essential for collaborative learning (a) learners must be aware of their learning partners' knowledge, this will enhance the ability of knowledge exchange, and (b) more important learners need to stimulus their prior knowledge that is relevant to the given task (Erkens and Bodemer 2019). In mobile collaborative learning, Shadiev et al. (2017) articulate that context-aware collaborative mobile learning applications are useful for learners to improve sets of knowledge and skills-based location environments.

For example, Liu et al. (2018) examined the impact of a mobile-based collaborative learning system supported by context-aware tools and videos on improving student's English listening comprehension in a fitness center. To successfully complete collaborative learning activities, the teacher provides students with a QR code attached to the exercise machines for accessing videos and additional materials. In the process of learning activity each participant first asked to (a) go to the fitness center and scan a QR code attached to the machines for listing video-based materials, (b) working collaboratively and actively with peers in learning activities related to video contents and (c) answer series of questions and submit them to the system. In addition, Participants have given an opportunity to practice anywhere and at the fitness center to master their English listing comprehension. All group members (12 groups, each group has three members) asked to complete learning tasks by generating a new QR code. When the learning task is completed, the system notifies the member by showing a green light. Every member could scan the QR codes obtained from his teammate so that the system will show three green lights for each member.

Accordingly, the participants could thus move on to the next task. Such a learning system approach could help students to share their knowledge and work together in a collaborative manner (Liu et al. 2018). The result concludes the ubiquitous learning system combined with context-aware for improving student's comprehension English learning activities has shown many benefits such as improved students listing comprehension, increased interaction and cooperation. Furthermore, students use multiple listing strategies during engaging in conducting comprehensive learning activities (e.g., effective strategies, social strategies, and metacognitive strategies). This system allows students to collaboratively engage in language learning in the authentic learning environment and interact with groups and mobile devices.

Fakomogbon and Bolaji (2017) compared the academic performances of small groups of students in a mobile collaborative learning platform to study Chemistry subject. The students were worked with various treatment conditions depending upon different collaborative and non-collaborative learning styles. The collaborative learning styles include think-pair-share, reciprocal teaching, think aloud pair problem-solving, group grid, a group writing an assignment for collaborative learning style and non-collaborative. In measuring changes between pretest and posttest, they did, however, find that student's performances improved in the mobile collaborative learning platform, in particular, think-aloud pair problem-solving make significant progress than other groups. Fakomogbon and Bolaji (2017) concluded that collaborative learning through a ubiquitous learning environment allows students to become more active.

15.9 Key Challenges of Technology Adoption

In an era in which students are able to instantly access a variety of information via mobile devices and wireless technologies or gather together and work in real-time situated and virtual spaces, educators must break away from the traditional models of teaching and learning to move into more innovative and creative learning approaches. Despite, educators have made efforts to innovate a number of teaching and learning approaches to facilitate technology integration in a variety of learning contexts, there still some challenges remained with incorporating appropriate pedagogy to leverage wireless communication and ubiquitous learning technology. This because, emerging technologies such as mobile devices are not designed to use as educational tools and therefore, not surprisingly their adoption in schools or universities is likely to present some challenges. In summary, the inclusion of ubiquitous learning technology to benefit learning has faced some challenges including;

1. Educators lack of digital technology skills

The major challenges hinder digital technology adoption in teaching is the lack of teacher performance of digital technology skills and unwillingness to adopt them in their classroom practices. Educators need to develop wireless communication and digital learning tools skills. Furthermore, they need to know how to integrate such technologies into school culture in every subjects area, specifically in experimental ways. These efforts probably need to be implemented through ongoing systematic workshops and training with collaboration and discussion organized and guided by specialized scientific institutions.

2. Valid assessment patterns

The difficulties in determining appropriate and valid analysis patterns during the learning processes have remained. Particularly tasks combine formal and informal learning activities and those comprise authentic and virtual learning environments so that more efforts to develop valid and effective assessment technology tools for analyzing data gathered through processes of various learning environments are required.

3. Adaptability of the learning system

There is another problem associated with the adaptability of the ubiquitous learning system. The problem can occur when the system should instantly respond to provide desired learning services, for instance, adaptability for anywhere any time services, so that the system can have the capability to respond and handle the full range of expected learning challenges.

15.10 Conclusion and Future Direction

The inclusion of emerging technologies in an educational context, for instance, ubiquitous learning technologies open new opportunities to enhance learning, promote students motivation, increase academic performance and develop skills of social interaction (Mendoza et al. 2015). With these digital technologies, teachers also have great opportunities to come up with new innovative approaches in teaching practices, and therefore generate possible learning conditions in which students can overcome challenges and gain experiences (Sampaio and Almeida 2015). While the use of mobile technologies in teaching and learning alone without following any pedagogical approach, likely to be not useful to help student success in learning; however, the only way determines effects of mobile learning technology on students outcomes is how educators implement and integrate them into their teaching practices.

Overall this chapter provides an explanation for the affordances of mobile and ubiquitous learning and how wireless technologies could utilize to benefits student learning. Subsequently, the chapter also analyzes the literature reviews, particularly the empirical studies that have proven processes of effective strategies supported by mobile and ubiquitous learning technologies in different subject areas.

While some challenges of adopting ubiquitous technologies into teaching practice are related to the technologies themselves, educators essentially need to develop skills enabling them to integrate technologies into teaching methods. Further, educators must seek and emerge effective strategies to offer students more creative approaches to develop twenty-first-century skills such as critical thinking, complex problem solving and collaboration. More intervention studies of mobile learning and ubiquitous learning in a different context are required to implement in multiple learning environments; however, this will be useful to elicit and adopt an appropriate learning approach that can incorporate in similar mobile learning environments.

No doubt, in the near future, the learning will become more personalized, dynamic and open than ever before, these aspects can influence pedagogical practices. With the emergence concept of ubiquitous learning technologies as a vital and crucial paradigm for the future, the learning will be more outside than inside classrooms and traditional pedagogical approaches will expected to undergo drastic changes (Gros 2016). Therefore, by addressing these challenges, fundamental changes are likely to happen in learning pedagogy, and comprehensive educational models are also essential to facilitate technology adoption. The empirical studies that have proven in this chapter shown, there were effective pedagogical approaches can be incorporated successfully to support deeper and meaningful learning in a variety of learning environments include personalized and collaborative learning strategies, inquiry-based learning and informal learning. However, such pedagogical approaches can be applied to the similar learning context to utilize potentials of ubiquitous learning technology.

Glossary of Terms

UPBLS Ubiquitous Problem-Based Learning System
P2P Peer-to-Peer Learning
PBL Problem-Based Learning
IBL Inquiry-Based Learning
VR Virtual Reality
RFID Radio Frequency Identification
GPS Global Positioning System
QR Quick Response
IoT Internet of things is the network of devices and things such as tags, sensors and smartphones phones are able to connect, interact and exchange information

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Chapter 16
From Video-Conferencing to Holoportation and Haptics: How Emerging Technologies Can Enhance Presence in Online Education?

Chryssa Themelis and Julie-Ann Sime

Abstract Video-conferencing, if used effectively, can support learning and teaching in online and distance learning serving the human need to communicate, and to learn by watching, and interacting with teachers and learners from anywhere. The demand for a more human approach to online education drives technologists and software developers to investigate new ways of being present online while connected with others, thereby making the experience as real-life as possible. This chapter discusses the implications of using emerging synchronous technologies in online education and explains why educators need to develop their teaching practice and understand the role of presence in online teaching in Higher Education. Drawing on the Tele-Community of Inquiry model, embodied cognition and research into 'honest signals' we examine the potential of emerging technologies such as holoportation, holograms, and haptic devices used in augmented learning environments. Innovative examples from Higher Education are presented to illustrate creative ways in which emerging technologies are beginning to be used in teaching practice. Technological advances continue to increase the potential for how synchronous communication technologies can support and improve presence online and enhance virtual and real-time interactions in online education. As these technologies are still emerging there is a great need for further educational research and some directions are highlighted.

Keywords Distance education (DE) · Online education · Community of inquiry model (COI) · Tele-proximity theory · Transactional distance theory (TDT) · Holoportation · Holograms · Synchronous video communication (SVC) · Augmented reality (AR) · Avatars · Presence · Haptics

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16.1 Introduction

Distance and online learning are increasing in popularity in Higher Education Institutions as more and more people prefer to communicate, learn, work and socialize online. While teaching online is not new, increasing numbers of educators are becoming online educators as it has moved into the mainstream; however, technology continues to advance and offer new opportunities and challenges to educators. This chapter explores the implications of adopting these new technologies for the educator and outlines the importance of presence and why it must be considered when using synchronous communications technologies in online education.

Visual teaching strategies are promoted by online courses such as MOOCs (massive open online courses) and 'thinking on-screen' occurs in social media and vlogs, where visuals promote social interaction and discussion (Themelis and Sime 2017; Sime and Themelis 2018). Synchronous technologies (such as video-conferencing, holographic teleportation and avatars in 3D virtual environments) have the potential to enrich the 'feeling of presence', of 'being together' in real-time while physically separated. For example, experienced educators introduce video-conferencing into their online courses to increase their connection with students, especially distance students who may feel isolated or alienated from campus (Themeli 2013). The importance of concepts, such as transactional distance, 'being present online' and a 'sense of place', needs further exploration to understand the relevance of emerging technologies to online education. Online presence plays a key role for educators and students to build trust and create a 'stage' where people can interact synchronously and understand visual cues that have transformative power in dialogues and decision-making (Pentland 2008). To what extent can synchronous communications technologies support human communication in online education?

This chapter explores synchronous communications technologies in distance education, discussing relevant theory and teaching practice that illustrates the technologies available, from video-conferencing to holoportation and haptic devices. This contextualization process provides an overview of synchronous educational media which is uncharted. It also presents theoretical models and frameworks that may be useful for educators, researchers and instructional designers striving to design for learning and teaching in a networked world.

16.2 Transactional Distance Theory

Transactional distance theory is a well-known theoretical framework that refers to the closeness of the connections between participants in an online environment, and the degree to which the digital setting assists or hampers their ability to construct knowledge and facilitate understanding (Moore 1980). Moore's theory conceptualizes transactional distance as "a psychological and communications space to be crossed, a space of potential misunderstanding between the inputs of instructor and those of the learner" (Moore 1993, p. 22). The psychological aspect of distance is described by Wiener and Mehrabian (1968), as immediacy that could influence synchronous and asynchronous means of communication. Peters (1998) defined it as communication of mental distance. Transactional Distance Theory argues that the distance in online education is transactional and not solely spatial or temporal, it is seen as emotional and cognitive (Gorsky and Caspi 2005).

Jacquinot (1993) expressed the view that 'distance can be managed' in the field of distance education if the instructional design is carefully planned. Moore (1993) analyzed transactional distance in relation to the interactions that exist within instructional design. The core elements of transactional distance are dialogue, structure and learner's autonomy. The content of the course, the nature of the medium of delivery, the philosophy and emotional characteristics of teachers, and the learners' personalities have a direct effect on the quality of the dialogue, and the gap of transactional distance (Moore and Kearsley 1996; Aluko et al. 2011). Of course, critics highlight the need for further examination of the variables (dialogue, structure, and learner's autonomy) or potential sub-variables (Gorsky and Caspi 2005); and more empirical support for the theory (Goel et al. 2012).

What seems to be clear is that the interactive nature of the medium is a determinant of dialogue in the teaching-learning environment, and by manipulating the communications media, dialogue can be increased, and thus transactional distance may be reduced (Mueller 1997). Consequently, synchronous communications media can have an influential role by enhancing presence in online environments through improving dialogue and interaction and reducing transactional distance.

16.3 Tele-presence: The Sense of 'Being There'

Another concept that explores the distance among participants in online environments is tele-presence, or presence. There are many definitions of presence; presence is defined as an experience of 'being there' in a mediated environment (Minsky 1980). It has been used many times in discussion of virtual environments and avatars but also for real-time face-to-face communications. What tele-presence assumes about distance is that with effective technology, vividness, transparency and interactivity, it is possible to create a 'feeling of being there' (Haans and Ijsselsteijn 2012).

The International Society for Presence Research (2000, para. 3) uses the following definition:

> Presence (a shortened version of the term telepresence) is a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience. Except in the most extreme cases, the individual can indicate correctly that s/he is using the technology, but at 'some level' and to 'some degree', her/his perceptions overlook that knowledge and objects, events, entities, and environments are perceived as if the technology was not involved in the experience.

Another term that first appeared in the writings of Barbatsis (1999) is 'Hypermediated tele-presence' which refers to the sense-making aesthetics of digital media. 'Hypermediated tele-presence' entails sensory-rich online communication and interaction. Barbatsis created a contextual framework synthesizing a set of aesthetic principles relevant to hypermedia which addresses what communication scholars recognize as the 'sensory world' of mediated communication. In other words, hypermedia involves its participants in a particular kind of 'sensory world' (Shapiro and McDonald 1995; Barbatsis 1999). What seems to be of importance are the contextual media aesthetic characteristics of a medium, working uncritically and automatically, and relatively independently of literal content, to establish a framework for the cognitive and affective perception of a mediated event (Zettl 1999; Barbatsis 1999):

> Developed from the branch of aesthetics that deals with sense perceptions and how to influence them, it is concerned with such fundamental image elements as light, space, time-motion, and sound for the ways in which they structure perceptual or sensory experiences in a system of aesthetic fields. (Barbatsis 1999, p. 283)

What is of paramount importance is that the sense of being there, even when in an immersive space such as in virtual reality environment, triggers emotional and physical reactions to a situation even though someone is aware that the experience is not real:

> The whole point of presence is that it is the illusion of being there, notwithstanding that you know for sure that you are not. It is a perceptual but not a cognitive illusion, where the perceptual system, for example, identifies a threat (the precipice) and the brain-body system automatically and rapidly reacts (this is the safe thing to do), while the cognitive system relatively slowly catches up and concludes 'But I know that this isn't real'. But by then it is too late, the reactions have already occurred. (Slater 2018, p. 432)

So, whether the 'sense of presence' is real as in video-conferencing or illusionary, as in virtual reality, it is an immersive experience that satisfies the need to see faces and interact in a human or human-like manner with rich communication that includes visual cues, embodied reactions and 'honest signals' (Pentland 2008).

16.4 Honest Signals and Mirror Neurons

Pentland (2008) has carried out extensive research into non-linguistic communications and its importance in social behaviour, e.g. facial expressions, patterns of interaction, and levels of activity can signal interest and emotions.

In his research into human behaviour Pentland has examined the behaviour of individuals in organizations, examining sociometer data and observations of honest signals, i.e. unconscious or non-verbal communications. For example, body posture, gestures, and facial expressions which convey additional information that can provide a window into our real intentions, goals and values. This understanding of communication between people in the context of social networks shows that social signals can convey much more than language alone (Pentland 2008). Research into social psychology has shown that imitation plays a crucial role in creating empathy and neuro-science has discovered the physiological mechanism for this effect—mirror neurons (Iacoboni 2009). Neuro-mirroring facilitates social behaviour and our ability to understand other people.

Asynchronous communications that are restricted to text-based dialogue are not able to convey these unconscious signals although emojis can be seen as an attempt to fill this gap and communicate emotions. So, synchronous communications such as video-conferencing where part of the body is visible, typically head and shoulders, has an increased communicative power compared to asynchronous text-based communications. Facial expressions and hand gestures are conveyed along with non-verbal communications such as nodding or shaking of the head. This means that synchronous communications through holographic representations of the whole body in augmented reality, increases this power further so that the person appears to be present to the viewer and communications can occur in a more natural and human manner, complete with honest signals.

16.5 A 'Sense of Place'

Fayard (2006) questions the assumption that face-to-face is 'a natural and perfect state—being there', i.e. the assumption that when online participants are not co-located, they are in an imperfect state, and expect technology to reconstruct a perfect state. Fayard adopts theatrical metaphor theory which Goffman (1959, 1974) used to analyze human behaviour in social situations with its "notions of stage, performance, and roles to describe social interactions and presentation of self" (Fayard 2006, pp. 153–154). Fayard suggested that what is of utmost importance is the 'stage' of the social interaction where identities and processes perform. Moreover, people in video-mediated contexts adjust and evolve the well-established routines that they have developed for interaction in everyday communications to build a 'stage' for video interaction. The stage not only refers to a spatial frame of reference, but also refers to a shared social and cultural context, a "place" that participants collaboratively construct. The duality of the stage is emphasized in video-mediated settings. Being onstage, you are acting, talking or playing a role. Being backstage when you are 'onstage' (on camera) means that you are not an actor, but part of the audience (Fayard 2006). Therefore, educators supporting communications in video-mediated settings should be aware of the affordances of the medium and the construction of a shared social context that gives a 'sense of place' to participants (McGrath 1991). This notion of stage could also apply with other synchronous communications technologies, such as holograms, where a physical performance is required.

Barbatsis talks about Joseph Squire and his 'manifesto' of hypermedia installation in which the 'place' contributes much to the experience the speaker intends:

> In the place there are no objects, spaces or bodies. Remember, these things are not sacred in themselves. The place explores the boundary between tool and myth, instrument and concept (to see the ways in which they mutually constitute each other). The place requires

> new constructions of bodily reality. Never fail to recognize the difference between self and other. Avoid any confusion of boundaries. The place will not be appreciated by all. But it presents its own seductions. The place is inhabited by random memories, dream-addicted mercenaries, and second-hand scraps of excitement. (Barbatsis 1999, p. 289)

Turkle (1995) sees the opportunity to explore and express different aspects of identity through the creation of personalized avatars (or virtual representation of self) and interactions in virtual environments. Virtual environments provide valuable contextual and emotional involvement that can also improve memory and problem-solving abilities (Zhou 2013). Virtual environments can support team role-play in training where it is important to have environmental and visual cues that set the scene for the communication activity (Jaeger and Helgheim 2009). Acting via an avatar means that each team member can see themselves in the environment and this can be particularly beneficial for the practice of people-facing skills. Training in a virtual environment can also be an advantage where safety is a concern, e.g. safe preparation of radioactive pharmaceuticals (Sime and Kemp 2008).

Whether online participants feel like 'being there' or feel the need to create a sense of 'place', social and cultural context, and emotions are important for online education, whether in real, virtual, augmented or mixed reality environments.

16.6 Tele-proximity Theory

Many researchers, including the authors of the Community of Inquiry Model (Anderson and Garrison 1995), consider it to be a basic analytic framework for understanding distance education (Gorsky and Caspi 2005) and it has inspired a great deal of research (Jung 2001). The popular Community of Inquiry framework (CoI) is widely used for studying text-based asynchronous online discussion (Garrison et al. 2010). The central components of the model are: teacher presence, cognitive presence and social presence. Teacher presence includes the role of tutors in course design and delivery, cognitive presence is defined as construction of understanding through collaboration and reflection, and social presence focuses on the social relationships among the learning community. All three presences are required to create an effective and supportive learning environment.

The model has inspired a great deal of research over the years and has evolved to include verbal interactions supported by synchronous and asynchronous tools of communication, without, of course, body language being perceived (Jézégou 2012). Some studies have shown that the teacher's visual presence plays a central role in facilitating and maintaining a community of inquiry and orchestrating communication in synchronous environment (Saw et al. 2008; Martin et al. 2012).

Themeli (2013) expanded the community of inquiry model to include synchronous visual communications and developed the theory of tele-proximity (Themeli and Bougia 2016). Tele-proximity theory expresses the human need for face-to-face contact and defines the ecosystem of synchronous media as a theatrical stage up on which embodied presences perform. Online embodiment has ecological significance because it is the environment in which participants are embedded. The tele-proximity theory claims that synchronous communications have the potential to reduce transactional distance in online education. Tele-proximity as embodiment ‘on-stage’ allows for audio-visual identity, affects learning and content and enhances immediacy. It integrates visual presence and communication among teachers, learning community and learning resources on video-enhanced environments as an expansion of the community of Inquiry Model. The extension of the Community of Inquiry model consists of:

Tele-teacher presence which is seen as expression of an embodied identity (audio-visual presence) that mirrors thinking processes, behaviours, emotions, and aesthetics for the purpose of realizing personally meaningful learning outcomes and a sense of ‘place’ for online students and instructors as well. Tele-cognitive presence is seen as the extent to which learners and instructors are able to: make their thinking and feelings visible; construct and confirm meaning; learn skills and play roles through sustained sensory-rich reflection (offline embodiment) and discourse (online embodiment) on ‘stage’. The presentation of content is based more on interconnectivity, interactivity and mindful presence than lectures. Finally, Tele-social presence is the ability of participants to create their identity in a sensory-rich ‘stage’, communicate purposefully in a trusting environment and develop inter-personal relationships by projecting their individual experiences and feelings.

Research into tele-proximity theory and the practice of experienced online educators concluded that context is vital to the success of online learning with synchronous communications technologies and contextual factors can be summarized in three categories (Themeli 2013). The first category refers to technological implications (connectivity), synchronous tool choices, time zone differences, institutional support, type of knowledge (conceptual, practical, etc.) and contextual aesthetics. Contextual aesthetics is the way instructors and students appear on screen (the way they are dressed, their tone of voice, their appearance and movements, and etiquette) and the distortion effects that can affect learning, impressions and perception. The second category, includes educators’ academic expectations, teaching style, pedagogy, professional salience and confidence with technology as these are recognized as important determinants of the learning process. The third category includes students’ self-motivation, attention span, level of task difficulty, language fluency, cultural background and personality traits as these are factors affecting a learning community that communicates synchronously.

Many of the studies associated with synchronous tools, have placed greater emphasis upon technical problems and solutions and lack guidance on how to link synchronicity with learning aims and integration into larger teaching scenarios (De Freitas and Neumann 2009). One more challenge of synchronous communications is that existing guides for educators do not provide high-level support for the inter-relation of multiple media used synchronously for educational purposes, or consideration of the current models being used to support practice (Schullo et al. 2005). In other words, educators need to have more experience with emerging synchronous media such as holoportation.

The theory of Tele-Proximity suggests that visual presence and interaction in visual space have the potential to enhance social, cognitive and teacher presence and this is based on the research on honest signals (Pentland 2008) and neuro-mirroring (Iacoboni 2009). In other words, human communication can be based on interpretation of visual cues and body language which are understood on an unconscious level. This underlies the importance of seeing other people in synchronous communications; however, the importance of contextual factors should not be forgotten.

16.7 From Video-Conferencing to Holoportation and Haptic Experiences

16.7.1 Video-Conferencing

According to Edtechnology (2019), one of the top tech trends for teaching in 2019 is High Definition video and video-conferencing. Synchronous video communication (SVC) is defined as real-time, video-enhanced conversation where there is an immediate give and take between at least two participants in different locations (Alexander et al. 1999; Chandler and Hanrahan 2000; Gibson and Cohen 2003; Suthers 2001). The prominent characteristic is the immediate exchange of information and sharing of facilities among distant users (Anastasiades 2007). "The introduction of the video-conference facility to the education system some 20-years-ago was quickly recognized as having the potential to resolve difficulties facing distance education" (Gillies 2008, p. 108). Since then, more and more people are using video-conferencing to communicate, teach, learn, seek medical assistance or even appear in court, and telecommunications technologies are steadily improving (Burton and Kitchen 2010; Tierney 2010).

Over 100 products are available commercially for a range of platforms including desktop video-conferencing which allows for audio-visual feeds to be transmitted between sites, and web conferencing which allows groups of users to enter an online meeting space and use features such as whiteboards, screen sharing, chat, voting. Some of the common virtual classrooms available in the market today are Elluminate, Adobe Connect, Cisco Webex, Flashmeetings, DimDim, Vyew, TokBox, VCS, Blackboard Collaborate, Big Blue Button and Horizon Wimba.

Synchronous interactions can be used for interviews, project meetings with multiple participants, chaired by a leader or for webcasts of physical lectures, virtual seminars and video lectures connecting participants and institutions. In addition, during SVC, other communication channels are available such as public group text chat, a voting system and emoticon mood indicators to support synchronicity. URLs can also be shared for collaborative web browsing. Furthermore, some software allows for automatic recording and can monitor participation, e.g. FlashMeeting uses polar area charts to provide a visual representation of dominance (who is talking most) so that participation can be monitored. Synchronous video communications can enhance educator and learner interactions, using text, audio and video to express themselves while experiencing a feeling similar to face-to-face.

16.7.2 Holographic Experiences and Holoportation

Holograms and augmented reality are already being used for training and educational purposes in a wide range of settings, for training, informal learning in museums, and capturing cultural heritage as an educational resource, e.g. ancient artefacts can be brought to life in 3D holograms through mobile phone apps (CGTN America 2017); and holograms of penguins, polar bears and killer whales can be seen up close by members of the public (BBC Frozen Planet 2013).

Augmented Reality software and mobile apps have been developed for educational purposes, e.g. ARTutor (Augmented Reality Tutor), which includes a web-based authoring tool for creating augmentations, and a mobile app for learners to interact with learning material (Tsinakos 2018). ARTutor is designed to be used by educators for creation of learning materials (e.g. augmentation of pdf files) and no programming skills are required—this makes it widely accessible to educators. These augmented reality educational materials can be appealing to learners and provide vivid visual illustrations for teaching purposes. Mobile augmented reality apps and headsets promise stimulating visuals to explain theories, demonstrate procedures and present historical events and people.

Innovative synchronous communications technology such as 3D holographic video-conferencing, or holoportation, promises to improve the communications experience, freeing the user from sitting in front of a computer and maintaining appropriate eye contact with multiple speakers (Kipman 2016). The term holoportation is defined as 3D holograms displayed in augmented reality that are used for real-time communication between remote users. 3D holographic images of people can be transmitted in real-time without significant delay so synchronous communications are possible and have the potential to offer a more realistic interaction than video-conferencing. The Microsoft HoloLens headset was the first untethered holographic device and combined with appropriate apps and software, it can provide augmented and mixed reality experiences for learners (Kipman 2016). A range of other, affordable, devices are also appearing on the market, e.g. Magic Leap.

In an educational setting, holograms can be used for one-to-one interaction or one-to-many broadcast in real-time, and recordings can also be played back to animate memories (Orts et al. 2016). Imperial College London is using holographic conferencing technologies so that holographic representations of lecturers can appear on stage to teach students in real-time. They believe that this provides a greater sense of presence than would be experienced with video-conferencing (Kelion 2018).

The Whole-body Interaction Learning for Dance Education project, funded by the Horizon 2020 programme of the European Union, has carried out ground-breaking research into the use of holograms in teaching dance and choreography (WhoLoDancE 2018a). Using motion capture technology and a range of holographic technologies, including the Microsoft HoloLens immersive headset, they have: captured cultural dances (i.e. flamenco, and Greek folk dance) and preserved them for future dancers and choreographers to study. They have also created a wide range of apps for annotating and processing the captured images. The captured dances (including contemporary and ballet) are stored in a movement library where choreographers (and those learning choreography) can choose and combine movements then playback the new dance using holographic images of the dancers. This technology has the potential to revolutionise choreography. For dancers learning to dance, they can view life-sized holographic dancers performing the dance they want to learn, and they can dance alongside them. This project has demonstrated a proof of concept and given us a glimpse of dance and choreography teaching in the future (WhoLoDancE 2018b).

Holoportation has the potential to play a major role in online education as it can enhance a sense of presence but more importantly it can create a greater sense of presence and a feeling of co-location, than video-conferencing thereby creating a more human communication experience. The theory of embodied cognition (Lakoff and Johnson 1999) and Pentland's 'honest signals' explain how holoportation facilitates interaction and understanding and creates a sense of immersion (Invitto, Spada, and De Paolis as cited in De Paolis and Mongelli 2015). Limitations need to be further explored and researched as data compression systems, eye tracking systems and more effective algorithms may assist in the adoption of immersive technologies in online education.

16.7.3 Technologies for Haptic Experiences

Video-conferencing and holoportation technologies can serve the need to 'see faces', facilitate synchronous discussion and enable a sense of presence, but they do not provide haptic perception, or the ability to touch or grasp something. 3D virtual reality software and headsets (e.g. Oculus Rift) can provide high levels of immersion and presence in virtual environments and can evoke real emotional reactions. These have been used for educational purposes for many years, perhaps the best well-known virtual environment is Second Life which has been used widely in Higher Education institutions (e.g. Molka-Danielsen and Deutschmann 2009). Learners from different locations, represented as avatars, can interact within virtual environments and engage in learning activities, e.g. role-play, problem-based learning, collaborative discussion. The 3D virtual reality environment can facilitate direct communication between learners, and support identity development, with a sense of presence, of co-location in the same place even though separate in the real-world. However, this is not the same as face-to-face communication as found in video-conferencing and holoportation as there is not the same opportunity to see the face or body and interpret unconscious, honest signals.

On the other hand, tactile experience through haptic suits is possible in virtual environments. The most innovative systems include the: KOR-FX haptic gaming vest, the full-body Tesla Suit, and the Haptics full-body TactSuit. Most haptic technologies have been produced for gamers and offer the user the feeling of pain or impact when playing virtual games that include boxing, martial arts or armed combat: "These technologies can provide more fulfilling interactions by enhancing the sense of presence. This feeling of 'being there' and the sense of 'space' can be increased with the addition of haptic feedback" (Cohen et al. 2017, p. 1). So, haptic technologies provide a new level of immersion in virtual environments that has the potential to be exploited in education and training applications. Further research is required to explore this area and its potential for online education.

16.8 Conclusions and Further Educational Research

From video-conferencing to holoportation and haptic feedback, emerging synchronous communications technologies can support human communication in online education by enhancing online presence and improving visual, auditory, spatial and haptic (tactile) aspects of communication. Eyes pick up cues to attention, turn-taking, aesthetics, emotions and can provide additional information, e.g. in detecting deception. Hand gestures and body movement complement speech at both conscious and unconscious levels as emotions modify the interpretation of language. Communication is achieved through a complex and dynamic dialogue where body movement complements spoken language.

The sense of embodiment is a significant dimension in the learning process via synchronous media. The embodied perspective maintains that knowledge during online synchronous meetings is generated by complex and dynamic human communication. Technology-enhanced learning can be seen as both online embodiment (when being there in real-time) through synchronous media such as synchronous video communications or augmented reality, and offline embodiment (when video or holograms are played back as embodied memories).

Video-conferencing technologies are widespread and provide adequate support for synchronous communication with the ability to 'see faces' and read 'honest signals'. Holoportation in augmented reality environments offers the educator a more realistic means of synchronous communication where online presence and communication can be enhanced by the ability to perceive honest signals in a more natural, human manner. While virtual reality environments can offer a sense of presence and a feeling of immersion in the environment, it is much more difficult to transmit honest signals. However, haptic technologies provide an opportunity for tactile perception in online environments—a feeling that cannot be achieved through video-conferencing or holoportation.

These technologies present opportunities and challenges to educators in their integration into online education. Emerging technologies offer educators new opportunities to reduce alienation in students and enhance learning experiences by improving a sense of presence or a sense of place. Communications between learners and tutors can be enhanced by improving 'honest signals' and a sense of belonging. The implications of using emerging synchronous communications technologies are that educators need to understand how to 'set the stage' for communications and understand the cultural and social context, including relevant theories surrounding presence, honest signals and embodiment. The challenge for educators is not just to keep up with the advances of new technologies but also to understand learning theory and the potential uses of the technologies in online education. As a result, opportunities for professional development and sharing experiences and knowledge about how to use these technologies in online teaching are invaluable to online educators.

Further research is needed to investigate the sense of presence in emerging technologies in distance courses and to map the uncharted field of tele-presences. The Tele-proximity theory may be used to assist educators and policymakers to make informed decisions and design online courses that address the human need to communicate visually. Tele-proximity theory was developed based on research into synchronous video-conferencing in online education but may be applicable for other synchronous media so further research is needed in this area. As holographic technologies and holoportation become more affordable and integrated into online teaching, further educational research is required to evaluate its effectiveness and to enhance understanding amongst educators about suitable learning theories and appropriate use of these technologies. The emergence of haptic suits that provide a more realistic tactile experience has great potential for training applications in some areas and further research is also required to fully understand how and when this emerging technology can be exploited.

A Glossary of Terms

Augmented Reality Technology that enables the real world to be enhanced with additional computer-generated information that is perceived at the same time

Avatar A computer representation of an individual that is used in online games or virtual reality environments

Haptics Interaction with a computer that involves the sensations of touch and movement that would be felt by a user interacting with objects in real world

Holograms An image that is projected in 3D and which can be seen in real-life environments

Holoportation Immersive technology that enables the capture and transmission of high-quality 3D images from one place to another where remote participants can see and hear them, through augmented reality, as if they are present

Presence or Telepresence A perception, or *sense of being there* in virtual environments

Synchronous Video Communication (SVC) Real-time communications with video and audio, i.e. video-conferencing

Tele-proximity Online embodiment that explains how instructors and students are connected in synchronous networked environment via tele-operations

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Part II
Research and Applications

Chapter 17
Designing and Implementing Adaptive MOOCs

Haipeng Wan and Shengquan Yu

Abstract MOOCs, as an innovative learning method, allow learners with different educational backgrounds, learning abilities and learning needs to participate in the same course. However, the content of the current MOOCs is fixed. The organizational concept of MOOCs is "one size fits all", which can no longer meet the individual needs of learners with heterogeneous and diversified characteristics. To address the above problems, the study puts forward the concept of adaptive open course from the perspective of discipline knowledge adaptation, including dynamic generation and evolution, sociality, semantic aggregation, choice and customization, consistency and continuity, openness of learning data and adaptive mechanism and so on. Then, the study elaborates the process of constructing and implementing adaptive open course from two aspects: content organization structure and the design and implementation of the prototype, which is expected to provide reference for designers and implementers of MOOCs.

Keywords MOOCs · Adaptive MOOCs · Hybrid MOOCs · Discipline knowledge · Learning cell knowledge community

17.1 Introduction

MOOCs have experienced a period from its birth to its explosive development and from the platform construction to the calm thinking. MOOCs, as a new way of learning, are open, large-scale, free, networked, and participatory (Kop, 2011), which are different from traditional online courses and open educational resources and allow learners with different educational backgrounds, learning abilities and learning needs to participate in the same course at the same time. This new online education model is making a profound impact on global education. However, a lot of problems still exist

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in MOOCs, such as high enrollment rate and low retention rate (Belanger & Thornton, 2013; Laverde et al., 2015), large-scale visits but no large-scale learning (Yu & Wan, 2014), no difference in teaching methods between MOOCs and conventional face-to-face or distance courses, technical support platform just being a tailored version of the traditional learning content management system (García-Peñalvo et al., 2017; Gros & García-Peñalvo, 2016).

The fact that the fixed content and one-size-fits-all organization cannot meet the needs of diversified learners has led researchers to think about how to provide adaptive MOOCs. Wu (2017) proposed that the course should not be the static content or result, but be a process of dynamic change. During the changing process, the course would be updated to meet the development needs of each student. The adaptability is even more necessary for large, heterogeneous, and diverse MOOCs (Esteban-Escaño et al., 2017; Sein-echaluce et al., 2011), which is expected to bridge the huge gap between the popularization and heterogeneity of MOOCs. Studies demonstrated that providing adaptive learning materials based on learning styles in the learning management platform could significantly reduce learning time under the condition of obtaining the same academic performance and completing the same tasks (Kinshuk, 2007). In view of the current shortcomings on cMOOC, xMOOC and hMOOC, García-Peñalvo et al. (2017) proposed adaptive hybrid MOOC (ahMOOC). Then they conducted the application practice based on iMOOC platform, which demonstrated that the courses based on ahMOOC mode had a higher completion rate. Different from the resource organization in the previous MOOC mode, all course resources in ahMOOC mode were organized by dynamically updated knowledge map, allowing different participants to choose different learning paths, and different learning content resources and course certificates were adapted to different learning paths. Nevertheless, the adaptability provided by ahMOOC mode was still a variety of preset learning paths, and the adaptive mechanism was also not open to learners. At the same time, the knowledge map in ahMOOC was mainly used to update the learning resources in different courses and ignored the learners' master level of the knowledge behind the learning resources, thus failing to realize the high-level adaptation to the learners' individual knowledge level. Therefore, from the perspective of discipline knowledge adaptation, this chapter will discuss the core features and content organizational structure of adaptive MOOCs, and take the prototype support system as an example to elaborate the course adaptation process.

17.2 The Core Characteristics of Adaptive MOOCs

Traditional courses are often static and closed, which usually guide the learners to learn in a fixed order and present the same content, learning activities, learning sequence without taking the differences of different learners into consideration. For this reason, many effective adaptive and personalized course design mechanisms have been proposed, including adaptive course content presentation, adaptive course learning navigation, and personalized course learning sequence (Chen, 2008). With the development of pervasive computing technology, semantic technology, and learning analysis technology, the connotation of the adaptive MOOCs has been deepening and developing. In the future, adaptive MOOCs will have a higher level of flexibility and openness, including the adaptation of course content, course structure, course evaluation, learning process and the open of the construction of content, management, assessment, access and adaptation mechanism (Fig. 17.1). The source of course content is not limited to teachers, but allowing learners, educational and scientific research institutions to make contribution to the content. The learning process and management mode become open and free, and the course content has established semantic association with the discipline knowledge. Then, the course support platform could automatically provide suitable learning evaluation standards, learning time, learning methods, and learning process according to learners' different learning needs and learning context. With the suitable learning evaluation standard, the learners would get their own discipline knowledge learning status which was used to aggregate and reorganize the contents of the unit (different learners having different learning content on the number of units), unit of learning sequence (different learners having different learning content unit order) as well as the learning network. All of these adaptive services would be visualized in a way that is consistent with learners' learning style, learning mood, learning context, and learning devices.

Specifically, the core features of future adaptive open courses will mainly be embodied in six aspects: dynamic generation and evolution of content, sociality of content, semantic aggregation of structure, selectivity and customization, continuity of design, openness of learning data and adaptation mechanism.

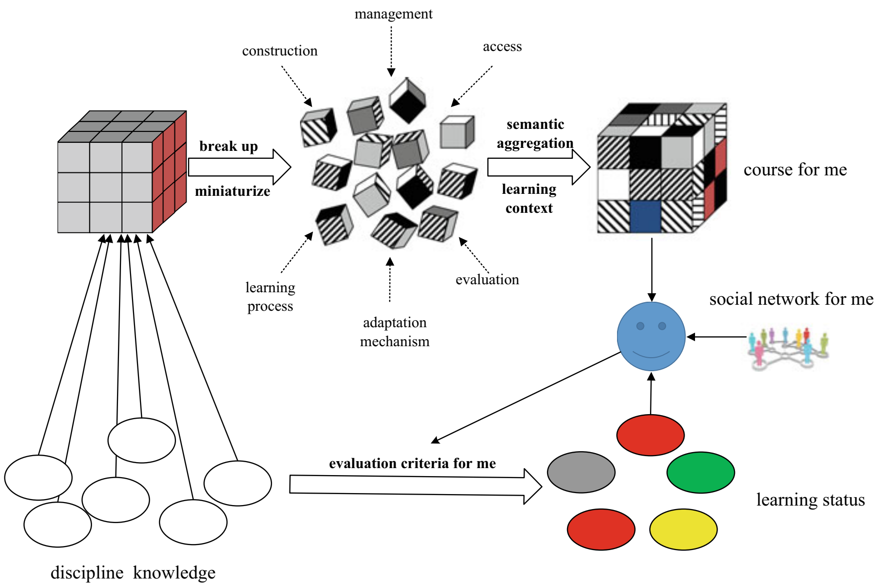

Fig. 17.1 Construction of adaptive MOOCs

17.2.1 Dynamic Generation and Evolution of Content

The current MOOCs basically follow the design and development model of the online course. The lecturer or teaching assistant pre-sets the content and learning activities of the course in advance, and then opens the course to online learners within a certain time. The established courses are basically fixed in the follow-up teaching and learning process, and will not be adjusted according to the different content of the course and learning activities according to the learner. Then, this course development mode brings a lot of problems, such as the slow update of the course content, the closed structure of the course, and the time-consuming and laborious effort for course development.

Adaptive MOOCs will break the traditional practice of unchanging online course content, in which the course teacher or teaching assistant will no longer be the sole contributor to the course content. Adaptive MOOCs will not only provide the content of free access for learners but also provide learners with convenient course content editing, learning activity design, and knowledge contribution. In the process, the learners would be able to participate in sharing, disseminating and contributing to their own wisdom and get different experiences of both the teacher (producer) and the student (consumer) roles. At the same time, adaptive MOOCs relying on the discipline knowledge behind the course will obtain the course content and resources that meet the target knowledge requirements from the external network based on the semantic crawler technology. In addition, with the continuous participation and increase of course learners, the adaptive MOOCs will gradually evolve to generate different versions of the learning objectives, support different teaching modes and learning methods, meet different media format requirements, and adapt to multiple versions of different learning devices for learners with different levels of learning ability and different learning needs.

In order to ensure the high quality and order of course content generation and evolution, it is necessary to have a mechanism to detect and monitor the quality level of generated content. Only new content that reaches a certain quality threshold can be included in the formal course content. The automatic implementation of this mechanism relies on more accurate and efficient content similarity calculation technology and content version control technology. By separately extracting the feature vectors of original content and new content, the similarity of the two vectors is calculated as the judgment of the quality level of the new content. When the quality of the new course content reaches a preset threshold, the new content can be added and the course content forms a new version which serves as a scaffold to understand the evolution of course content. In terms of content generation and evolution research, Yang (2015) proposed a content evolution intelligent order control technology based on semantic gene and social trust evaluation model. The key technology is to calculate the credibility of the new content based on the semantic similarity information between the newly added content and the current content and the contributor trust value.

17.2.2 Sociality of Content

With the information and knowledge rapidly growing and updating, no individual can access all the information and master all the knowledge. The “pipeline” for information and knowledge sources is obviously more important than information and knowledge itself (Yu & Chen, 2011). Therefore, the adaptive MOOCs need to fully consider the social factors of people in addition to the roles of producers and consumers as materialized learning resources. People should become an important part of the content of adaptive MOOCs.

The social nature of the learning process and the learning content are also fully reflected in the learning concept of Connectivism which emphasizes that learning is no longer limited to individual activities, but a process of establishing connections with specific nodes or information resources (Siemens, 2005). Through the connection of such nodes, a close connection will be created between individuals in the learning process, which is also served as an important medium for knowledge generation and dissemination. In the process of constructing adaptive MOOCs, it is necessary to pay attention to the construction of knowledge content network and social network. The construction of social network is the key to effective learning, because it is convenient for learners to communicate and seek the most suitable help by gathering the most relevant learning peers and the most authoritative expert network that will help to reduce loneliness in learning process.

The construction of the knowledge content network is relatively simple and has a relatively mature method, which can be realized through the catalogue system, discipline knowledge, keywords, labels, etc. But how to effectively sort out the various learning interactions generated during the learning process and then construct the social network has become the key issue. First of all, it is necessary to systematically sort out the types of direct learning interactions that may exist between learners and course content, learners and learners. Then, utilizing the semantic technology to represent the learning interaction behaviors in the form of triples. After that, the discipline experts will be mined behind the course content based on the existing related information between the course content and the learner’s learning performance and presented to the learners in the form of social interpersonal resources.

17.2.3 Semantic Aggregation of Structure

In the current MOOCs, there are too many contents with strong logic in a single lecture which requires learners to learn it together and goes against the characteristic of fragmented, miniaturized in mobile era. The adaptive MOOCs will no longer be the large and comprehensive class time content like the traditional MOOCs, but being a micro-course group composed of many micro-courses. Each micro-course has a complete teaching structure, including miniaturized learning resources, learning activities for promoting knowledge internalization, learning evaluations for providing timely feedback to learners, and learning certification (Yu & Chen, 2014). The micro-course in the micro-course group is not disordered but is organized and managed based on knowledge graph. The knowledge graph includes discipline knowledge, semantic and logical relationships between this discipline knowledge and establishes associations with specific micro-course. Based on the relationship between knowledge graph and micro-course, it is possible to automatically establish the connections between different micro-courses by using the semantic reasoning and association aggregation techniques. In this way, it is convenient to reorganize the content structure between different micro-courses according to specific teaching needs and learning context and to aggregate and generate micro-course groups for different learning objectives and different learning groups.

17.2.4 Selectivity and Customization

The adaptive MOOCs will provide learners with more choices. For learning the content of the same discipline knowledge point, the learner is allowed to choose different learning time, different learning objectives, different instructors, different media formats, different learning sequences, different learning contents, different learning activity design, different learning strategies, different presentation methods, different learning methods, different learning scenarios, etc. The learners could also selectively learn according to their actual learning conditions to improve the efficiency of learning. At the same time, the adaptive MOOCs will also allow learners to choose the learning evaluation according to the different learning objectives selected, and break the traditional one-size-fits-all evaluation model.

In addition to providing choices for the various elements of course, the support platform of adaptive MOOCs will provide a variety of customized and analytical services for learners, teachers, and administrators. For learners, they will be allowed to personalize their course functions, course content templates, course learning tools, course learning paths, course page layouts, and color styles according to their individual learning preferences or habits. For teachers and administrators, they will be allowed to customize the analysis services according to their own needs, such as class learning defect analysis, class advantage analysis, student learning difficulties mining, and comparative analysis for inter-school of different regions.

17.2.5 Continuity of Design

The learning process is beyond the learning context, and the learning experience is seamless. Learners' learning experience can be continued in different learning situations as long as learners are curious about the situation (Chan et al., 2006). This requires that the design of the entire adaptive MOOCs is consistent, i.e., different learning content can adapt to different learning contexts. Therefore, the adaptive

MOOCs should not only keep the continuity of the course content and the learning process, but also maintain the continuity between the discipline knowledge points behind the course content to realize the continuity of the learning interaction process data gathering between the formal learning and the informal learning environment, the learning process of online and offline learning and the learning experience in different learning contexts.

Interaction data collection technology, data synchronization technology, context-aware technology, and adaptive reasoning technology are the premise and basis for achieving course consistency and continuity. The interaction data collection technology can collect the procedural data generated by the learner during online and offline learning, and store the learning record in a unified format to ensure the scalability and cross-platform for the learning record. For example, the next-generation SCORM interface specification, the Experience API, uses the Learning Record Store (LRS) mechanism to describe and store the learning activities in the form of "Actor + Verb + Object", which could be shared between different learning systems (Li & Kong, 2013). The data synchronization technology can ensure the integration of learning data generated by learners in different learning modes, including real-time recording and storage of online learning process data, real-time saving and timely uploading of learning process data in offline state, timely entry and uploading the offline learning process data. The context-aware technology needs to use the GPS location service function, wearable devices such as Google Glasses, and context sensors to sense and acquire the learner's current learning context information in real-time, and then transmit it to the adaptive reasoning engine. After receiving the context information, the adaptive reasoning engine will extract the specific content and activities according to the previous learning evaluation information of the learner and then arrange the content and activities in a specific sequence to suit the learning context and learning level.

17.2.6 Openness of Learning Data and Adaptation Mechanism

Adaptation refers to the adaptation of the body to the environment, which is the process of individuals changing themselves according to changes in environmental conditions and achieving balance with the environment (Gu, 1998). Bian & Xie (2009) proposed the problem of "two-way adaptation" in the adaptive learning system, that is, the learner's adaptation to the system and the system's adaptation to the learner. Therefore, it can be seen that the adaptability of the course should not only include the support system of the course to make timely adjustments to the content, structure and presentation form according to the different personality of the learner, but also the learner's individual to actively adjust their psychological state, and actively select and customize the learning support service in line with the current learning context on the premise of knowing the principle of curriculum adaptability.

Although the recommendation function provided by some support platforms of MOOCs can give learners a choice to some extent, this choice is still a passive form of choice. The principles and mechanisms behind the course are mostly closed. The principle of adaptation is a “black box” for the learners and the learner does not know the specific content of the principle. However, constructivist learning theory believes that allowing students to view the course or the system’s assessment for themselves could provide students with opportunities for reflection and self-evaluation, which will increase the learner’s reflective awareness of the knowledge, learning difficulties and learning process (Zhang et al., 2010). In this way, it is necessary to break the closeness of the course adaptation principle and open up some or all of the principles to the learner, and then improve the scientific nature of the learner’s self-selection and customization of the learning support service.

On the one hand, the realization of the two-way adaptability of the curriculum depends on a variety of adaptive learning support services. On the other hand, it relies on the way to present the implementation mechanism and learning data to the learners. Recently, many studies focus on the design and implementation of the adaptive learning support services and ignored the latter’s related research. In the future, adaptive MOOCs will focus on the opening of the adaptation mechanism to learners, showing the logic of the mechanism to the learners in a visual form, the process and results of the course learning data analysis. Only in that way can learners truly understand the principles of adaptation and make reasonable judgments and choices to achieve success.

17.3 The Content Organization of Adaptive MOOCs

Adaptive MOOCs will be structured and componentized on the basis of discipline knowledge and learning context (Fig. 17.2). Adaptive MOOCs include learning content, learning activity and learning evaluation, which are associated with each other. Learning contents and learning activities are associated with specific discipline knowledge and learning context.

Adaptive MOOCs break up the content of courses in the form of micro-components, and adaptively aggregate and reorganize the content according to the corresponding elements in different stages of learning. Before starting the learning, the course would conduct the analysis of the initial ability, learning goals, personality characteristics (such as gender, cognitive style, learning context) of learners, and then according to the different teaching modes, dynamically generated learning content, learning activities, learning evaluation and learning sequence according to different types of learners. In the learning process, the generated course for specific learners would also make dynamic feedback and adjustment according to the cognitive status and knowledge structure formed by learners in the learning interaction process, including adding or subtracting learning content, adding or subtracting learning activities, changing learning evaluation, optimizing learning order, etc. At the end of

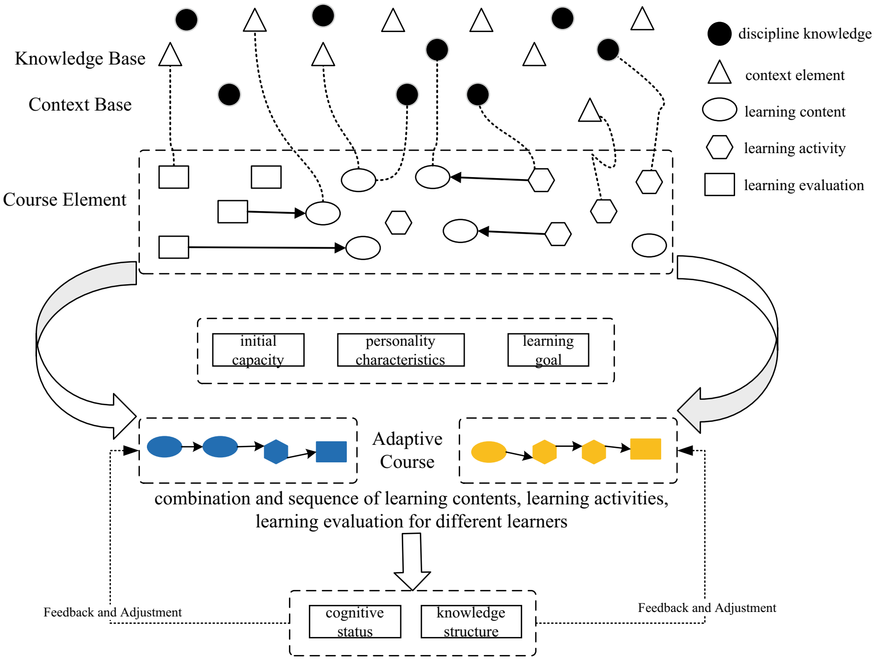

Fig. 17.2 Content organization of MOOCs

the learning, the course could also provide remedial courses and subsequent courses for learners according to their learning outcomes and weaknesses.

17.4 Prototype Design and Implementation of Adaptive MOOCs

Learning Cell is an organizational model of new learning resources that supports ubiquitous learning and has the characteristics of generativeness, openness, connectivity, cohesion, evolution, intelligence, miniaturization, and self-tracking (Yu et al., 2009). Based on the concept and technical framework of the adaptive MOOCs, our team explored the adaptive MOOCs prototype design by utilizing the Learning Cell Knowledge Community. The adaptive MOOCs prototype could support the collaborative editing of content, open and layered learning evaluation, course organization based on discipline knowledge, the generation of social cognitive networks, the integration of multiple learning devices, and the visualization of adaptive services.

17.4.1 Collaborative Editing of Content

Different from the existing MOOCs learning platform, the Learning Cell Knowledge Community allows any user to create learning content, enriching and open the source of the course content. For the specific content, there is no fully solidified role division between the creator of content (like teacher) and the reviewer of content (like learner). For the courses in the Learning Cell Knowledge Community, learners are free to edit the learning content and design the learning activities in the process of learning. At the same time, for the content edited by the learner, the Learning Cell Knowledge Community has a complete set of credibility calculation and evaluation mechanism to detect the quality level of the new added content, and then decide whether the content can be included in the content system of the course and whether new version of the course should be generated. In addition, the Learning Cell Knowledge Community also provides a comparison function for historical versions of different course contents, which is convenient for teachers and learners to compare the differences between different course content versions and to view the evolution of course content (Fig. 17.3).

17.4.2 Open and Layered Learning Evaluation

The Learning Cell Knowledge Community realizes open and layered learning evaluation, in which the subjects and items of evaluation are diverse. Both course teachers and learning peers in the learning process can make evaluation. The items of evaluation include both regular content browsing, content and resource downloading and also participation in learning activities and contributions to the content of the course. At the same time, the Learning Cell Knowledge Community opens up the construction of the course learning evaluation program. It allows the course assistants and collaborators other than the course teachers to adjust the evaluation modules, the weights of the evaluation modules, the evaluation items, and the weights of the evaluation items. Even more, it supports to create a hierarchical evaluation for learners with different learning abilities. In the hierarchical evaluation, each evaluation scheme could have different evaluation modules and items and their weights. At the beginning of the course, the learner is allowed to choose an evaluation scheme that suits his or her ability level, and as the learning progresses in the learning process if the selected evaluation plan is found to be inappropriate, the learner can choose to apply for the exchange (Fig. 17.4).

Fig. 17.3 Editing, comparison, and historical version of content

17.4.3 Course Organization Based on Discipline Knowledge

The Learning Cell Knowledge Community constructs the semantic relationship between course content and learning activities, course content and discipline knowledge points, and their learning objectives, learning activities and discipline knowledge points. A one-to-many relationship can be established between course content and learning activities, course content and discipline knowledge points. Many-to-many associations can be established between learning activities and discipline knowledge points. The same discipline knowledge points can be with different learning objectives in different learning contents. The course teacher can add discipline knowledge points by manually inputting or selecting from knowledge ontology library of the Learning Cell Knowledge Community, and then set the grade level to which it belongs to, the required learning goals, and the description information

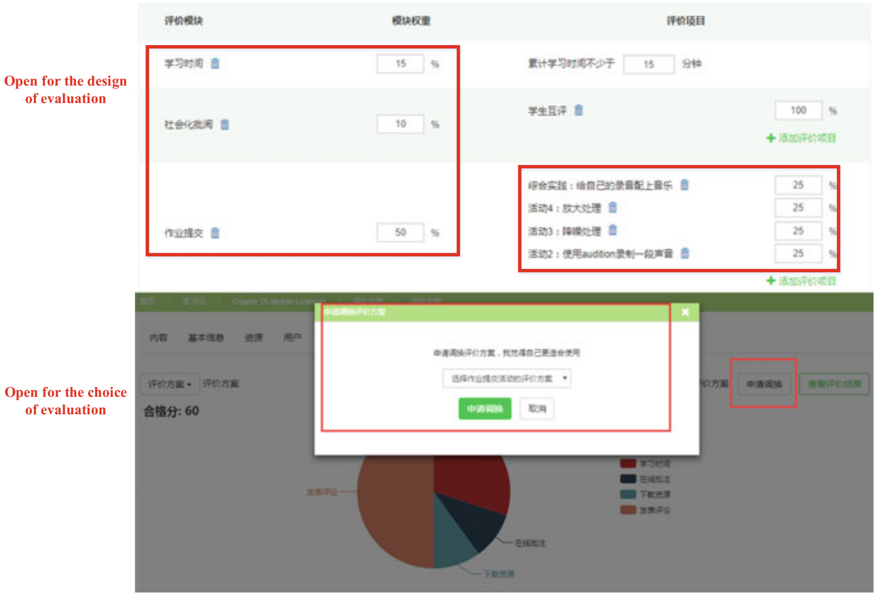

Fig. 17.4 Open and layered learning evaluation

of the association. At the same time, the association established by manual control need to be voted by the user's credibility before it becomes a formal association. Subsequently, the course teacher can select the appropriate knowledge points from the associated knowledge points with the course content to establish association with the learning activities, and set the corresponding association weights, as shown in Fig. 17.5. Based on the semantic relevance information between the course content, learning activities and discipline knowledge, the course content and learning activities in the Learning Cell Knowledge Community can be dynamically aggregated and reorganized to form a course for different learning objectives.

17.4.4 Generation of Social Cognitive Networks

Based on the semantic relationship between course content and discipline knowledge, the Learning Cell Knowledge Community dynamically builds a knowledge network between course content. At the same time, the Learning Cell Knowledge Community also regards people who participate in the course content interaction as an important learning resource, and dynamically calculate the relationship between the people involved in the interaction (such as creation, editing, collaboration, collection, annotation, commenting, downloading, and adding as a friend) and form the interpersonal network. With the continuous deep interaction between people and content and between people and people, the social cognitive network is generated by

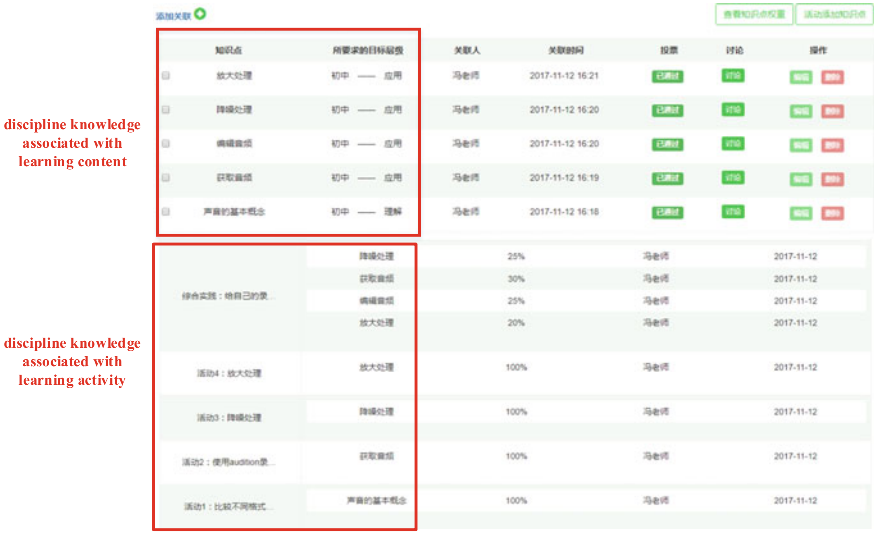

Fig. 17.5 Course organization based on discipline knowledge

combining knowledge network with interpersonal network, as shown in Fig. 17.6, which is convenient for learners to find the interested material and interpersonal resources.

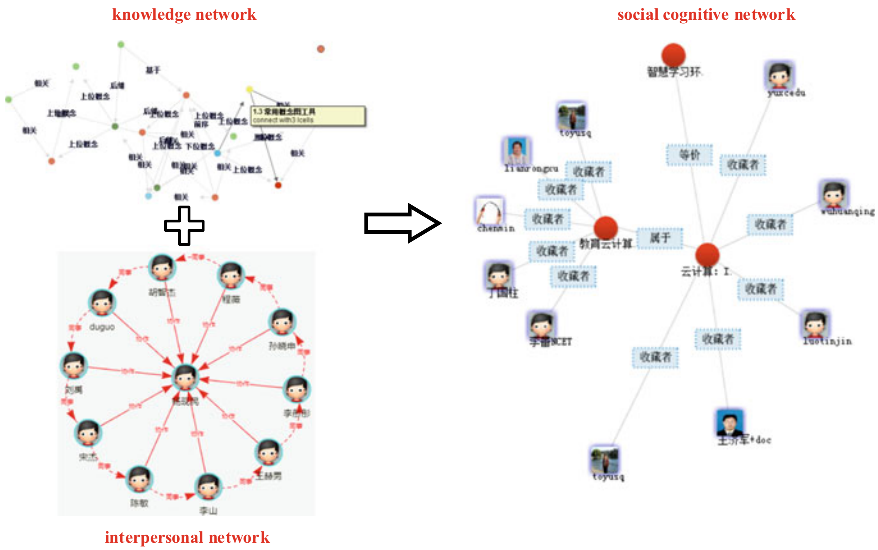

Fig. 17.6 Social Cognitive Network

17.4.5 Integration of Multiple Learning Devices

Online learning should be independent of time and space, and the learning process experience should be consistent and continuous. The Learning Cell Knowledge Community supports learners to use different learning devices for open access to course content and participation in course activities. The learning process interaction data generated on each learning device in different contexts are recorded in the information pairs by using the technical framework of xAPI. The course content and learning activities in different learning devices will be adapted according to the context, as shown in Fig. 17.7.

17.4.6 Visualization of Adaptive Services

The Learning Cell Knowledge Community utilizes the collected learning process data, calculates the learning state of the learner based on the learning evaluation scheme and mines the learner's knowledge structure, and constructs a visualized personal learning cognitive map of the learner (Wan & Yu, 2017). Then, based on the learning cognitive map, the Learning Cell Knowledge Community provides the learner with the most suitable course content, learning path and learning companion, and the adaptive mechanism. The most suitable learning content recommendation mainly considers the different learning status of the learners and recommends the course content and learning activities that associate with the unqualified discipline knowledge. The most suitable learning path is based on mining the prerequisite relationship between the acquired knowledge points and then generate the learning sequence of the knowledge points which excludes the achieved knowledge points. The most suitable learning companion is formed by calculating and sequencing the similarity between any two different learners' learning cognitive maps. All the adaptive services are shown in visualization format (Fig. 17.8).

17.5 Conclusion

In the perspective of discipline knowledge adaptation, this chapter put forward the core characteristics, architecture and realization technology of adaptive MOOCs, and implemented the adaptive MOOCs based on Learning Cell Knowledge Community. In the future, adaptive MOOCs will place more emphasis on miniaturization and fragmentation and allow learners to learn the content of courses according to the individual learning time and learning needs of learners. Currently, relevant MOOCs support platforms have started to provide digital badge certification, self-paced MOOCs for multi-level learners. In the future, MOOCs will be more open and apply the mechanisms of adaptive learning navigation, adaptive learning evaluation,

Fig. 17.7 Integration of multiple learning devices

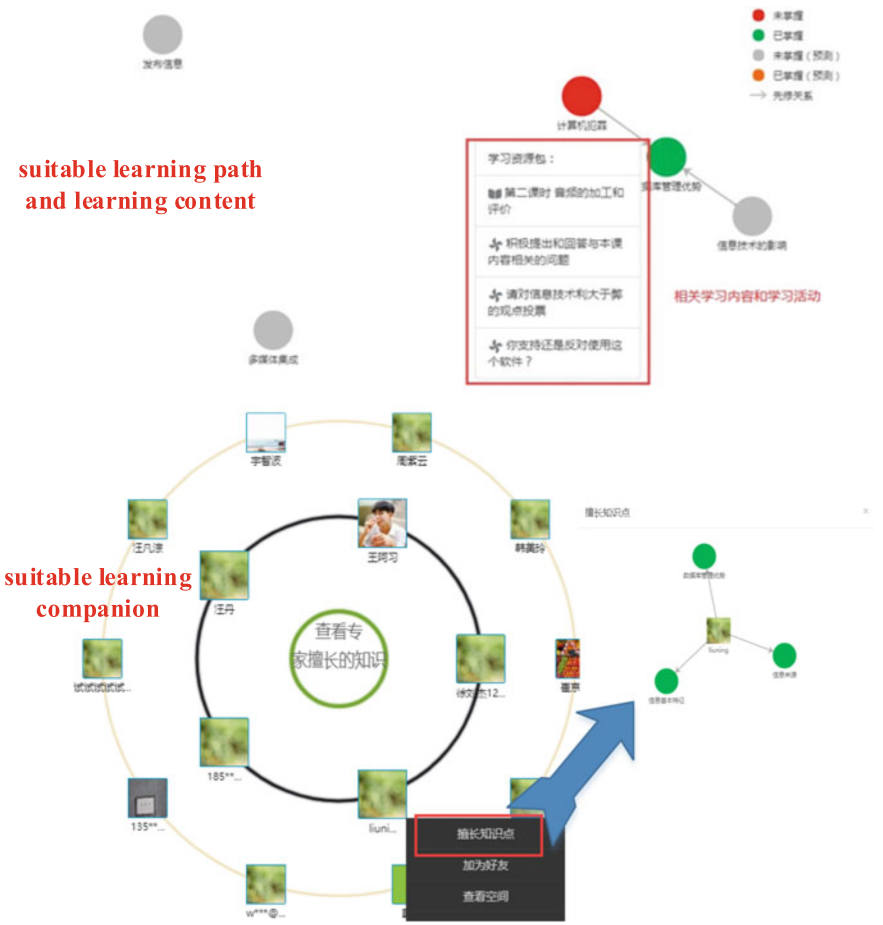

Fig. 17.8 Visualization of adaptive services

personalized learning path, diversified resource forms, precise guidance, and feedback. More research is needed on adaptive MOOCs to make MOOCs more effective and to personalized learning.

Glossary of Terms

MOOC Massive Open Online Course.

cMOOC The Massive Open Online Course which is designed based on the learning theory of Connectivism.

xMOOC The Massive Open Online Course which is designed based on the learning theory of Behaviorism.

hMOOC The Massive Open Online Course which is designed based on the blending learning theory.

Adaptive MOOC The Massive Open Online Course whose content and structure can be changed according to the learning need of learners.

Learning Cell Learning resource with collections of content items, activity items, service items and their semantic descriptions based on a single learning objective.

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Chapter 18
Augmented Reading Through Emerging Technologies: The Living Book Approach to Teachers' Professional Development

Maria Meletiou-Mavrotheris, Constadina Charalambous and Katerina Mavrou

Abstract Recognizing the importance of reading, the EU Education and training 2020 (ET 2020) benchmarks set in 2009, included having less than 15% of 15-year-olds being under-skilled in reading by 2020 as one of its main targets. Unfortunately, while some EU countries have since made significant progress toward improving their students' performance in reading skills, other countries are still lagging behind. In an attempt to respond to this challenge and to address the under-achievement of European students in reading, the EU-funded *Living Book—Augmenting Reading for Life* project has developed an innovative approach that combines off-line activities promoting reading literacy with online experiences of books' "virtual augmentation." A professional development program targeting teachers of upper primary and lower secondary school (ages 9–15), which aims at strengthening teachers' profile and competences in adopting the *Living Book* approach and in dealing with diversified groups of learners, and particularly with pupils from disadvantaged backgrounds has been designed within the project, and is currently being pilot tested in five partner countries. The current chapter describes the content and structure of the "Augmented Teacher" professional development course, and reports on some of the initial insights gained from the pilot delivery taking place in one of the partner countries, Cyprus.

Keywords Reading literacy · Augmented reading · Augmented reality · Professional development · Living library

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18.1 Introduction

Recent technological advances have provided the opportunity to create an entirely new learning environment that can boost students' reading engagement by significantly increasing the range and sophistication of possible classroom activities. One promising approach lately explored is the use of augmented reality (AR). This concept has gained a growing interest among researchers during the past few years, especially in the field of education (Cheng and Tsai 2014; Dünser 2008; Gandolfi et al. 2018; Ibáñez and Delgado-Kloos 2018; Lytridis et al. 2018). In particular, AR books, which combine physical books with the interactive potentials provided by digital media, constitute a playful and engaging way for enhancing teaching and learning. Most importantly, through the integration of text, audio, 2D illustrations, 3D virtual content and animation, AR books can meet students' diverse needs and different learning styles. For instance, visual learners' needs can be addressed through 2D and 3D illustrations, while auditory learners can hear sounds throughout the book and kinesthetic learners can engage in tactile activities utilizing mobile devices (McNair and Green 2016). In line with this, Rohaya et al. (2012) have stated that a static story experience can be transformed into a dynamic and engaging reading experience through the incorporation of AR into a physical book. It is then possible that AR books, being a physical means of interaction, can lead students to intuitive utilization of paper books through the assistance of AR (Hornecker and Dünser 2009).

The EU-funded Erasmus +/KA2 project The *Living Book*—Augmenting Reading for Life project (September 2016–August 2019) was proposed in an attempt to exploit the affordances of AR and other emerging technologies in order to address the underachievement of European students aged 9–15 in reading skills. Its overall aim is to increase young people's motivation to reading, while also promoting a cluster of other key and transversal competencies in students (e.g., digital skills, critical thinking, and cooperative skills). *Living Book* aspires to achieve this through the development of a novel pedagogical approach that combines off-line activities promoting reading literacy with online experiences of "virtual augmentation" of a book and with social dynamics.

The *Living Book* consortium, which is comprised of nine partner organizations originating from six different European countries (Cyprus, Estonia, Italy, Romania, Portugal, and UK), has been reaching out to teachers to inform them about new technological developments that could be utilized in schools to augment students' reading experience with rich media content. Through a combination of open educational resources (OER) and involvement in professional learning activities, *Living Book* has been contributing toward strengthening the profile and competences of European teachers in adopting standards-based practices and dealing with diversified groups of learners, and particularly with pupils from disadvantaged backgrounds. A Living Library (http://thelivinglibrary.eu/) supports the project activities by offering students and teachers with online tools to augment the reading experience with rich media content. The Living Library also hosts a social community of "Augmented Teachers" and "Augmented Readers" across Europe.

A main output of the *Living Book* project is a professional development program targeting teachers of upper primary and lower secondary school (ages 9–15). The course has been jointly designed by a multinational consortium of educators, representatives of teachers' organizations, experienced distance-learning instructors, authors of technology-supported courses, and technicians, in order to ensure consideration of all different perspectives into its design. The course design has been based on the importance of dialog and collaboration among teachers and researchers, and of inquiry and exploration as a process of knowledge construction. Particular care has been taken to build on teachers' knowledge and workplace experiences.

The current chapter provides an overview of the "Augmented Teacher" professional development course. It also describes the course content and structure, and reports on some of the experiences gained from its pilot delivery that took place in one of the partner countries, Cyprus.

18.2 Background

While AR and other emerging technologies present some exciting opportunities for augmenting students' reading engagement and learning, their introduction into the classroom does not come without challenges. Careful strategic planning and reflective implementation grounded in solid research are necessary, for such technologies to be effectively integrated within school systems to enhance learning opportunities for all learners. This should focus on the broad preparation and ongoing engagement of all key stakeholders involved in the educational process (prospective and practicing teachers, teacher educators and other college faculty, adult educators, educational leaders, and technical managers). These professionals should be helped to recognize the added value of ground-breaking technologies such as AR for books, and their true potential for improving teaching, learning, and assessment, and should be informed about best practices in their exploitation as instructional tools.

The provision of high-quality teacher training, in particular, is of paramount importance, since the change in teaching practices is always one of the main factors in any educational change. A number of studies have asserted that it is much more demanding for teachers to exploit the growing prominence of AR and other digital technologies and their transformative potential in instructional settings than was originally anticipated and that many teachers remain unprepared to effectively employ ICT tools in their teaching practices (e.g., Blackwell 2014; Ertmer et al. 2012; Sanders and George 2017). Thus, to bring about the necessary changes in teaching cultures that will enable education to reap the full benefits of AR, it is of utmost importance to provide teachers with high-quality pre-service and in-service training opportunities that will equip them with the required knowledge and skills to effectively infuse AR and other emerging technologies into teaching and learning (Dunleavy et al. 2009; Okada et al. 2018; Solak and Cakir 2015).

The literature suggests that many gaps exist in the preparation of pre-service and in-service teachers for ICT integration (Haydn and Barton 2007). One common problem of teacher education identified in the literature is the lack of content-area relevance and inadequate transfer of technology skills to instructional strategies (Cheng and Zhan 2012). An important consideration of any model of professional development is whether it is useful and supportive of teachers' efforts to improve their teaching practices (Whitaker et al. 2007). Historically, professional development efforts have largely been ineffective in producing reform-based classroom change (Templin and Bombaugh 2005). As Robinson (1998) points out, staff development often fails to transfer to the participants' workplace situations, because it might be too remote from "real-work" needs or organizational realities.

Recently, there have been calls for reforms in teacher education on technology integration, to better prepare teachers to effectively utilize computers in teaching with a sound pedagogy (Niess et al. 2009). Different frameworks have been proposed on how to shift the focus from teaching technology to using technology to enhance learning. One such framework is technological pedagogical content knowledge (TPACK), the influential conceptual framework proposed by Mishra and Koehler (2006) in response to the absence of theory guiding the integration of technology into education. Building on Shulman's (1986) idea of pedagogical content knowledge, TPACK emphasizes the importance of developing integrated and interdependent understanding of three primary forms of knowledge: technology, pedagogy, and content. The framework is based upon the premise that effective technology integration for pedagogy around specific subject matter requires developing understanding of the dynamic relationship between all three knowledge components. Thus, teacher ICT training cannot be treated as context-free, but should be accompanied with emphasis on how technology relates to the pedagogy and content (in our case teaching literacy and literature).

TPACK has, in recent years, become central to research into technology education and teacher professional development in many different disciplines (e.g., McKenney and Voogt 2017; Schmidt and Gurbo 2008; Tondeur et al. 2013; Voogt and McKenney 2016). In the area of literacy education, several studies targeting pre-service and/or in-service teachers undertaken during the past decade have been grounded in the TPACK model (e.g., McKenney and Voogt 2017). Conducted studies illustrate the usefulness of TPACK as a research framework for facilitating and assessing teachers' professional growth in the instructional use of ICT for the development of students' literacy in young learners. As suggested by the literature, better understanding of TPACK among pre-service and in-service teachers can help enhance integration of technology in their teaching practices, and this, in turn, can foster early literacy.

Despite the usefulness of the generic TPACK model, some limitations and challenges do exist. Phillips (2016), in particular, has pointed the basic TPACK model's individual-oriented focus as a drawback, since it fails to take into account the socially mediated contexts in which teachers develop their TPACK. Phillips (2016) considers TPACK not as an individually acquired attribute but as an embodied phenomenon shaped by social, organizational, and cultural factors extending beyond individuals.

18.3 "Augmented Teacher" Course Design

18.3.1 Pedagogical and Didactic Approach

Following the main premises of the TPACK conceptual framework, the "Augmented Teacher" course has been designed to help teachers move beyond technocentric strategies that focus on the technology rather than the learning (Mishra and Koehler 2006) and to promote their critical reflection on the instructional use of AR and other technologies for enhancing learners' reading experience. In accord with Phillips' (2016) revised TPACK model, the basic TPACK model has been enriched with the addition of the components of communities of practice (Wenger 1998) and school-based teacher development (McLaughlin and Talbert 2006). Rather than adopting a transmission-of-knowledge instructional model, the "Augmented Teacher" course has been designed to facilitate inquiry and problem-based learning.

The course design aimed at the creation of a constructivist social setting, where teachers are the main agents of their professional development, facilitated by an environment rich in challenges, interactions, and collaborations. Particular emphasis has been put on drawing upon and extending teachers' workplace experiences. Participants' training on the *Living Book* approach is followed by classroom experimentation, where they apply the use of literacy-related AR pedagogical approaches in their classrooms. We believe that this can help to further determine the actual educational potential of the augmented reading pedagogical approach adopted by Living Book.

18.3.2 Course Content and Structure

The "Augmented Teacher" course aims to develop upper elementary and middle school (ages 9–15) teachers' knowledge and skills in teaching using the Living Book approach, so as to enrich children's experiences in reading. Central to the course design is the functional integration of technology with existing core curricular ideas, and specifically, the integration of augmented reality and other technology-enhanced tools and resources provided by the Living Library platform.

The course is made of eight modules, covering the following topics:

- *Module* 1: The Living Book approach, why it is important to motivate to reading and to augment books. The learning outcomes (in person)
- *Module* 2: Pedagogical basis to teach to read (in person)
- *Module* 3: Motivating disengaged pupils from groups at risk (in person)
- *Module* 4: Using the Living Library platform and exploring the tools available (video classes)
- *Module* 5: How to apply the Living Book Approach in the classroom and how to match it into the curriculum (in person)

- *Module* 6: Assessing the reading skills and the competence of the "Augmented Reader" (in person)
- *Module* 7: Preparing for, conducting, and reflecting on the teaching experimentation (guided-field practice)
- *Module* 8: Practical course tasks, self-assessment of learning outcomes and self-generation of the Augmented Teacher Certificate (interactive resource).

The course is being delivered using a "blended-learning" method. At the beginning of the course teachers in each country gather together to attend a series of face-to-face seminars familiarizing them with the project philosophy, objectives, and resources. Teachers are introduced to the objectives and pedagogical framework underlying the course and get familiarized with the technological tools and facilities offered by the Living Library. More importantly, they get the chance to meet and interact with one another, share issues and problems, as well as exploit the course facilitators' presence to ask questions about things they are unsure of. The remainder of the course is delivered online using the instructional content and services of the Living Library and of the course dedicated platform for teaching, support, and coordination purposes. The sites offer access to various tools and resources:

- *Living Book Guidelines*: E-publication providing teachers (and other stakeholders) with methodological guidelines to implement Living Book approach
- *A Pedagogical Framework and Curriculum Definition*: Layout of structure of different modules, phases, methodologies, and learning outcomes for teachers; description of main topics to be treated
- *Instructional Contents*: A line of research-based curricular and instructional materials used during the professional development course.
- *Recorded Teaching Episodes*: providing examples of classrooms making use of the Living Book approach
- *Living Book Lesson Plans for Teachers*: Plans provide teachers with examples and ideas on how to integrate the living book methodologies into their classroom activities
- *Collaboration Tools*: *for professional dialog and support* (e.g., online reading groups, forums, wikis, and chats).

The course curriculum and key contents have been developed in English and translated into the partners' national languages (Estonian, Greek, Italian, Portuguese, and Romanian). They have been culturally differentiated to accommodate local conditions in each participating country.

A special emphasis of *Living Book* is on building an online community for the exchange of ideas, content, tools, and didactic approaches among the educators participating in the training. Throughout the course duration, teachers participate in online discussion forums and reading groups, exchanging experiences, ideas, and educational resources.

18.4 Methodology

18.4.1 Context and Participants

The Living Book teacher professional development program, which involves AR-enhanced learning activities through combined use of e-Learning and physical meetings, was designed during the first 18 months. Following its design, a pilot testing of the course is currently taking place in each partner country (Cyprus, Estonia, Italy, Romania, and Portugal). This chapter focuses on the pilot testing taking place in Cyprus.

A case study design was employed. The case studied consisted of the twenty-six ($n = 26$) teachers (23 females, 3 males) that participated in the training. With the exception of two secondary school teachers, everyone else worked at the primary school level. Two-thirds had a Master's degree, while one participant also held a doctorate. Despite being fairly young in age, participants tended to be experienced educators with several years of teaching experience. Sixteen teachers ($n = 16$) had between 11 and 20 years of teaching experience, while seven ($n = 7$) had taught for more than 20 years.

The pilot testing of the course in Cyprus started in May 2018 with a series of hands-on face-to-face seminars covering Modules 1–6 of the course. These seminars, which were completed in November 2018, introduced participants to contemporary theories of learning and to innovative, ICT-augmented pedagogical approaches that can help diversified groups of learners to develop their reading skills while, at the same time, also boosting a cluster of other key and transversal competencies (e.g., digital skills, learning to learn, critical thinking, and cooperative skills). Special focus was given to ways of increasing the level of participation and achievement of the most unmotivated learners from disadvantaged backgrounds.

The seminars consisted of a combination of mini-workshops that included AR-enhanced and hands-on activities in small groups (5–6 persons), presentations by experts, role-play, videos documenting learning activities with children, and discussions. The project Living Library supported the workshop activities.

In the second, still ongoing, part of the course (December 2018–April 2019; Modules 7–8) the focus has shifted to classroom implementation issues. Participants have been asked to undertake a teaching experiment, where they activate "Living Book" didactical paths. They have/will customize and expand upon the lesson plans and learning materials provided to them, and apply them in their own classrooms. Local partners have been acting as mentors, providing their support to teachers using online communication tools.

Once the guided-field practice is completed, teachers will gather together to report on their experiences to the other teachers, and also provide video-taped teaching episodes and samples of their students' work for group reflection and evaluation. They will apply a critical analysis of their work and that resulting from students, and exchange insights as to how to further improve their teaching practices and increase their students' interest toward reading, and their reading skills and habits.

18.4.2 Instruments, Data Collection, and Analysis Procedure

The success of the *Living Book* program in increasing teachers' level of competence in cultivating young students' motivation to reading, while at the same time building other transversal competences, has/will be evaluated using Guskey's (2002) five-level hierarchical model. According to Guskey (2002), professional development evaluation should move from the simple (reactions of participants), to the more complex (student learning outcomes), with data from each level building on the previous. Based on Guskey's model, evaluation has/will occur at five levels, employing a variety of both qualitative and quantitative data collection techniques to gather information from teachers and their learners, as well as from parents: (i) participant reactions, (ii) participant learning, (iii) organization support and change, (iv) participant use of new knowledge and skills, and (v) student motivation and learning outcomes. The analysis of the different sources of data obtained/to be obtained during the pilot testing and follow-up classroom experimentation has/will inform the revision of the Augmented Teacher course, and of the accompanying methodological and pedagogical frameworks, and instructional materials and services included in the Living Library.

For the purposes of this chapter, data collection was restricted to a post-survey administered to the participants upon completion of the pilot testing of the professional development seminars, in order to evaluate the impact of the training on participants' attitudes, confidence level, and self-reported proficiency in adopting the *Living Book* approach in their teaching practices.

The survey instrument was built based on the international literature and similar surveys employed in previous studies (e.g., DEC 2012). Most of the questions were closed-ended, requesting Likert-type ratings or multiple-choice responses. A few open-ended questions requiring text-based responses were also included to obtain more comprehensive information. The questionnaire was finalized after being pilot tested and was administered in electronic format. They were posted via Google Forms and took about 15–20 min to complete.

Quantitative data obtained from the post-survey were analyzed using descriptive statistics. The text-based responses were coded and clustered as themes. An interpretive case study approach was employed in the analysis of these data. We did not use an analytical framework with predetermined categories to assess how teachers' perceptions and TPACK developed after going through the first phase of the course. What we attempted instead was to produce a holistic understanding of the research situation through considering practitioners' own views and reflections on the model of professional development adopted *by Living Book* and its influence on their learning (i.e., Levels 1 and 2 of the Guskey model). The next section will share some of these insights.

18.5 Results

This section outlines the main findings obtained from the analysis of the online survey completed by participants ($n = 26$) upon completion of the face-to-face seminars.

Participants were first asked to indicate, using a five-point Likert Scale (1 = *Strongly Disagree*… 5 = *Strongly Agree*), their level of agreement with a number of statements regarding the training. Table 18.1 indicates (in descending order) the percentage of students agreeing or strongly agreeing with each statement.

As seen in Table 18.1, everyone agreed that the seminars were well-organized. They all found both the presentations and the hands-on workshops included in the seminars to be motivating. They also all agreed that adequate time was devoted to the presentation and discussion of the underlying topics/issues. All teachers also believed that the seminars had improved their theoretical and practical knowledge and skills regarding the educational exploitation of emerging technologies for augmenting reading, and agreed that the methodological strategies and approaches introduced can be implemented in real teaching practice. Almost everyone (25 out of 26 teachers) also agreed that the seminars had provided insights and solutions to practical issues/problems facing teachers, and also that the tasks and activities they engaged with during the training, had helped them to develop their ability to adopt the *Living Book* pedagogical approach in their teaching.

Participating teachers were prompted to note the aspects of the professional development seminars that they liked the most. Positive aspects pointed out included:

Table 18.1 Percentage of participants "agreeing" or "strongly agreeing" with each statement concerning the seminars

Statement	% Agreeing or strongly agreeing (%)
The seminars were well-organized	100
The presentations made during the seminars were interesting	100
The hands-on workshops were motivating	100
Adequate time was devoted to discussion	100
The underlying topics/issues were adequately covered by the seminar facilitators	100
The methodological strategies and approaches presented can be implemented in practice	100
The seminars have enhanced my theoretical and practical knowledge and skills regarding the educational exploitation of emerging technologies for augmenting reading	100
The seminars have provided solutions to practical issues/problems facing educators	96
The tasks and activities included in the seminars have helped develop my ability to adopt the *Living Book* pedagogical approach	96

- Program innovation/originality
- Focus of program on the promotion of children's love for books
- Enjoyable learning methods proposed
- Exposure to best practices
- Focus on accessibility and differentiation of instruction
- Good design of the program and use of multiple tools
- Familiarization with AR and other innovative technological tools and with how to use them in the classroom
- Practical examples and tips on how to integrate the Living Book approach in the school curriculum
- Familiarization with and use of the Living Library
- Promotion of cooperation between teachers, exchange of experiences with other teachers and schools in Cyprus and beyond.

The aspect of the seminars that the teachers seemed to have liked the most was the hands-on workshops. Almost everyone pointed out that the hands-on nature of the seminars gave them the opportunity to get familiarized with new, innovative technological tools (e.g., AR tools, QR Codes, text creation tools, comic creation tools, and digital games), and with ways in which these could be exploited to augment students' reading experiences. Participants expressed their appreciation for the fact that a big part of the seminars was led by teachers (from the local primary school participating in the project consortium) that had already tried out the Living Book approach in their classrooms, and had useful tips to share.

Respondents were also asked to indicate, again using a five-point Likert Scale, their level of agreement with each of a number of statements regarding the online platforms of the "Augmented Teacher" και "Augmented Parent-Trainer" courses (Table 18.2), and the project Living Library (Table 18.3).

Table 18.2 Percentage "agreeing" or "strongly agreeing" with each statement regarding the "augmented teacher" and "augmented parent-trainer" course platforms

Statement	% Agreeing or strongly agreeing (%)
The course platforms are easy to use and navigate	100
The course platforms are aesthetically attractive	96
The course platforms provide useful tools for the project and its implementation	100
The course platforms provide help and guidance to users	100
Both courses' content is well-organized into modules	100
Course modules include useful material and resources	
The modules' wording is simple and clear	96
The course modules include components that give greater clarity to the text (e.g., diagrams, images)	96

Table 18.3 Percentage of participants "agreeing" or "strongly agreeing" with each statement concerning the living library

Statement	% Agreeing or strongly agreeing (%)
Living library is easy to use and navigate	100
Living library is aesthetically attractive	96
Living library provides useful AR tools	96
Living library provides supporting educational material	100
Living library provides help and guidance to users	100
Living library supports the hosting of the courseware that we developed or will develop during the course	96
Living library supports the sharing of our teaching material	100
Living library contributes to my communication/collaboration with other teachers in Cyprus	96
Living library contributes to my communication/collaboration with other teachers abroad	96

As shown in Tables 18.2 and 18.3, both the technical and pedagogical features, as well as the tools and resources of the online course platforms and the Living Library received extremely high ratings from all or almost all of the participants.

Respondents were also asked to indicate the degree to which the different types of tasks, materials, and resources included in the online learning environments had contributed to their professional development in the context of the Living Book program. Everyone rated the contribution of suggested activities as very important, while a very high percentage also rated as important the contribution of the videos (81%), educational material in text form (88%), and suggested readings (63%) included in the course platforms and the Living Library.

Teachers in our study reported a number of challenges they anticipated to face in their attempt to introduce the *Living Book* approach in their classes. They cited various factors as obstacles to technology integration: limitations in the availability of PCs, laptops and tablets, limited resources, limited time, technical issues (e.g., lack of Internet connection, Internet connection going down at times), lack of support regarding ways to integrate technology into the curriculum, an oversized curriculum, shortage of suitable software, and lack of knowledge about suitable software. The need for additional training on the use of AR and other digital tools was particularly emphasized by the participants. When asked to rate their overall level of readiness to integrate contemporary technologies (e.g., mobile devices, augmented reality, mixed reality, QR codes, etc.) in their instruction after participating in the seminars, only 54% stated that they now felt "well" or "very well" prepared to do so, while the rest felt prepared only "to a certain extent". Teachers, who did not feel sufficiently prepared yet to incorporate the Living Book approach in their teaching, stressed the need, but also their intention for further training, in collaboration with the course facilitators and other teachers:

- More hands-on practice on their own with the new tools and technologies introduced during the seminars
- Familiarization with additional educational apps and tools
- Design of lessons using the technological tools
- More examples and suggestions for ways of integrating the technologies in the school curriculum
- Opportunities for collaboration with other teachers in designing activities that are based on the same theme.

Eight of the participating teachers reported having already used some of the technological tools introduced during the seminars (e.g., Kahoot, StoryJumper, QR code, Quiver, and HP Reveal), either for personal use ($n = 2$) and/or for teaching purposes ($n = 7$): "*I have used QR code…I did a birthday card and created a QR code with the song that I wanted to dedicate…very impressive.*" The experiences of the teachers who had attempted to introduce the *Living Book* approach in their classrooms were generally very positive, since they all made comments such as the following: "*I have taught the Little Prince using Augmented Reality. Children got really excited and the lesson was very effective.*" The rest of the teachers stated that although they had not yet tried out in their classrooms, they were looking forward to the next stage of the program, pointing out that they were planning to use the *Living Book* approach in various subjects including Language, History, Geography, Mathematics, Literature, Art, and Theatrical Studies.

Teachers' strongest incentive behind their intention to adopt the Living Book approach was, their anticipation that this would attract their students' attention, and motivate them to get interested in books: "*My long term objective is for children to get to love books*"; "*My objectives would be to utilize the Living Book platform so that children can get exposed to more books, through a different approach with the use of technology*"; They were expecting that through exposure to augmented reading and thus "*to multiple ways/means of creative expression,*" students would not only "*be provided with a more motivating learning environment that would promote their reading habits,*" but they would also gain several other educational benefits:

- Better comprehension of concepts and ideas
- Promotion of creativity, development of inquiry and problem-solving skills, and of critical thinking
- Acquaintance with the possibilities offered by emerging technologies such as AR
- Development of information technology soft skills.

When asked to indicate the profile of students that they believe would benefit the most from the implementation of the *Living Book* approach in their classroom, most teachers noted that augmentation of reading will benefit "*all students in diverse ways,*" and will "*increase everyone's motivation and maybe their love for books.*" Some teachers, however, argued that the adoption of the Living Book approach will be particularly beneficial for "*students who face learning difficulties,*" "*students that have low motivation for learning,*" and "*students that need visual stimuli.*"

18.6 Conclusions

Technological growth has given rise to diverse modes of communication technologies, different types of texts (e.g., digital texts, multimedia, etc.) and (ii) increased contact between different languages as a result of cultural and linguistic diversity, leading to the emergence of multiliteracies' as a new approach to literacy. This approach recognizes that oral and written language is no longer the sole means of communication and that new types of literacy have appeared or emerged as part of students' cultural backgrounds. This entails a significant shift in what a "literate" student looks like and a recognition that there is actually not one "thing" that can be defined as literacy. Instead, the multiplicity of literacies (e.g., media literacy, digital literacy, computer literacy, political literacy, cultural literacy, and visual literacy) is highlighted in the literature (Kalantzis and Cope 2001). Among the different types of literacy that are of vital importance in modern society, literary literacy is of particular concern to the *Living Book* project presented in this chapter.

Recognizing the important role of literature in children's cognitive and emotional development, *Living Book* has been exploring ways of utilizing AR and other contemporary technological tools to promote children's love for reading, while at the same time, serving the achievement of a variety of educational goals across the curriculum. Acknowledging the crucial role of both traditional and digital forms of literacy in contemporary education, the 'Augmented Teacher' professional development course that has been designed through the project, aims to build European teachers' capacity to contribute toward raising children's motivation toward reading and engaging them in different types of literacy practices across disciplines. Taking into account current theoretical developments in literacy education, adult education, teacher education, and distance learning; the course aims to offer high-quality in-service teacher training, ultimately aspiring to enrich European elementary and middle school children's experiences and skills in reading.

Concurring with the literature (e.g., Niess et al. 2009), our research has illustrated the usefulness of TPACK as a means of studying and facilitating teachers' professional growth in the use of technology in education. Key conclusions from the analysis of the data collected during the first phase of the study are that the professional development program has been quite successful in helping this group of educators move beyond their restricted views regarding the role of technology in teaching and learning. Although there was no pre-post assessment to formally track changes in participants' TPACK, there are also strong indications in the collected data of improvement in the participants' confidence level and proficiency in using AR and other innovative tools as a means of augmenting learners' reading experience.

The ultimate success of the *Living Book* approach will be determined through the data collected during the guided-field practice currently taking place in the participating teachers' classrooms. Analysis of these data will indicate the degree to which the participants are able to transfer and adopt their acquired TPACK into actual teaching practice. Research focusing on the integration of *the Living Book* approach in realistic school settings will also shed light into both facilitating and inhibiting factors to its successful implementation in formal learning contexts. This, in turn, will help to overcome researchers' and policy-makers' tendency to overlook the difficult conditions under which most teachers and students are operating in schools when investigating "state-of-the-art" technologies.

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Glossary of Terms

Augmented Reality (AR) An enhanced (augmented) version of the real environment overlaying digital information/objects being viewed through a device (such as a smartphone and/or tablet camera).

Augmented Reading The use of the digital ecosystem as a research and content space which can be usefully explored to complement reading activities.

The Living Book Approach A comprehensive framework for developing teachers' ability to support students in growing the reading skills and love for reading.

Living Book Guidelines An e-publication providing a methodological framework for implementing the Living Book approach.

The Living Book Library An open educational resource that conjugates reading and digital creativity to bring books to life. A "world" of resources for teachers and students across EU and beyond to read, socialize, and apply digital skills.

"Augmented Teacher" Professional Development Course A comprehensive training curriculum to develop knowledge and skills in teaching and learning using the Living Book approach.

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Chapter 19
Enhancing SPOC-Flipped Classroom Learning by Using Student-Centred Mobile Learning Tools

Lisa Law, Muhammand Hafiz, Theresa Kwong and Eva Wong

Abstract The aim of the study was to investigate the effectiveness of using student-centred online/in-class activities to enhance the learning performance of a group of teaching assistants ($n = 51$) in a Small Private Online Course-Flipped (SPOC-Flipped) classroom approach. A leading liberal arts university in Hong Kong has taken an initiative to develop a SPOC as a pilot for one of the training courses designed for teaching assistants. This six-week SPOC-Flipped classroom team teaching included a three-week online course that made use of the available online learning features like article, video, quiz, graded test, interactive discussion forum, etc. to incorporate key concepts of the course curriculum. A "3-stage SPOC-Flipped Classroom with Evidence" model was designed as a framework to enrich learners' online learning experience in the study. To better enhance learners' online learning concepts, various student-centred mobile learning (mLearning) tools like personal response systems and scenarios driven augmented reality mLearning technology were adopted for classroom activities in a gamified environment with timely feedback given by teachers. Marks of learners' online and classroom participation were recorded and analysed against their overall grade (i.e. learning performance) of the course. Results from both quantitative and qualitative data analyses indicated that: (i) there was positive correlation of learners' online/in-class participation marks against their overall learning performance, (ii) learners' in-class engagement increased by using mLearning technologies to reinforce their online learning concepts in a gamified environment and (iii) few learners preferred traditional classroom teaching due to the unfamiliarity of flipped classroom pedagogy.

Keywords Augmented reality · Flipped classroom · Mobile learning technology · Small private online course (SPOC)

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19.1 Enhancing SPOC-Flipped Classroom Learning by Using Student-Centred Mobile Learning Tools

There is an increasing popularity to develop online courses to allow learners the flexibility to learn their subject matters in their own time and at their own pace in this techno-generation. Coupled with the impetus to satisfy learners' autonomous motivational needs via a variety of learning modes, a leading liberal arts university in Hong Kong has taken an initiative to develop a Small Private Online Course (SPOC) as a pilot for one of the training courses designed for teaching assistants. The purpose of the training course is to prepare learners to take up teaching assignments at the university with an introduction to the basic theoretical teaching knowledge and practical skills. The training course, which was originally a seven-week face-to-face traditional classroom-based teaching, was redesigned into a six-week SPOC-Flipped classroom team teaching. The course team began the course design by developing a three-week online course with an e-learning development platform called FutureLearn and made use of the available online learning features like article, video, quiz, graded test, interactive discussion forum, etc. to incorporate the key concepts of the course curriculum.

Flipped classroom is a model where the traditional classroom and homework elements are reversed and viewed as a student-centred teaching approach (Jesurasa et al. 2017; Jing Ping 2016). The use of personal mobile devices was integrated with the flipped classroom pedagogy to motivate learners' classroom participation. Learners were instructed to complete the three-week online learning activities before the class. The role of teachers acted as facilitators to reinforce learners' online learning concepts with timely feedback and clarification. Various student-centred classroom activities were designed so that learners could use their mobile devices to access designated mobile applications to participate both inside and outside classroom activities. This approach has created what Wang (2017) suggested as a seamless and flexible environment that satisfy learners' autonomous motivational needs via a variety of learning modes. Wang further evaluated that flipped classroom could facilitate learners' learning experiences through pedagogies that engage their in-class active learning activities with intense interaction among learners and teachers. Apart from providing timely feedback, teachers (facilitators) could also make use of the mobile learning (mLearning) technology to assess learners' online learning concepts as a kind of formative assessment. Student-centred mLearning tools like personal response systems (PRSs) (e.g. Kahoot!, uReply, etc.) could motivate learners to participate in-class activities in a gamified environment with fun (Chan et al. 2019). In addition, the adoption of scenarios driven augmented reality (AR) mLearning technology for outside classroom activities allowed learners to immerse themselves in the virtual situations to create a level of context-awareness for better comprehension of conceptual issues like academic integrity. The scenarios described with picture, sound, video, storytelling, etc. were triggered by using QR code, IR (Image Recognition) and BLE (Bluetooth) via learners' mobile devices—another means of enhancing online learning experience.

19.2 Literature Review

19.2.1 Flipped Classroom

Flipped classroom is defined as a set of pedagogical approaches that moves most of the information-transmission teaching out of the class and use the class time for learning activities that are active and engaging. It also requires students to complete the pre- and post-activities learning online or through other mediums that are non-class based (Abeysekera and Dawson 2015). Flipped classroom is also known as a student-centred approach to learning where the learners are more active than the instructor in the classroom activity. In this case, the instructor acts as a facilitator to motivate, guide and give feedback on learners' performance (Sams and Bergmann 2012).

It has been suggested that the flipped classroom approach creates an active learning environment, which increases learners' performance and learning (Gross et al. 2015). Specifically, it allows learners to gain exposure of the content prior to in-class participation, allows teachers to assess learners' understanding or learning in class through learners' participation so as to customise suitable teaching and learning activities in time (Rutherfoord and Rutherfoord 2013).

However, flipped classroom pedagogy is not without limitations. Firstly, findings on the efficacy of the flipped classroom approach have been mixed. Jensen et al. (2015) found no significant difference between the flipped classroom and traditional learning. A recent study comparing flipped classroom with traditional instruction class and blended learning class found that perceived learning scores were the highest in the flipped classroom, highlighting the efficacy of flipped classroom pedagogy (Thai et al. 2017). Such contrasting findings necessitate further investigation on the usefulness of flipped classroom. Secondly, learners seemed to be less enthusiastic towards the use of flipped classroom (Tune et al. 2013).

Tune et al. (2013) attributed the lesser enthusiasm to the perceived increased in workload as compared to traditional class. Unlike traditional classes, learners were required to do their reading prior to attending classes. A significant amount of work has to be undertaken by the learners outside of the typical classroom time and could affect learners' motivation level to learn (Abeysekera and Dawson 2015). In addition, Gross et al. (2015) found that learners who completed the pre-class activities fared better than those who did not. In that sense, completing the pre-class activities is crucial for learners to benefit from the flipped classroom.

19.3 Use of Student-Centred Mobile Learning Technologies

The use of mLearning technologies could address some of the limitations associated with flipped classroom pedagogy. Mobile learning is defined as the ability to learn about the subject content across different situations and through social interaction on personal mobile devices (Crompton 2013). It allows information to be easily accessible by learners and provides collaborative learning practices that support multitasking and group activities, which enable learners to interact with others (Roehl et al. 2013). Lending credence to the need to adapt mobile learning is the increasing reliant on mobile devices as a source of information. Chiang et al. (2018) postulated that such trends changed the way learners seek information. Putting the aforementioned studies together, there is a need to integrate mobile technologies and learning into current teaching practices.

One advantage of using mLearning technologies in teaching is increasing learners' engagement level (Hung 2017). The author posits that learners are better engaged in class when platforms such as clickers are introduced, and learners are required to respond using their mobile phones. The use of clickers such as Kahoot! can be viewed as a gamification technique, which makes learners more willing to participate in the quizzes (Martyn 2007). However, it seems that the adoption of mLearning in the form of clickers-like platforms is limited to traditional classrooms. Since there has been a limited use of mobile technology in a flipped classroom environment (Lin et al. 2018), it remains unclear if the perceived advantages associated with mobile technologies could be transferred to a teaching approach such as the flipped classroom.

The use of mLearning technologies also provided the opportunity to allow AR to be introduced and integrated into education. AR has already been used in ethics education of several disciplines such as academic integrity, medical, engineering, arts and design, nursing education, hall life education (Kwong et al. 2018; van Krevelen and Poelman 2010; Yue et al. 2017). The reception of learners towards the use of AR in education context has been encouraging. Learners enjoyed the process of learning through AR because they were able to experience activities that they could not otherwise experience in a classical classroom such as creating virtual explosions (Bower et al. 2014; Schachter 2018). Also, the positive learning experience through AR had led the students to think "more deeply" about the subject matter (Kamarainen et al. 2018). This seems to suggest that more learning could take place when learners became more involved or were satisfactorily engaged with the learning process. AR could also be deployed to make teaching and learning more interactive and interesting.

More importantly, the use of mobile technology could complement and enhance flipped classroom pedagogy (Bidin and Ziden 2013). Heflin et al. (2017) posited that learners' attitude towards collaborative learning improved when mobile technology was introduced as part of classroom activities and, in turn, improved learners learning. The use of such technologies in teaching and learning allows various activities to be introduced as part of the lesson plan to make learning more fun and engaging.

In addition, the numerous features of mobile learning such as individualised interface, forum discussion and real-time accessibility to learning content could facilitate self-directed learning (Sung et al. 2016). This in turn could increase learners' motivation in learning. These benefits could overcome some of the limitation associated with flipped classroom in particular learners' poor reception because of perceived increased in workload.

19.4 The Study

The "3-Stage SPOC-Flipped Classroom with Evidence" model, which combined the use of flipped classroom with mLearning technologies, was specifically designed as a framework to guide this study. The first three stages of the SPOC-Flipped classroom approach, i.e. "Before Class", "In Class" and "After Class" together with the assessment methods devised for the course as "Evidence", allowed us to investigate if there were any relationships between different participation variables and the overall learning performance of participating learners under this type of pedagogical approach as shown in Fig. 19.1.

Stage 1—Before Class

Learners were expected to spend about 2 h per week to study the pre-designed SPOC learning materials before class. Key concepts of the course curriculum were designed and presented through the online learning features like article, video, etc. Other online activities like quiz, interactive discussion forum, etc. were developed to assess learners' online learning understanding in a formative manner. Activity of online graded test was designed as a summative measure for respective weeks. Upon completion of all pre-designed online activities, marks would be given as an "Online

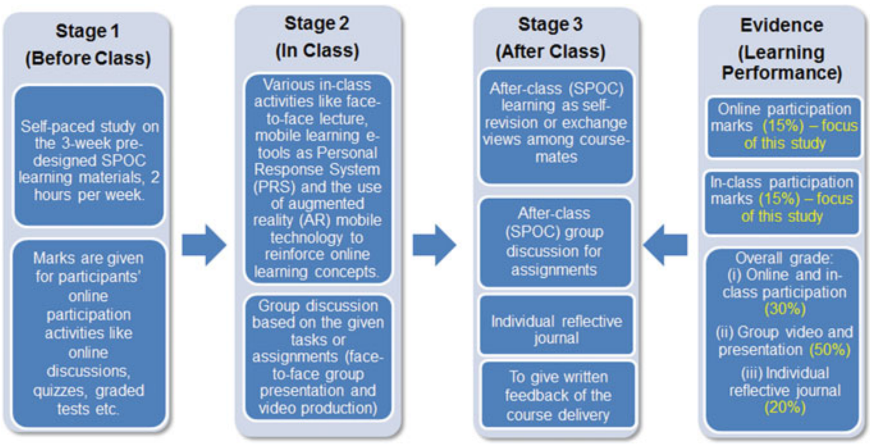

Fig. 19.1 A "3-stage SPOC-Flipped classroom with evidence" model

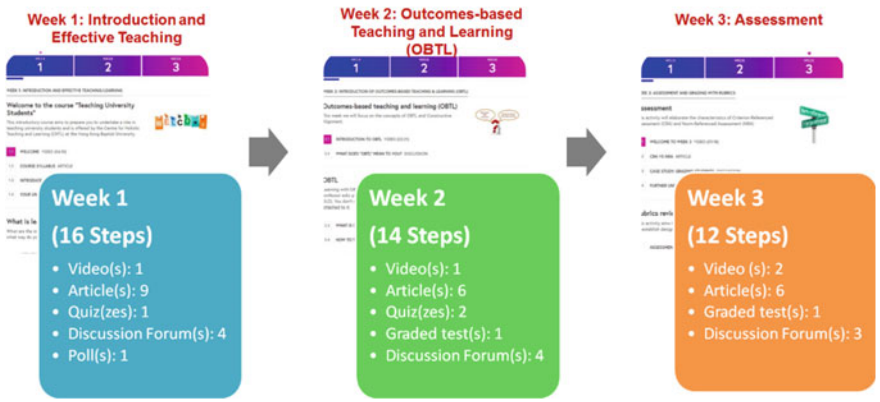

Fig. 19.2 Three-week SPOC structure with key topics

participation" score. The three-week SPOC structure with different key topics of the course curriculum and the related online activities is shown in Fig. 19.2.

Stage 2—In Class

Apart from the online participation, learners were required to attend scheduled face-to-face class sessions. Each session lasted for about 2 h and was facilitated by a course team of three teachers. Efforts were made to ensure learners would be motivated during in-class participation in order to reinforce their online learning concepts. Marks would be given to learners who actively participated in in-class activities as their "In-class participation" score. Student-centred in-class activities were designed in such a way that learners could use their own mobile devices to download mobile learning applications like Kahoot!, uReply, etc. (see Fig. 19.3) to attempt quizzes, discussions, etc. inside classroom setting.

These game-based personal response systems were played by the whole class in real-time mode. Multiple-choice questions for related teaching topic(s) would be projected on the screen and learners answered the questions with their own mobile devices. Teachers would give the class praises (or awards) as an incentive for correct answer(s) to question(s) and provided timely feedback/clarification on wrong answer(s) when required. An online application called "Padlet" to create online bullet board so that learners could post their ideas/questions via their mobile devices and projected on screen for in-class discussion activity was also used in class.

The adoption of AR mobile technology was to motivate learners' participation and to reinforce their conceptual understanding on less interesting but important issues like academic integrity, through an outdoor learning trail. Learners were instructed to download a mobile app called "AR-Learn" on their mobile devices (Wong et al. 2018). Once the app was installed, they could start the trail of "Trails of Integrity and Ethics" (TIE) on the campus during the session by using different triggers like QR code, IR (Image Recognition) and BLE (Bluetooth) to activate the four scenarios (or four checkpoints) about (i) plagiarism, (ii) citation, (iii) data falsification and (iv) ethical

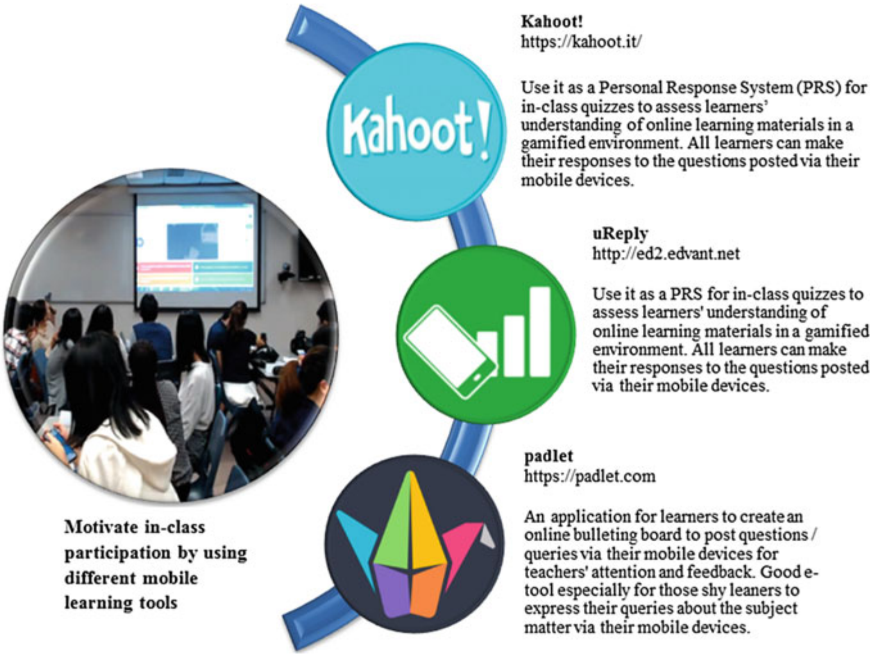

Fig. 19.3 Use of student-centred mobile learning tools for in-class activities

use of library books as shown in Fig. 19.4. Learners were able to immerse themselves in the given virtual scenarios and to make appropriate responses to questions given via their own mobile devices in a free learning environment. Learners' participation in this activity also counted as part of their in-class participation marks.

Stage 3—After Class

This stage allowed learners to consolidate their newly learned knowledge by working in groups for designated group assignments (i.e. 10-min group presentation and 5-min video production) and to write an individual reflective journal on their learning experience from the course (500–800 words). They could always revisit the online learning materials when needed.

19.4.1 Objective of the Study

The study aimed to investigate whether the adoption of student-centred online/in-class activities could motivate learners' participation, which in return enhanced their learning performance in the SPOC-Flipped classroom approach. This was achieved by examining learners' learning performance or overall grade and their participation in the various online/in-class activities. The assignment methods designed for the

Fig. 19.4 Use of AR mobile learning technology for conceptual learning

course consisted of (a) Participation, 30%, (b) Assessed Team Teaching and Learning Activities (in-class group presentation and video production), 50% and (c) Individual reflective journal, 20% with a maximum score of 100% (4 marks) as an overall grade. The overall grade (or "learning performance" for the ease of explanation in the study) of the course is calculated based on the formula "Overall grade = learning performance = a + b + c".

In addition, learners were also required to submit open-ended response questions in the form of a Course Feedback Questionnaire to gather their feedback on the course.

A mixed-method of both quantitative and qualitative data analyses had been deployed to the study for deeper understanding of the phenomenon of interest than the use of either a quantitative or qualitative approach alone (Doorenbos 2014). Quantitative data analysis emphasised on interpreting available data to pose and resolve research questions. Once categories and meanings are made from the quantified data, initial understanding of the issues being studied could be developed. Initial generated understanding is then tested and modified through cycles of additional data collection and analysis until coherent interpretation is reached (Bredo and Feinberg 1982; van Maanen 1983).

The use of qualitative data in the study was to yield data from which richer explanations of how and why the outcomes occurred could be developed (Markus and Robey 1988). The collected responses would provide valuable insights on how to improve the SPOC-Flipped classroom pedagogy at its subsequent offers and even for bigger class size in the future. More importantly, the findings could act as an indicator whether the designed interactive online/in-class activities under the mentioned SPOC-Flipped classroom model were effective to enhance participating learners' learning performance.

19.5 Method

A total of 51 learners ($n = 51$) from different subject disciplines were enrolled for this new training course held in the first semester of AY2017/18. However, due to attrition, the final sample size was 47 ($n = 47$).

19.5.1 Data Resources

Learners' marks from the course were collected as data. The breakdown of marks of the "Participation" assignment method was explained below.

a. **Online participation marks (15%)**

Marks were given to learners for their completion of the three-week online activities on quiz and online graded test, which covered the respective week's learning concepts for assessing learners' online understandings. The online participation marks contributed 15% of the overall grade of the course. A maximum of 4 marks for online participation could be achieved if learners reached the required standard.

b. **In-class participation marks (15%)**

Marks were given to learners for their in-class participation and contribution in various activities. The marks contributed 15% of the overall grade of the course. A maximum of 4 marks would be achieved if learners reached the required standard.

Furthermore, learners were required to complete the Course Feedback Questionnaire (CFQ) at the end of the course, which consisted of two related questions for this study, i.e. Question 1: Describe some good points about the course? and Question 2: Describe some areas of the course that could be improved?

19.5.2 Data Analysis Plan

"Statistical Package for Social Sciences (SPSS)" version 24 software was used to analyse the quantitative data. Descriptive statistics were examined and reported with the purpose of describing what occurred in the given sample. Pearson product-moment correlation coefficient (r), a quantitative data analysis was used to examine the relationship between learners' online/in-class participation marks (as described above) and their overall grade (as described in the formula above). The stronger the relationship of the two variables, the closer the Pearson correlation coefficient (r) would be to either $+1$ or -1 depending on whether the relationship was positive or negative, respectively.

Qualitative analysis was carried out for the written responses collected from the CFQ. The responses were coded and similar themes were grouped together. A frequency count was subsequently done to identify the top three categories.

19.6 Results

19.6.1 Quantitative Analysis

The marks collected from the mentioned assessment methods in this study, i.e. online quiz participation, online graded test, in-class participation and overall grade (learning performance) for $n = 47$ were analysed.

A breakdown of the mean mark (M) and standard deviation (SD) of the chosen assessment methods (AMs) was shown in Table 19.1. It was observed that the highest mean mark (maximum of 4 marks) among the mentioned participation activities was 3.60, i.e. "Online quiz participation" and "In-class participation" which suggested that learners were comparatively performed well in both online quiz and in-class participation in comparison with the online graded test.

Further investigation was carried out by generating the Pearson product-moment correlation coefficient I to observe the relationship between the online/in-class participation marks and the overall grade (i.e. learning performance) and the results were explained below.

Table 19.1 Mean (M) and standard deviation (SD) of assessment methods' (AMs) marks

AMs	M (SD)
Online quiz participation	3.60 (1.15)
Online graded test	3.09 (1.19)
In-class participation	3.60 (0.56)
Overall grade (learning performance)	3.39 (0.28)

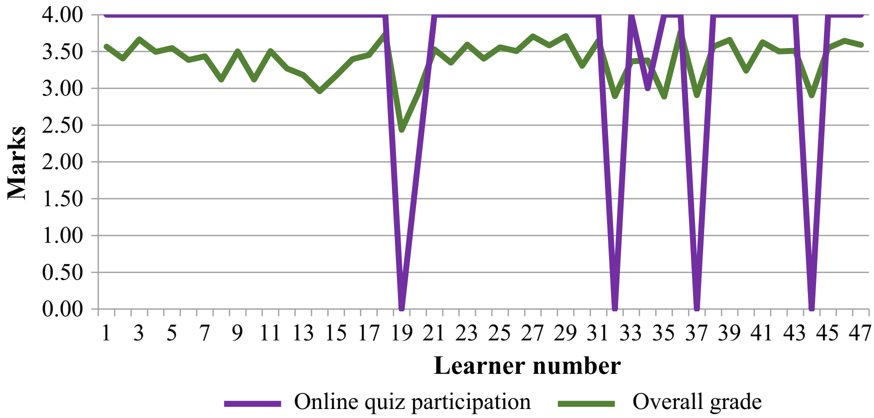

Fig. 19.5 Marks of online quiz participation and overall grade

(1) **Online quiz participation and overall grade**.

There was a positive correlation observed between the two variables, $r = 0.70$, $p = 0.000$. The strong and positive correlation between the marks of online quiz participation and overall grade indicated that increases in online quiz participation were correlated with increases in overall grade as shown in Fig. 19.5.

(2) **Online graded test and overall grade**.

There was a positive correlation observed between the two variables, $r = 0.74$, $p = 0.000$. The strong and positive correlation between marks of online graded test and overall grade indicated that increases in online graded test marks were correlated with increases in overall grade as shown in Fig. 19.6.

(3) **In-class participation and overall grade**.

A positive correlation between the two variables, $r = 0.55$, $p = 0.000$, was observed. The strong correlation between marks of in-class participation and overall grade indicated that increases in in-class participation marks were correlated with increases in overall grade as shown in Fig. 19.7.

19.6.2 Qualitative Analysis

Written comments collected from the two related CFQ questions listed below regarding learners' perceptions of the course delivery under this SPOC-Flipped Classroom model were categorised into different key themes according to their most frequent occurrence of similar phrases.

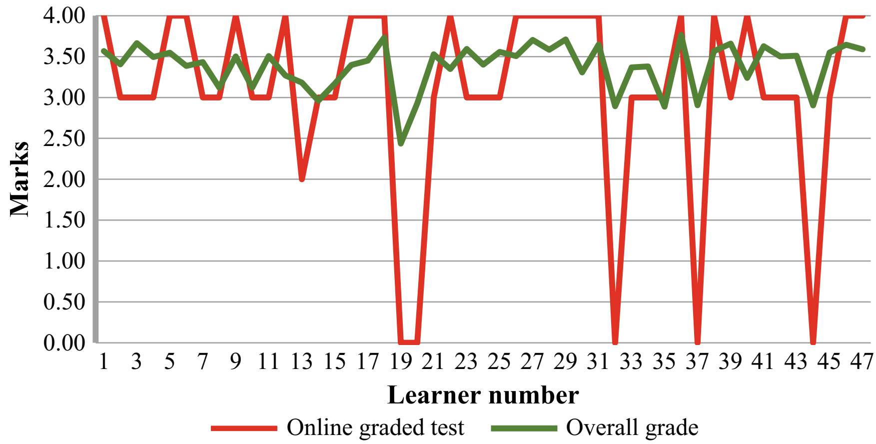

Fig. 19.6 Marks of online graded test and overall grade

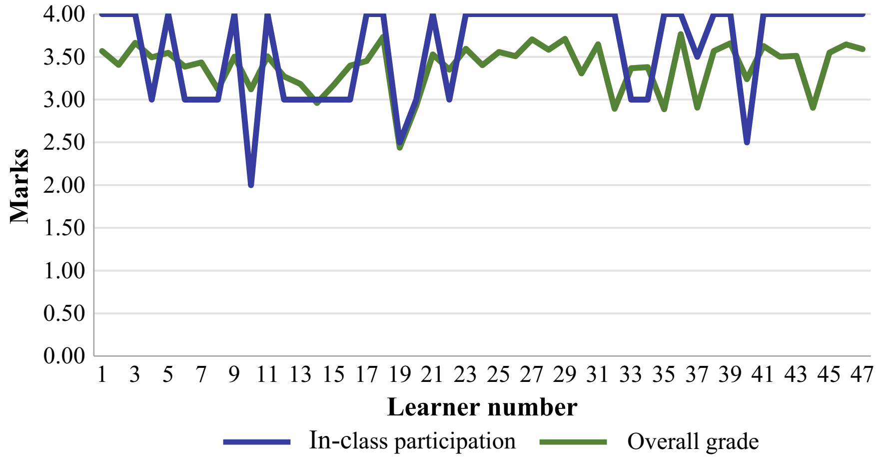

Fig. 19.7 Marks of in-class participation and overall grade

Question 1: Describe some good points about the course?
Question 2: Describe some areas of the course that could be improved?

Figure 19.8 categorised the most and least favourite responses (according to their occurrence frequency) for the course delivery under different key themes and sample of responses for Questions 1 and 2 were excerpted.

As shown in Fig. 19.8, the three most favourite categorised responses collected from Question 1 were (i) increased class participation, (ii) creative teaching method and (iii) characteristics of teachers. Forty per cent of the responses revealed that

Categorised key themes (n=38)	Number of similar responses (%)	Excerpts of responses
Most favourite responses for the course collected from Question 1		
Increased class participation and engagement	15 (40%)	"…we can be involved in this class."
		"Engage student very well…"
		"Many interactive activities…"
Creative teaching method	9 (24%)	"Interesting, useful."
		"…video part is interesting…"
		"The course is presented in a rather lively and interactive way."
Characteristics of teachers	4 (11%)	"They are all enthusiastic."
		"Good communication, patient…"
		"The lecturers [teachers] are well prepared for every lecture, including the learning materials." They have a great passion to teach us, even the topics are quite conceptual, hard to explain."
Others	10 (25%)	No comments
Least favourite responses for the course collected from Question 2		
Too much content	5 (13%)	"It takes too much time for before-class activities".
		"A lot of information has been given but sometimes I feel a little bit difficult to follow with professional terms."
		"Too much activity may cause some loss of focus, tired students may treat it as "interesting but useless part" then allow themselves to be distracted for a while."
Duration too long	5 (13%)	"Too long time"
		"…sitting through an hour to two hours of material before class and another 2 hours in class is a bit too much."
		"…class flipping means we learn most of the content by ourselves, this may consume us much more time to learn the same thing when compare with the traditional teaching approach."
Unfamiliar with the flipped classroom model	4 (11%)	"The Flipped Classroom teaching approach is new to me."
		"But the con is that there's so much responsibility that has been put onto students."
		"More living method (face to face)…"
Others	24 (63%)	No comments

Fig. 19.8 Categorised the most and least favourite responses for the course delivery

the course was conducted such that learners were given opportunities to participate in in-class activities. Twenty-four per cent of the responses revealed that the SPOC-Flipped classroom model was a creative teaching pedagogy and the use of mobile technologies (like PRSs and AR mobile learning trails) enabled the learning contents to be delivered in an interesting manner. Eleven per cent of the responses reflected the important characteristics of teachers in this kind of teaching model. For example, one of the responses said that the teachers aided learners' learning by

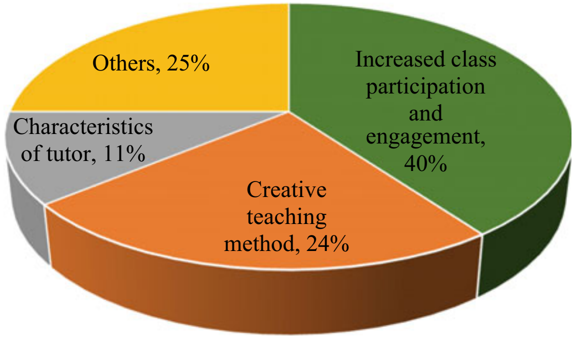

Fig. 19.9 Percentage breakdown for the most favourite key themes on the course delivery

reinforcing and making complicated concepts clearer in class, etc. Twenty-five per cent of responses formed the category "Others" in Fig. 19.8. The responses which consisted of single responses like "No", "NA", "Ok", "No comments", etc. were not significant enough to make any judgemental observation. The percentage breakdown for the key themes of the most favourite responses collected for the course delivery was shown graphically in Fig. 19.9.

Second part of Fig. 19.8 also showed the top three least favourite categorised responses of the SPOC-Flipped classroom model collected from Question 2. The three categories were (i) content, (ii) duration and (iii) unfamiliar with the flipped classroom model. Thirteen per cent of the responses revealed that the "Content" was too much and that the duration of the class was too long. These respondents felt that there was too much preparation work needed before each class such as online readings and activities. At the same time, the class duration was not reduced. Thus, they felt that with the increased workload of the online learning, the in-class duration should be reduced accordingly. It was interesting to note that there were respondents who felt that more face-to-face lessons were needed. One respondent even mentioned that he/she preferred traditional teaching than online learning. He/she felt uncomfortable that too much learning responsibility was placed on learners themselves. Sixty-three per cent of responses collected under the category of "Others" in Fig. 19.8 (under "*Least favourite responses for the course from Question 2*). It consisted of single responses like "No", "NA", "be more effective", "smaller classroom", "No comments", etc. and was not significant enough to make any judgemental observation. The percentage breakdown for the key themes of the least favourite responses collected for the course delivery is shown graphically in Fig. 19.10.

19.7 Discussion and Conclusion

The framework of "3-Stage SPOC-Flipped Classroom with Evidence" model as illustrated in Fig. 19.1 was specifically designed with the intent of improving learners' learning motivation was evaluated. Results from both quantitative and qualitative

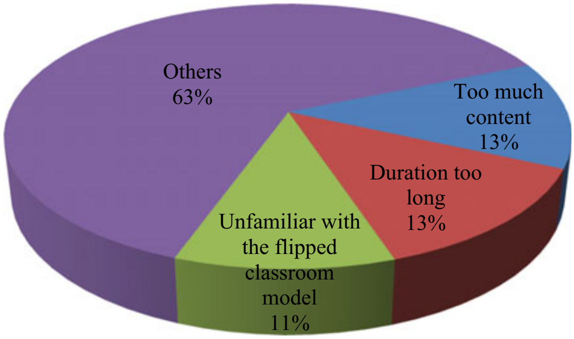

Fig. 19.10 Percentage breakdown for the least favourite key themes on the course delivery

data analyses on learners' online/in-class participation marks and the written feedback indicated that: (i) there was positive correlation of learners' online/in-class participation marks against their overall learning performance, (ii) learners' in-class engagement increased by using mLearning technologies to reinforce their online learning concepts in a gamified environment and (iii) due to the unfamiliarity of this type of SPOC-Flipped classroom pedagogy, there were a few learners who preferred traditional classroom teaching.

The intention of using mobile technologies to design interactive activities was to motivate learners' in-class engagement and interaction and to reinforce their online learning concepts (Hung 2017). The use of different PRSs like Kahoot! and uReply motivated learners' in-class participation in real-time game-based competition environment, which in turn strengthened their cognitive understanding of the online concepts. In addition, the use of an online application such as "Padlet" allowed learners to actively participate in in-class discussion. It also provided the opportunity for learners who were shy to speak in front of the class to express their point of views anonymously.

In this regard, teachers could further assess learners' needs and make necessary teaching and learning activities in time. This further strengthened mobile technology ability to motivate learners' in-class participation and allow teachers to give timely clarification on any unclear concepts. They could also adjust teaching and learning activities in time to meet learners' needs if required (Rutherfoord and Rutherfoord 2013; Sams and Bergmann 2012).

The collaborative learning experience that was created by integrating the mLearning technologies in the flipped classroom pedagogy allowed learners to access learning materials more easily and more engaged in in-class discussions that enhanced the benefits of flipped classroom (Lin et al. 2018). Having more classroom engagement and interaction enhanced learners' understanding, which in turn resulted in better overall grades (Gross et al. 2015).

Mobile learning through the use of AR enabled learners to be engaged in ways that was not possible in a traditional classroom (Bower et al. 2014). The current study adopted the use of an outdoor AR mobile learning trail to enhance learners' conceptual understanding on the less interesting but important issues like academic integrity.

Learners could immerse themselves in the virtual scenarios regarding ethical issues like plagiarism, citation, data falsification and ethical use of library books and to make responses to the questions posted within the mobile app called “AR-Learn”. The positive impact of using the said mLearning tools and the AR mobile technology to engage learners was supported by the quantitative and qualitative results. The results also implied that learners were engaged in in-class activities and willing to contribute what they had learned from the online learning materials, which in turn enhanced their deeper cognitive understanding.

An interesting outcome was the mediating role that teachers played in ensuring the success of mLearning in increasing learners’ motivation and engagement. Findings from the qualitative data highlighted the importance of teachers’ characteristics in determining the successful application of mLearning technologies. Similar observation was also made by Jesurasa et al. (2017) where facilitators played an important role to the success of SPOC-Flipped classroom. The course, with a student-centred teaching at its core, was designed to specifically integrate SPOC-Flipped classroom with mLearning technologies complemented by the facilitative role of the teachers contributed to the positive outcome.

Despite the encouraging support on the use of mLearning technologies, negative feedback was also recorded from learners. The top three least favourite categorised responses were related to the course content, class duration and unfamiliarity with flipped classroom. There seemed to be a difference in expectation regarding the flipped classroom. Students were unsatisfied that the duration of classes was too long or expected more face-to-face mode of lesson. Managing learners’ expectation and satisfaction had been identified as a key factor determining the success of the flipped classroom (Jesurasa et al. 2017). Since SPOC-Flipped classroom approach was a new attempt in the university, it might be useful to clearly explain to learners before the class or at the first session of the course about the rationales and advantages of adopting SPOC-Flipped classroom approach to ensure they truly understood what was expected of them and what SPOC-Flipped classroom entailed as this would affect their satisfaction which in turn affect their learning (Gilboy et al. 2015).

Implications from this pilot study could serve as a reference for future studies. These results suggested that the use of mLearning technologies and the “3-Stage SPOC-Flipped Classroom with Evidence” model complemented each other. Nevertheless, further research could be conducted for bigger class size with the use of the latest mobile learning technologies to check the validity of data collection for the better enhancement of the SPOC-Flipped classroom pedagogy.

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Glossary of Terms

AM Assessment Method
AR Augmented Reality
BLE Bluetooth
CFQ Course Feedback Questionnaire
IR Image Recognition
M Mean
SD Standard Deviation
SPOC Small Private Online Course
TIE Trail of Integrity and Ethics

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Chapter 20
Academic Integrity in the Digital Era: Student Skills for Success Using Mobile Technology

Alice Schmidt Hanbidge, Amanda McKenzie, Kyle W. Scholz and Tony Tin

Abstract Engaging students and instructors in academic integrity (AI) education is of ongoing concern to the quality of higher education. Although many institutions rely on instructors to educate students about academic integrity in the curriculum (MacLeod 2014), insufficient time is spent teaching and practicing its concepts (Bertram Gallant 2008). Traditionally, AI information is shared during orientation week to assist first-year students with the academic transition to university; the quality of this instruction is, however, frequently inconsistent. These methods have not been highly effective at increasing students' level of academic integrity and incidents of academic misconduct are increasing (Dee and Jacob 2012; Gillis 2015, 2016; Kezar and Bernstein-Sierra 2016). Mobile learning or "education on the go" (Ally 2004; Wu et al. 2012) can enhance students' access to and awareness of AI through anytime, anywhere learning experiences. The innovative mobile application, *Integrity Matters*, aims to develop learners' knowledge and skills in AI by learning key values to guide understanding of academic integrity. The application focuses on authentic, scaffolded video scenarios that align with the International Center for Academic Integrity's (ICAI) core values of AI: honesty, trust, respect, responsibility, fairness and courage (ICAI 2014). Significant gains in academic integrity knowledge occurred for students ($N = 1149$) in this usability research study in six undergraduate faculties following completion of the *Integrity Matters* learning modules. *Integrity Matters, an open-access, tri-lingual (English, French, and Chinese) application, is designed for higher education institutions. Available under a creative commons (CC) license, Integrity Matters content can be customized, branded, and integrated across educational settings.*

Keywords Academic integrity · Mobile learning · Open educational resource

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20.1 Introduction

Engaging students and instructors in academic integrity (AI) education is of ongoing concern in higher education. AI is a foundational part of academia, and it is imperative that all members of campus uphold integrity in their work. Without AI, there is a lack of credibility and a threat to the value and quality of educational degrees; therefore, schools must work to enhance students' and instructors' understanding and commitment to maintaining academic integrity.

When it comes to teaching students about academic integrity, most schools rely on educating students about academic expectations during orientation week and in the first week of classes (Haas 2005). This is problematic for a variety of reasons. First, this vital information gets lost in the excess of information students receive when they arrive on campus; the traditional timing of any AI instruction falls within early stages of one's academic career, again, either occurring in a student's orientation, or as part of an instructor's introductory lesson on the first day of class. The message conflicts with all of the other information a student is processing and quickly becomes an afterthought until confronted with academic offenses.

Second, institutions rely on instructors to educate students about academic integrity (MacLeod 2014), yet insufficient time is spent teaching and practicing its concepts (Bertram Gallant 2008). Finally, the quality of instruction about academic integrity is inconsistent and not well reinforced after the start of school. It is evident that methods used thus far have not been highly effective at increasing students' level of academic integrity. Rather, increasing incidents of academic misconduct continue (Dee and Jacob 2012; Gillis 2015, 2016; Kezar and Bernstein-Sierra 2016).

A collaboration of faculty and staff from the University of Waterloo and Renison University College in Southwestern Ontario, Canada, spanning various faculties and support units determined a need to rethink how tenets of academic integrity were being shared, understood, and reinforced in higher education. Traditional methods of academic integrity instruction, whether through workshops held during orientation week, overt policies written on syllabi, or an expectation of instructors to reinforce what constitutes plagiarism and other academic integrity offenses, have not been very effective. Depth of learning can be attained by embedding academic integrity in the curriculum and then overlapping coverage of the topic through multiple courses, across years and through various methods in university. Without an institutionally coordinated approach supported by students, staff, faculty, and the administration, the onus to inform learners of what constitutes academic integrity depends on individual instructors and it frequently falls to the wayside.

In order to address these challenges in AI education, we developed and rigorously tested a mobile application *Integrity Matters* to deliver consistent, timely, and learner-centered instruction. The *Integrity Matters* app accomplishes four primary goals: First, it instructs and reinforces the core values of AI through pedagogically sound and validated modules with accompanying assessment; second, it focuses on an educational approach to AI, rather than a punitive or disciplinary approach to academic misconduct; third, it does so in the mobile environment, allowing for anytime, anywhere learning to occur; and finally, by virtue of it being mobile, it allows learners to acculturate themselves to post-secondary education and to the core values of academic integrity *before* they arrive on campus.

20.2 Literature Review

20.2.1 Academic Integrity

Academic integrity is the foundation of educational institutions, and it provides credibility and value to the credentials these institutions confer. According to the International Center for Academic Integrity (ICAI), academic integrity is defined "as a commitment, even in the face of adversity, to six fundamental values: honesty, trust, fairness, respect, responsibility, and courage" (ICAI 2014, p. 16). Research in the field of AI indicates that better education is the most effective mechanism for reducing cheating [i.e., academic misconduct] (Fishman 2016, p. 15). Over the past 20 years, institutional approaches to academic integrity have shifted from being punitive or rules-focused to being more educative (i.e., teachable moments) and values-based (Bertram Gallant 2008, 2011; Cole and Kiss 2000). Bertram Gallant (2011) emphasized that "schools should aim to infuse the value of integrity into structures, processes and cultures of the organization" (p. 13). Therefore, to embrace the concept of academic integrity, students need to have scholarship and integrity role modeled and nurtured within the educational institution (Batane 2010; Glendinning 2014; Rolfe 2011; Stappenbelt and Rowles 2009; Young et al. 2018).

Traditionally, scholarly rules to maintain academic integrity have been passed onto students directly from their instructors. While a focused and interactive discussion about academic integrity remains the most effective way to get students to embrace AI (East 2016; Fishman 2016), this practice is variable among instructors, and there is vast inconsistency in both the AI content shared and the depth of the discussion (Haas 2005). MacLeod (2014) studied faculty attitudes on students' academic integrity at 17 Canadian universities and concluded that every university "mentions the importance of academic integrity and affirms that they expect students to act ethically. Regrettably, there are often no follow-up provisions for actually teaching students to do so" (p. 11). Hence, it is imperative that students receive this foundational information in a consistent manner that will augment any other instruction (or lack thereof) they have received about AI.

East (2016) states, "the challenge is not only to inform students about academic integrity, but also to engage students in this education and to provide them with opportunities to develop their scholarship capabilities" (p. 482). She also highlights that an AI module should include the following key elements: be engaging (e.g., use a progression of challenges and decision-making activities); use more images than text to convey meaning; incorporate games to immerse students in the content and provide them with immediate and memorable feedback; and provide opportunities to apply their learning and practice these concepts (pp. 486–489, 493). This final element, that of applicability beyond the classroom, is integral; Bertram Gallant (2011) points to the work of Pfeiffer and Goodstein (1983), who refer to "an inferential leap [that] is made…to the reality of everyday life" (p. 4). The ultimate goal of educating students about the fundamentals of AI is for them to recognize the importance of these values and how they transcend beyond their academic life, applying to their personal lives and future careers.

Young et al. (2018) suggest that "the extent to which campus climate encourages a holistic and positive academic climate, and the extent to which students view campus policies as working to reduce cheating, consistently influence the probability of students' developing a greater understanding of academic integrity" (p. 9). Hence, educational institutions must build a culture of integrity by promoting the values of AI at all levels of the institution, including through the curriculum. In addition, institutions must actively engage in AI through open discussions and role modeling, which leads to increased awareness, and personal and social responsibility to uphold these values (p. 15). With these in mind, a mobile application is a fitting way to bridge new learners' understanding of academic expectations, heighten understanding of academic integrity, and acculturate students to higher education.

Given that technology is rapidly changing the way information is sent, the transfer of knowledge about academic integrity needs to keep pace with the best and most innovative ways to educate students. The *Horizon Report: 2016 Higher Education Edition* points to mobile learning applications on student's personal devices as the imminent means to be used by higher educational institutions (New Media Consortium, 2016, p. 1). A mobile application is not only visually stimulating, but it can be interactive and appeal to students' desires to engage with content rather than just receive it. A mobile app also provides this education anytime, and anywhere, without being confined to a classroom or learning management system. Moreover, students have the opportunity to practice and learn from their mistakes in a simulated environment without fear of repercussion. As East (2016) argues, "all students take time and practice to become versed in academic codes and to understand academic culture" (p. 485).

There is limited research with regard to the efficacy of academic integrity instruction, particularly using metrics with pre- and post-measures, and even less is known about using a mobile application to teach AI. This project aims to contribute to the literature on academic integrity research, while making meaningful connections to the discipline of mobile learning.

20.2.2 Mobile Learning

Now, more than ever, university and college students spend a majority of their time online, whether it be for school, work, or leisure. This challenges traditional teaching methods, such as lectures, which remain frequently used to educate learners in higher education. In order to provide information to students in a format they relate to and readily engage with, new teaching approaches need to emerge to keep pace with pedagogical advances. This means bringing the act of teaching into a space where students spend much of their time—online. Since students are familiar and adept at using online technology, mobile applications are a viable way to teach today's students in a format that they relate to.

Mobile learning (mLearning) entails learning across multiple educational contexts while using personal electronic devices, such as cell phones or tablets. Generally, mobile learning is defined as the conducting of educational activities using a mobile device and wireless services in which both learner and device are mobile (El-Hussein and Cronje 2010). Mobile learning, innovative mobile technology pedagogy, or "education on the go" (Ally 2004; Wu et al. 2012) can enhance students' access to and awareness of academic integrity through anytime, anywhere learning experiences. Learning "just-in-time" enables students to take advantage of reviewing lessons at their own pace and in their free time, as they frequently have devices at their side.

Advancements in innovative and interactive mobile learning technology have led to various applications that augment active learning environments to support students to better understand concepts and skills (Bakırcı et al. 2011; Furio et al. 2015, Koong and Wu 2011). Mobile applications ('apps') are software programs designed to run on mobile platforms, such as Android or iOS. Learning applications are dedicated to educational purposes, to be used in and out of classrooms. As Scott McQuiggan et al. (2015) suggest, "mobile learning provides a new way to motivate students by providing high level of engagement and novelty, personalization, and autonomy. The ability to constantly use new apps and find new ways to use the device keeps it fresh and interesting for students" (p. 12). The ubiquitous availability of mobile devices is redefining how instruction is delivered and how learning can occur. Researchers suggest that information obtained through mLearning can be retained more effectively than traditional classroom lectures (Barzilai and Blau 2014; Hwang et al. 2015; Taskm and Kandemir 2010) while mobile learning has extended the learning to outside the classroom (Su and Cheng 2013). Furthermore, mobile learning can enhance the learning experience by increasing student motivation (Schunk et al. 2013).

The transition to embracing mLearning in academia is inevitable. This shift includes a pedagogical shift from teacher-centric to autonomous learner-centric, to education that is available on an as-needed or on-demand basis. While there are multiple advantages of integrating mobile learning into education, challenges remain and must be considered. Internet access, teacher training and support, and smartphone device limitations, such as memory size, small keyboards, and limited battery life, all impact usability of mLearning. Higher educational institutions globally are investing heavily to advance technology to address enhances learner's needs as mLearning offers new affordances to transform traditional learning platforms into digital classrooms.

20.3 Integrity Matters

20.3.1 Integrity Matters *Mobile Application Development*

The mobile learning application *Integrity Matters* aims to develop learners' knowledge and skills in AI by reinforcing six key values to guide understanding of academic integrity. As outlined previously, our project goals were:

- instruct and reinforce the core values of AI through pedagogically sound and validated modules with accompanying assessment;
- an educational approach to AI, rather than a punitive or disciplinary approach embraced the mobile environment, allowing for anytime, anywhere learning to occur; and,
- by virtue of it being mobile, it allows for learners to acculturate themselves to post-secondary education and the core values of academic integrity before they arrive on campus.

A diverse team from the University of Waterloo, including expertise from various academic departments (i.e., Math, Engineering, Social Work), the Office of Academic Integrity, the library, the Centre for Teaching Excellence, as well as student representatives, all participated in the development process of the app. Funding was provided through a research grant from eCampus Ontario which supported our project development (eCampus Ontario 2017). Due to the *Integrity Matters* app being funded by eCampus Ontario, whose mandate is to "support the evolution of online and technology-enabled teaching and learning at Ontario colleges and universities" (eCampus Ontario), this open-access mobile application operates with a Creative Commons license so that other institutions may use the lesson plans, vignettes, and quizzes and reuse and customize the content to their own needs. The *Integrity Matters* mobile application is available for both Android and IOS operating systems, and it is currently available in English, French, and Chinese languages.

20.3.2 System Design

The system utilizes a modular architecture, allowing individual components to be upgraded over time. It contains an evaluation module for users to gauge their knowledge and understanding of academic integrity concepts. It operates on a MYSQL database system which stores the content, user information and data (see Fig. 20.1). Users with different mobile devices can download and install the app through the iTunes store or Google Play.[1]

[1]IOS (https://itunes.apple.com/us/app/integritymatters/id1355112345?mt=8)
Android (https://play.google.com/store/apps/details?id=uwai.dev.uwai&hl=en).

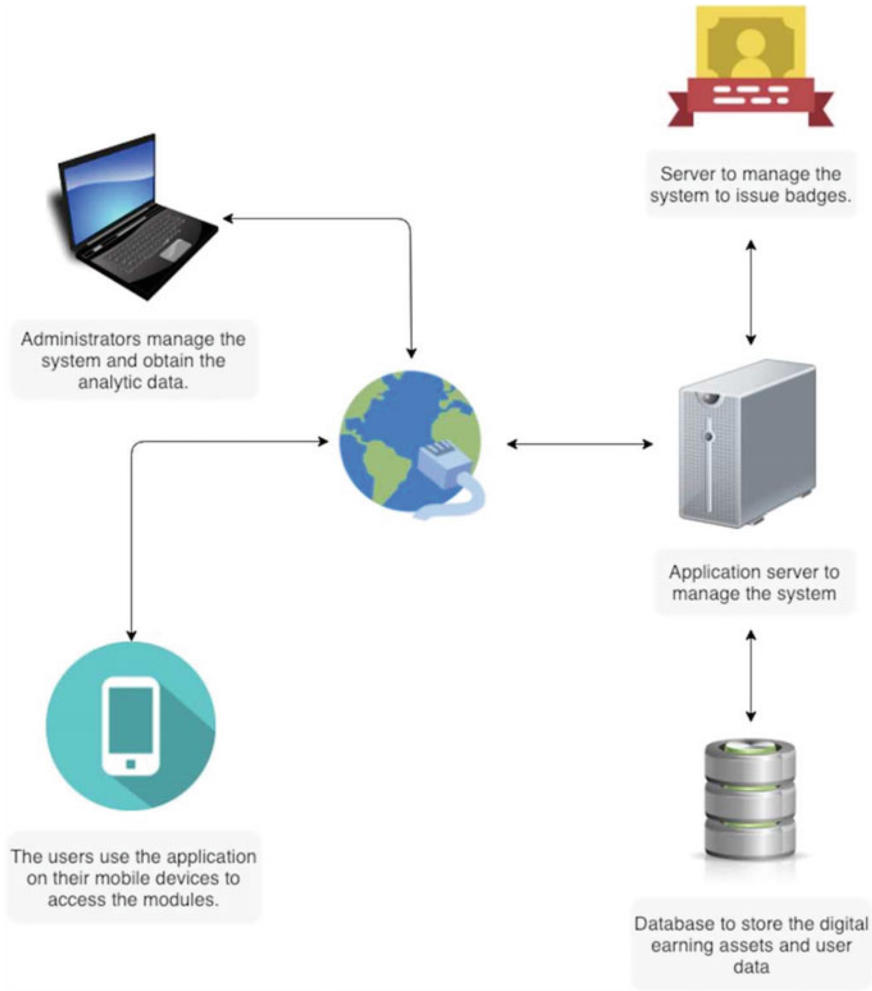
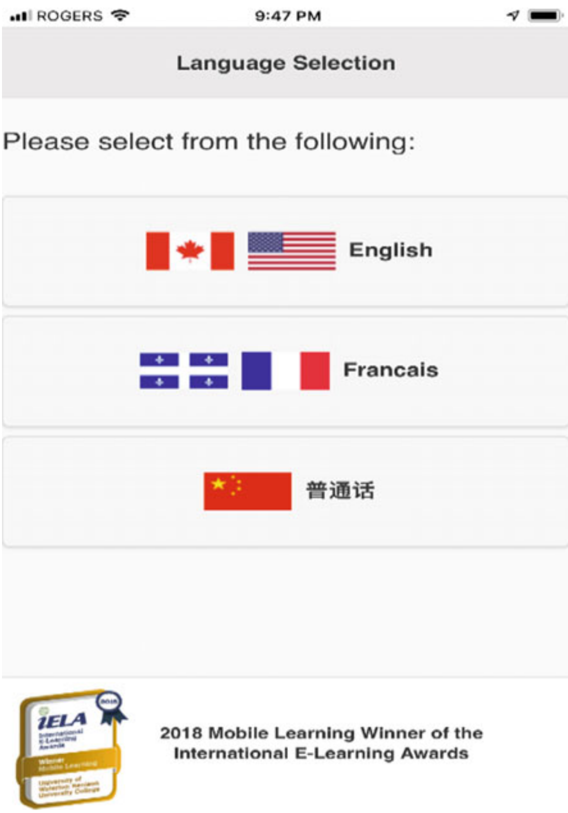


Fig. 20.1 System design

20.3.3 Multiple Languages

The *Integrity Matters* app is a tri-lingual (English, French, Chinese) application, designed primarily for post-secondary learners (see Fig. 20.2 for a screenshot of the *Integrity Matters* home screen and the ability to select language of choice). To appeal to a wide linguistic audience, the system was designed and developed in three languages that are commonly used within learner demographics across Canadian post-secondary institutions. Additional languages such as Russian and Punjabi are under consideration for future development.

Fig. 20.2 *Integrity Matters* language selection



20.3.4 Content

The app encourages academic integrity through value-based active learning that supports learners' academic success. "Real-life" scaffolded animated scenarios were developed in each learning module to model the International Center for Academic Integrity's core values of AI: honesty, trust, respect, responsibility, fairness, and courage (ICAI 2014[2]). These key values are well recognized by the international community of academic integrity practitioners and researchers. Each module contains visually stimulating multimedia and interactive content, accompanied by a definition of the core AI value addressed in each module (see Fig. 20.3).

Lessons depict authentic case scenarios with animated videos and text that involve diverse challenges that students may face, such as impending deadlines, peer pressure, and cultural differences. The intention is to help students understand the basic values of AI in academic life and beyond in hopes that they will strive to apply these values in their actions as members of the campus community and in their everyday life.

[2]https://academicintegrity.org/fundamental-values/.

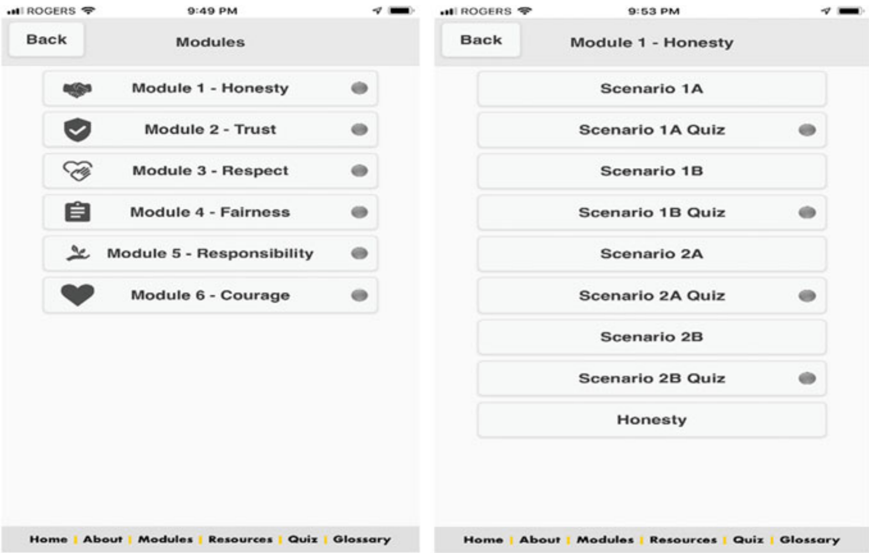


Fig. 20.3 Lesson structure

Learners are given a short quiz at the end of each module and are provided with immediate feedback on how accurate their response was, to help them understand the complexities of value-based decisions.

Upon successful completion of the modules and quizzes, students who demonstrate their AI competency by successfully completing all six modules with a passing grade of 75% or higher are awarded an e-certificate. In addition, students have the option of a customized digital badge to recognize their successful completion (see Fig. 20.3). A sample scenario and its related quiz are displayed in Fig. 20.4. Demonstration of specified learning outcomes is represented visually by a badge a digital image displayed on a Web site accompanied by written information indicates the issuer, date of completion, and criteria (see Fig. 20.5). Learners can claim a customized badge at the CanCred Passport site[3] and can choose to make their badges publicly visible by exporting the badge to their social media account profile (e.g., LinkedIn, Facebook) or an electronic portfolio.

The app also contains a glossary, an alphabetical list of terms in the domain of academic integrity knowledge and links to web resources concerning plagiarism, AI materials, paraphrasing, and different citation styles (see Fig. 20.6).

The app features two games to enhance learners' knowledge and understanding of the core AI values (see Fig. 20.7). The first game requires students to correspond each AI value with a definition within 60 s. In the second game, learners are tasked with

[3]https://passport.cancred.ca/.

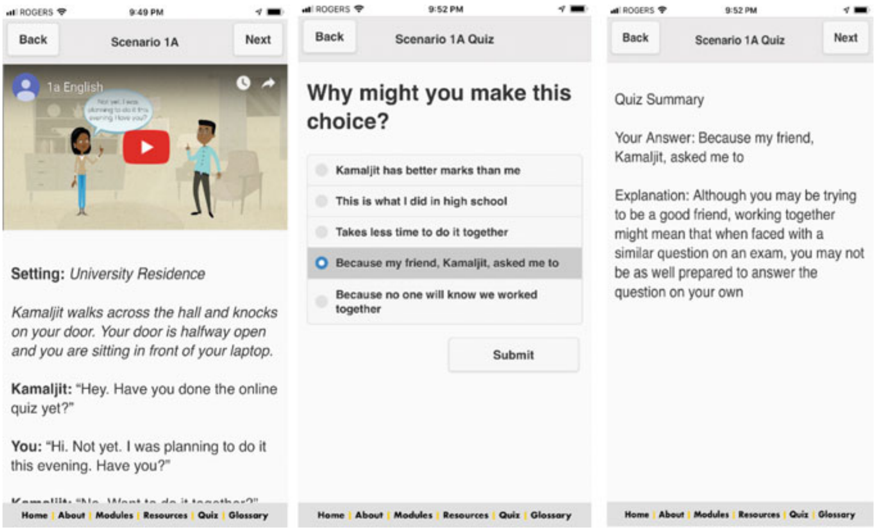


Fig. 20.4 Scenario video and related quiz

Fig. 20.5 E-certificate and open badge

matching six vignette scenarios with a corresponding AI value. Recent research indicates that gamification can engage learners and produce positive learning outcomes (Kapp 2012; Su and Cheng 2013, 2015).

20.4 Methodology

A mixed-method non-experimental methodology structure in this research study included University of Waterloo undergraduate study participants ($N = 1149$) and a control group ($N = 29$) who completed pre-/post-tests, student questionnaires, focus

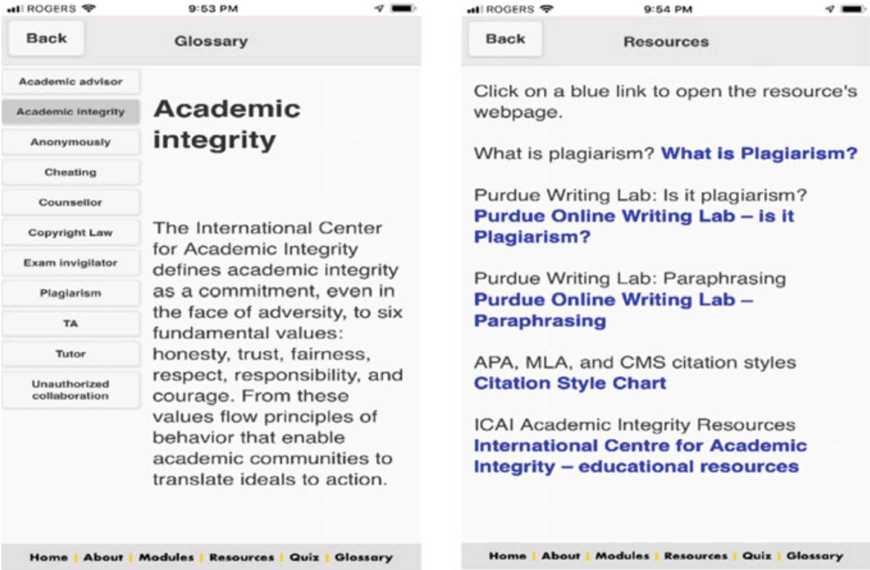


Fig. 20.6 Glossary and resources

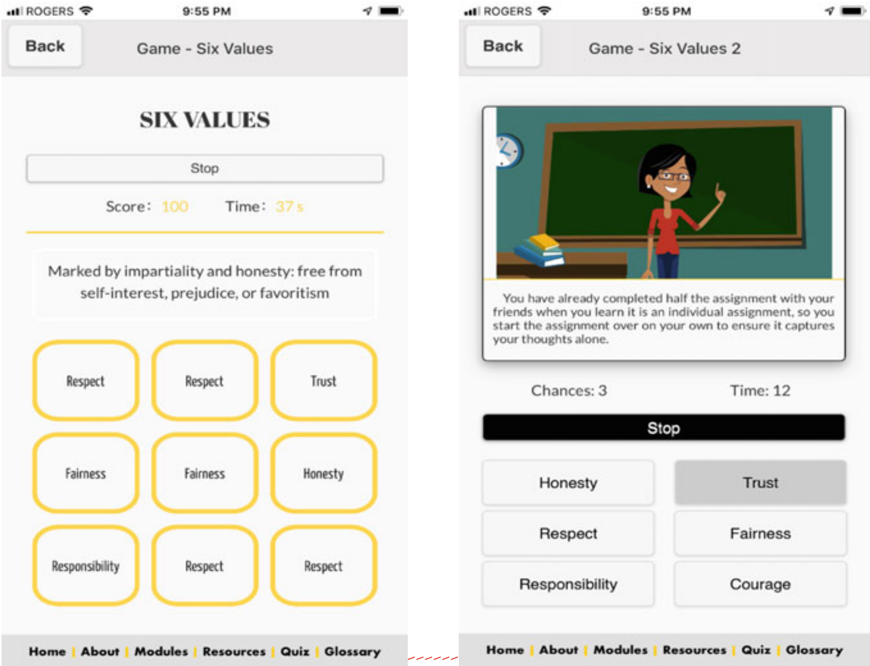


Fig. 20.7 Six values AI games

Table 20.1 Pre–post-difference tests

		Pre-test	Post-test	Difference
N	Valid	1149	1149	1149
Mean		7.50	7.98	0.49
Median		8.00	8.00	0.00
Standard deviation		1.255	0.802	1.151
Minimum score		1	3	−6

group interviews, and tool usability testing. Participants were recruited voluntarily through a usability study approved by the University of Waterloo research ethics board (ORE #22437) via an email invitation conveyed across campus. Statistical analysis revealed significant differences among participant groups regarding academic integrity testing results while the control group test scores did not improve significantly from pre- to post-test. Data analysis with a one-sample T-test indicated that students improved their test scores after completing the AI lessons by a mean of 0.49; 95% confidence interval [CI] = [0.42, 0.55]. The pre-test mean was 7.50, while the post-test mean was 7.98 and the difference was 4.9. Statistical tests revealed that the score distribution of pre-test and post-test were significantly different. We concluded the *Integrity Matters* module lessons significantly enhanced students' academic integrity knowledge. A repeated measures one-way analysis of variance (ANOVA) test (see Table 20.1) indicated significant differences between faculties in the pre-test ($p = 0.005$) as well as in the pre-/post-difference ($p = 0.008$).

More than half of the data was gathered from first-year students (51.5%; 592 students); participants also included learners studying in their second year (16.13%), third year (13.58%), and fourth year (17.0%) of university. Fifteen (1.4%) study participants were graduate students. Students from six faculties across campus were represented in the research study group; applied health sciences (6.63%), arts (12.22%), engineering (48.87), environment (4.71%), math (12.39%), and science (15.18%) (see Fig. 20.8).

Pre-/post-findings based on faculty. Students in the math faculty performed poorly in the pre-test (7.18), but they improved the most compared to other faculties following completion of the lessons (0.73). From the ANOVA test, significant differences between faculties were noted in the pre-test ($p = 0.005$) as well as in the pre-/post-difference ($p = 0.008$). In the pre-test, all faculties outperformed the faculty of math (see Table 20.2). In particular, the average score of applied health sciences was higher than math by 0.475, arts was higher than math by 0.538, engineering was higher than math by 0.276, environment was higher than math by 0.428, and science was higher than math by 0.42. In the post-test, there was no significant difference between faculties. Based on the average score, faculty of applied health sciences had the best performance. In pre-/post-differences, faculty of math students improved the most, while those in the faculty of arts demonstrated limited improvement.

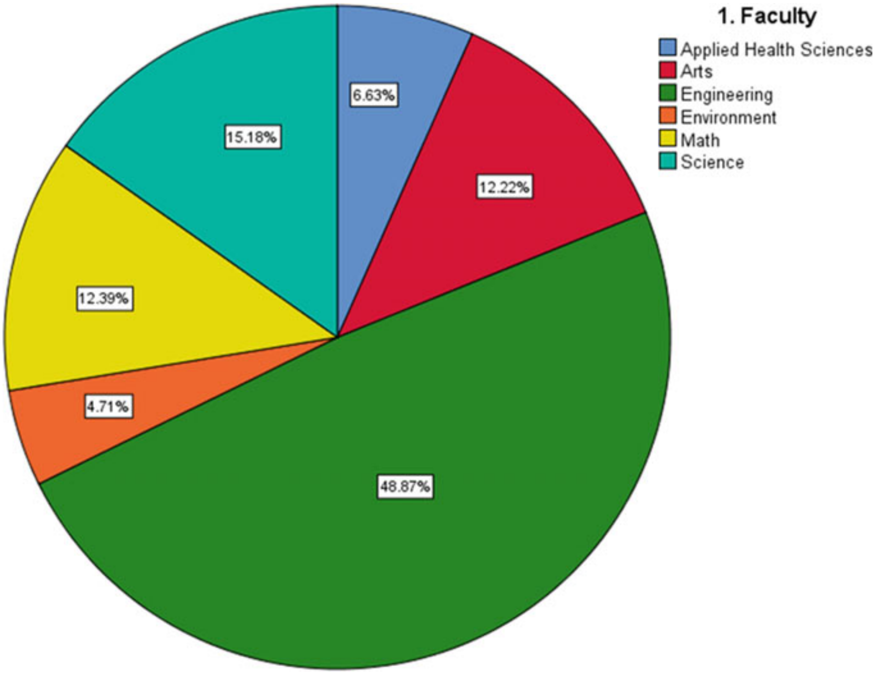
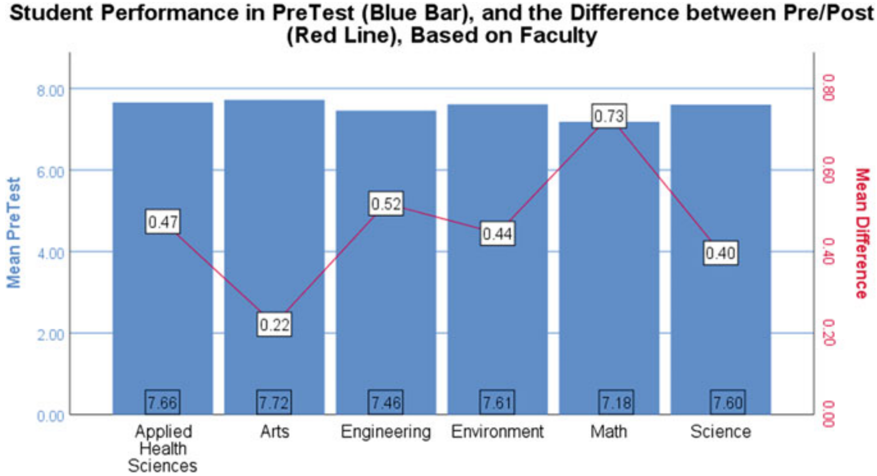


Fig. 20.8 Study sample based on faculty

Table 20.2 Performance based on faculty



Gender differences between the pre-/post-test results? The first-year students' sample population included 51.5% (592 students) of the entire sample. Male first-year students accounted for 66.05% (391) of the population, while 32.77% (194) were female students, and 1.18% (7) of the group were null gender (undetermined) students. Following one-way (or two-way) ANOVA, the mean of one group was compared with the mean of another using Fisher's least significant difference (LSD) test. The Fisher's LSD test is similar to a set of individual t-tests and is only used to follow up an ANOVA test. ANOVA and LSD tests were conducted to determine whether any performance differences were related to gender; however, no significant difference between gender groups in performance on the pre-/post-tests was found.

Canadian versus International student impacts? Canadian students and permanent residents outperformed international students in the pre-test. In the post-test, being an international student is negatively correlated with post-test score (Pearson correlation = −0.063), which means international students did not perform as well as other students in the post-test (see Table 20.3). However, international students substantially improved their performance by 0.89 points (12.9%). In the difference, there were some interesting results: Being a Canadian citizen was negatively correlated with pre–post-difference (Pearson correlation = −0.134), while international student status was positively correlated (Pearson correlation = 0.156). Therefore, international students improved their AI knowledge more than Canadian students.

Based on the LSD test result, Canadian students' score was 0.7 higher than international students in the pre-test, while in the post-test, it was only 0.155 higher. Similar results were observed with permanent residents and international student groups in the LSD test. In the pre-test, permanent resident students outperformed international students by 0.658. Yet in the post-test, this advantage was reduced to 0.153. No significant difference between the Canadian students and permanent residents was noted.

Table 20.3 Student performance based on citizenship

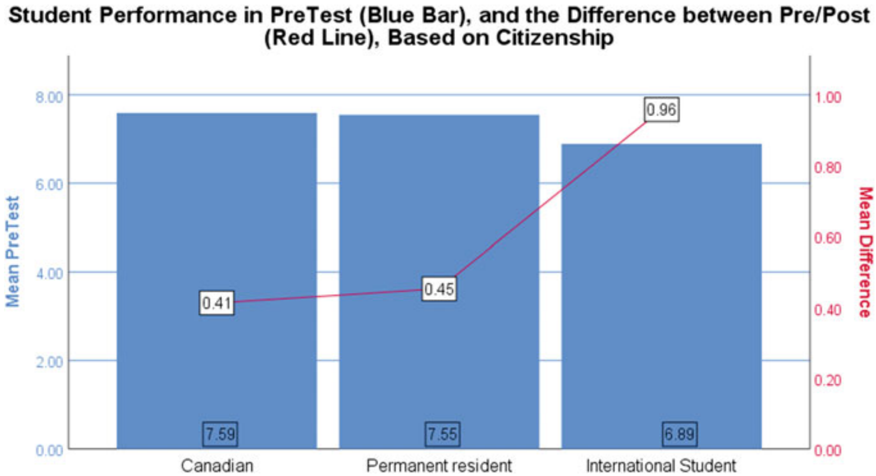


Table 20.4 Phone type comparisons

Dependent variable: pre-test

LSD

(I) Phone type	(J) Phone type	Mean difference (*I* − *J*)	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
No ID	1.00	−0.311	0.476	0.514	−1.24	0.62
	2.00	−0.113	0.476	0.812	−1.05	0.82
Android	0.00	0.311	0.476	0.514	−0.62	1.24
	2.00	0.198*	0.074	0.008	0.05	0.34
IPhone	0.00	0.113	0.476	0.812	−0.82	1.05
	1.00	−0.198*	0.074	0.008	−0.34	−0.05

*The mean difference was significant at the 0.05 level

Differences between Android and iPhone user results? There was a notable difference between Android and iPhone users in the pre-test. No significant difference was detected for the post-test and difference. An additional LSD test was conducted to examine the mean difference between phone types (see Table 20.4). On average, Android users outperformed iPhone user by 0.198 points in the pre-test.

20.5 Discussion

Multiple advantages were found for the mobile academic integrity tool. As an independent program not limited to a learning management system nor controlled by an internal technical unit, it can be monitored and updated as needed; hence, new learning objects can easily be kept current, fulsomely integrated, customized, and branded for the institution. A certificate of completion and a digital badge can effortlessly be shared with the university, individual course instructors, and with social media (such as LinkedIn or Facebook) as proof of successful completion of the learning modules. We explored the utility of the learning modules from the usability survey by asking the 1149 study participants about their experiences using the app. Over eight hundred and fifty ($N = 858$) learners who successfully completed the *Integrity Matters* course material responded to the usability survey.

Overall, results from a usability survey indicated that almost 84% of students agreed that learning about academic integrity with the mobile technology app provided flexibility for them to learn anywhere and at any time. A majority of users, over eighty-one percent (81.3%), enjoyed the format of digital learning objects, and they found the app easy to use. Sixty-six percent (65.88%) of survey respondents indicated they would recommend to other learners that they learn about academic integrity using mobile technology. In addition, almost seventy-five percent (74.7%) of study respondents agreed that their academic integrity knowledge increased because of completing these lessons. From our *Integrity Matters* pilot study, over ninety-eight percent of learners successfully completed the post-test questions at a rate of seventy-five percent or higher, demonstrating they learned to distinguish various aspects of academic integrity.

We intend to roll out implementation of the *Integrity Matters* app across our campus to first-year undergraduate students as an essential component of an academic integrity milestone degree requirement. Exploration into translation of the tool into additional languages, including Russian and Punjabi, will further enhance global accessibility of the tool. The *Integrity Matters* open-access app is freely accessible through a Creative Commons license, and additional colleges and universities have undertaken their own customization and branding of the app.

Use of mobile technology for teaching and learning academic integrity in higher education in both formal and informal settings is still an emergent area for exploration and study, and further scholarly research will aid in determining best practices. Academic integrity material curriculum designed to virtually reach first-year college and university learners will help prepare them for successful academic experiences while extending the walls of the classroom to make the leap into the workforce.

20.6 Recommendations

Based on our study findings, we believe that academic integrity, when understood and reinforced through the mobile application *Integrity Matters*, provides a compelling tool and resource to generate insight and spur the applicability of academic integrity. Extrinsically motivating features such as the aforementioned digital badges and e-certificate, or the embedded games within the app itself, help to sustain interest in completing the modules. The core of the modules with scenario-based learning and opinion-seeking assessment focuses first on what learners believe/know and then builds toward enhanced academic integrity understanding with deep exploration of a set of values that students can apply beyond academia. As a result, we believe *Integrity Matters* has broad application well beyond our own institutional context. Other institutions with similar AI challenges could use this tool as a powerful, evidence-informed solution to teach learners in an environment that speaks to them. Furthermore, due to the open-access nature of *Integrity Matters*, we encourage institutions to use what we have developed and adapt it to their own higher education institutional context.

20.7 Conclusion

It is imperative that an individual's understanding and application of academic integrity does not fall to the wayside or remain information that higher education institutions assume will be learnt at some point in learner's academic career. The core values of academic integrity guide much of what university students do; therefore, they require a solid foundation of AI upon which to base their understanding. Future studies should explore the long-term impact of this mobile app intervention, examine the enduring impact on student grades, and investigate whether or not these core academic integrity values resonate throughout the academic career of learners.

The approach developed in *Integrity Matters* has shown to support stronger understanding of academic integrity, reinforced in a way that makes learning these values worthwhile and evidences support for more mobile learning opportunities. This tool has shown success across various faculties and diverse learner demographics, ensuring that regardless who the learner is, academic integrity can be developed in this capacity.

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Chapter 21
"Exploring Students' Engagement Within a Collaborative Inquiry-Based Language Learning Activity in a Blended Environment"

Eirini Dellatola, Thanasis Daradoumis and Yannis Dimitriadis

Abstract Recent studies have shown that both inquiry-based and blended learning are beneficial pedagogies when implemented in language learning environments. Also, collaboration can provide opportunities and many advantages to language learners. Some of the latest studies have presented examples combining two or even all three of these approaches in many different disciplines with mostly positive results toward students' learning outcome. However, there is little research work exploring the combination of these approaches in the field of language learning and the correlation that may exist with students' engagement. To address this research gap, this work presents an experimental study where participants were divided in experimental and control groups. A quantitative analysis method was employed to collect and analyze data concerning students' perceptions as to whether a collaborative, inquiry-based language learning activity in a flipped classroom had a positive effect on the learning process. In particular, students' engagement is explored at four levels: behavioral, emotional, cognitive, and relational (social). The experimental group (EG) combined all the above pedagogies, following a collaborative inquiry-based learning approach in a flipped classroom. The control group (CG) followed a collaborative learning approach in a conventional classroom environment where neither inquiry-based nor blended learning methods were applied by the teacher. Our results showed that EG students' behavioral, emotional, cognitive, and social engagement was significantly increased comparatively to the one of CG students. Moreover, EG students accomplished higher learning outcome concerning fluency and vocabulary range than CG students.

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Keywords Language learning · Collaborative learning · Inquiry-based learning · Flipped classroom · Computer-supported collaborative learning · Students' engagement

21.1 Introduction

Language learning is considered to be one of the most technologically advanced fields of education. Recent studies in the field have shown that some of the most promising trends for the years to come are collaborative learning, inquiry-based learning and blended learning (Chong 2018). These approaches have been studied in depth separately, and their benefits are widely accepted by the research community (Dellatola et al. 2017; Hung 2015; Lee 2014). Particularly, all these methods have been proved to increase students' motivation and engagement as it is presented below in the literature review section.

However, the combination and implementation of different technologies and complex pedagogies can cause many difficulties in real classroom environments and create the so-called complex classroom ecosystem (Dimitriadis et al. 2013). Currently, there are a number of studies exploring the combination of two or even all three approaches in many fields with promising results, particularly regarding students' learning outcome (Hung 2015). Even so, little research has been conducted to the combination of these approaches and the impact it may have on students' engagement in a language learning environment.

For the above reasons, in this study, we have implemented blended learning, inquiry-based learning and computer-supported collaborative learning (CSCL) in a real classroom environment in a private language school in Greece so as to measure any differences in students' engagement and their learning performance.

More specifically, this study aims to answer the following research questions:

1. To what extent has a collaborative inquiry-based language learning blended environment achieved to enhance students' behavioral, emotional, cognitive, and social engagement in contrast to a conventional/face-to-face collaborative learning approach?
2. Is there a significant correlation between the above two environments and learning outcome?

The first section of this chapter presents a short literature review of CSCL, inquiry-based learning, flipped classroom, and students' engagement in language learning field. The second part presents the process that was followed and explains the methods used to select the sample, design the experiment, collect the data, and analyze them. Finally, the third part presents the interpretation of findings, our limitations, and our plans for the future work.

21.2 Literature Review

21.2.1 Computer-Supported Collaborative Language Learning

Computer-assisted language learning (CALL) is a field that has developed significantly in the last decades. Nowadays, it is a common practice among language teachers to use technology—such as computers, tablets, interactive whiteboards and furniture, augmented reality, etc.—during their lessons in order to increase students' interest and motivation and incorporate some realia in the classroom.

Many of the language teaching methods that are currently used around the world have originated from the Communicative Language Teaching (CLT) movement, which supports the use of computer-supported collaborative language learning (CSCLL) activities. Such activities promote the communication and collaboration among students and offer students a more realistic environment. Collaborative learning has been considered to be one of the most effective instructional strategies in language learning since it "has a 'social constructivist' philosophical base, which views learning as construction of knowledge within a social context and which therefore encourages acculturation of individuals into a learning community" (Oxford 1997; Wen et al. 2010). Recently, the scientific community of CSCL has been encouraged by Wen et al. (2015) to explore the potentials of collaborative language learning.

Studies that have been carried out in the field have shown that CSCL benefits students' learning in general. First of all, students feel more comfortable when interacting with their peers. Collaborative learning improves communication and negotiation skills and allows even the shy and slow students to participate more actively in their terms (Chen et al. 2011; Clark 2003; Yamada et al. 2011). Other findings have shown that CSCL plays important role for both high-ability and low-ability second language learners because it promotes communication among students and scaffolds more productive interactions (Wen et al. 2009). Furthermore, the use of collaboration makes learning process more realistic and simulates the natural conversations taking place outside the classroom. This allows learners to exchange ideas and opinions without time and space limits and improves the quality of learning experiences (Daniel Chen et al. 2008).

Researchers have also concluded that students are more motivated when they are to work in groups. Language learners, in particular, need to use the target language to interact with each other, which in turn improves their language skills through authentic learning materials (Rosenberg 2001). Finally, another positive result of collaboration is that learners usually exchange information in social and meaningful context, which allows assimilating new information into the existing schemata of the learners, and as a result, it improves performance in the target language (Domalewska 2014). All the above benefits demonstrate that collaboration seems to enhance students' motivation and helps to achieve the desirable learning outcomes (Zou 2010).

21.2.2 *Inquiry-Based Learning in English as a Foreign Language (EFL)*

Inquiry-based learning is a cognitive educational theory as well as a teaching and learning approach in which students follow methods and practices similar to those of scientists so as to construct knowledge (Keselman 2003). Similar to the way scientists conduct investigations, students engage in researching activities in inquiry-based classrooms in order to acquire knowledge (Deboer 2006). Inquiry-based learning is often considered to be an approach that helps students solve problems and requires the use of several problem-solving skills (Pedaste and Sarapuu 2006). Moreover, it emphasizes active participation of students (Coffman 2009; De Jong and Van Joolingen 1998) and involves the use of questioning to present materials and give directions for teachers (Lee 2014). Inquiry-based learning aspires to engage students in an authentic scientific discovery process.

Recent researches have proved that this approach has many advantages for learners in general (Alfieri et al. 2011; De Jong et al. 2014; Furtak et al. 2012; Minner et al. 2010), but it is also believed to be very effective with language learners in particular (Arauz 2013; Lee 2014; Nabhan 2017). Brown (2000) claims that students who use inquiry-based and problem-based strategies are better language learners because they are taught important metacognitive strategies. Furthermore, students have an active role on developing their investigations and reaching their conclusions which motivates them to pay more attention in class and be more willing to use the target language (Arauz 2013). Finally, the use of technology in inquiry-based approach has a positive effect in both motivation and construction of knowledge (Arauz 2013).

From a pedagogical perspective, inquiry-based learning is a complex scientific process and needs to be divided into smaller, logically connected units that guide students and draw attention to important features of scientific thinking. These individual units are called inquiry phases, and their set of connections forms an inquiry cycle. The educational literature describes a variety of inquiry phases and cycles (Bybee et al. 2006; Klahr and Dunbar 1988; White and Frederiksen 1998). In our study, we made use of the inquiry-based learning framework that was proposed by Pedaste et al. (2015) that includes the phases of orientation, conceptualization, investigation, and conclusion. It also includes the discussion phase that can be used at every point during inquiry-based learning process and connects to all the other phases (Fig. 21.1).

21.2.3 *Blended Learning in EFL (Flipped Classroom)*

Blended learning combines both face-to-face classroom activities and other kinds of online learning (Osguthorpe and Graham 2003). So and Brush (2008) describe blended learning as “any combination of learning delivery methods, including moreover face-to-face (f2f) instruction with asynchronous and/or synchronous computer technologies”.

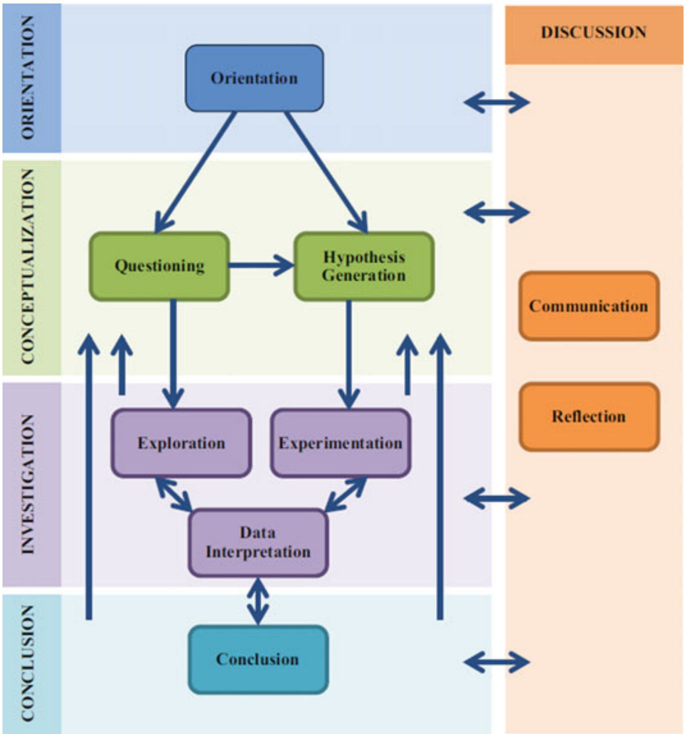

Fig. 21.1 Inquiry-based learning framework from Pedaste et al. (2015)

One of the common examples of blended learning is the so-called flipped classroom. Flipped classroom is a pedagogical approach in which the typical activities performed in classroom (lectures) and the activities given as homework in a traditional teaching practice are reversed in order (Baker 2000). In other words, teachers' explanations of the context of a textbook or a grammatical phenomenon are provided for students through an online platform so that they will be able to study them at home before they walk into classroom. Since students have already familiarized with the theory of the lesson, more time is available to practice what they have been taught at home under the direct supervision and assistance of the teacher. The opportunity of personalized coaching, which a flipped classroom offers, is perhaps the greatest benefit of this approach (Leis and Brown 2018).

Recent research has shown that when implementing flipped classroom approach in language learning environments, there are many benefits for both the students' motivation and learning outcome. According to Basal (2015), flipped classroom "serves the principles of personalized-differentiated learning, student-centered instruction, and constructivism." First of all, learning is personalized since students can study the learning material before getting into class at their own pace. Also, this autonomous aspect of learning enables students to choose when and where they want to view the learning material and have a control over how they prepare for the class (Egbert et al. 2015; Forsythe 2018; Lee and Wallace 2018; Muldrow 2013). Secondly, it is students-centered because as Mehring's (2014) study suggests there are more opportunities for active learning in comparison with those available in traditional classrooms. Students are highly active and greatly motivated to study harder and engage in class activities (Baepler et al. 2014; Basal 2015; Leis 2015), while students take more the role of organizer (before class) and facilitator (during class) (Basal 2015; Bishop and Verleger 2013).

Additionally, there is more available time for teachers to cater students' needs since students have already gained new knowledge at home (Mehring 2014). Teachers can manage available time to optimize their attention to each student, notice their difficulties in understanding and applying new knowledge and scaffold their learning process (Ekmekci 2017; Muldrow 2013). Moreover, a variety of learning activities, such as group work, interactive discussion, and more, can be incorporated in class time, which otherwise may not fit in a traditional curriculum due to time constraints (Basal 2015; Egbert et al. 2015; Muldrow 2013).

Flipped classroom follows the learning theory of CLT, and learners collaborate and interact with each other and their teacher in order to achieve understanding of the lesson (Ahmed 2016). Last but not least, recent research has proved that flipped learning has a positive effect on the learning outcome and particularly on students' writing performance (Ahmed 2016; Afrilyasanti et al. 2016; Ekmekci 2017; Farah 2014; Hung 2015; Leis et al. 2015).

21.2.4 Motivation and Engagement in EFL Classroom

One of the key factors in students' performance is motivation. Motivation can be translated into students' behavioral, emotional, and cognitive engagement (Davis et al. 2014; Pilotti et al. 2017; Wang and Eccles 2012). Behavioral engagement involves the active participation in learning activities, students' effort, persistence, and compliance with school structures. Emotional engagement means that students must be interested and in a good mood when dealing with the activities, and cognitive engagement means that students use actively some strategies in order to understand information in depth and solve problems. A forth aspect, however, needs to be taken into consideration; the relational or social engagement which refers to the sense of belonging and the relationships that students develop with their peers, their teachers, and the school (Fredricks et al. 2004).

Nonetheless, as Gardner (2005) states motivation in language learning is somehow different because "learning another language involves making something foreign a part of one's self." He continues by saying that there are three important phases during the process of learning a language: the past (past experiences, family, and cultural background), the present (students' current experience in classroom, teachers' behavior, and pedagogical procedures), and the future (use of target language outside the classroom). Different studies have shown that motivation is one of the most important factors in language learning (Dörnyei 2014; Ellis 2009). Motivated students are more likely to attend language classrooms, take part in language learning activities, and reach higher language proficiency regardless of aptitude differences (Dörnyei 2014; Ellis 2009).

The vast amount of motivational frameworks in language learning, however, makes it difficult to explain the exact role of motivation in second language acquisition (SLA). Despite the long history of research in the field, there is still plenty of confusion surrounding motivation, and our knowledge of the subject remains inconsistent (Dörnyei 1998). The history of motivation in SLA research can be divided in three stages: the early studies which are represented by a macro-perspective and are based on the learning outcome, the 90s studies which used a micro-perspective and were concentrated on the situation and the context of learning, and the resent studies which use a micro/macro-perspective and are more interested in the learning process the motivation changes (Zareian and Jodaei 2015).

21.2.5 Engagement in Collaborative, Inquiry-Based, Flipped EFL Classroom

Although a big amount of research has taken place regarding the benefits of inquiry-based in EFL classroom (Arauz 2013; Lee 2014; Nabhan 2017), flipped EFL classroom (Ahmed 2016; Afrilyasanti et al. 2016; Ekmekci 2017; Farah 2014; Leis et al. 2015), and collaborative EFL classroom (Chen et al. 2011; Clark 2003; Daniel Chen et al. 2008; Domalewska 2014; Rosenberg 2001; Yamada et al. 2011; Zou 2010) separately, there is still little research dealing with the combination of these methodologies (Hung 2015).

On the other hand, the existing literature usually focuses on the learning outcome, and the benefits that learners may have regarding SLA and students' motivation are not examined. However, we have already discussed the importance of motivation in language learning and language acquisition. Therefore, it is essential to examine the effect that the combination of these methodologies can have on the students' motivation in terms of behavioral, cognitive, emotional, and rational engagement. Recognizing the gap in the literature, the current study tries to examine these implications.

21.3 Methodology

Hereby, the methodological approach and research design that have been used in this study are being introduced and discussed. A classic quantitative design is proposed in order to arrive at answers to the research questions that have been posed previously.

21.3.1 Participants

The participants of the study were teenage learners of English as a Foreign Language (EFL) attending a private language school in Greece ($n = 30$). The sample was chosen by means of purposive sampling since only the students of a particular level of proficiency and upwards could take part in the activities and complete the given assignment. For that reason, students of intermediate level were selected ranging from levels B1 to B2 in the Common European Framework of Reference for Languages (CEFR). The learners (18 girls, 12 boys) were mostly from the same cultural and L1 background (Greek), and only three were from a different background (Albanian). All of them had at least some command of using computers and have been taught English for more than five years.

21.3.2 Data Collection and Analysis

The participants were divided in two groups: an experimental group (EG) and a control one (CG). Students had already been enrolled in different classes when the experimental phase took place, and as a consequence, whole classes of five or six students were assigned randomly in the one or the other group. The EG followed a collaborative, inquiry-based learning approach in a flipped classroom. The CG followed a collaborative learning approach in a conventional classroom environment where neither inquiry-based nor blended learning methods were applied by the teacher. Both groups were given a pre-test to be assessed on their previous knowledge on the topics presented afterward (past tenses, sequencing words, story writing techniques).

Particularly, students of the EG, who followed a flipped classroom scenario, were able to access a Moodle platform that contained all the necessary material that they were supposed to study before the classroom session. Before the beginning of the experimental phase, EG students had been presented with a session so as to familiarize with the platform, and they were given their log-in credentials and details on the material they had to study at home. In the classroom, students were given all the necessary means (chat, web-based collaborative real-time editor) to collaborate with their teammates, search for data to support their stories, analyze them, and produce a piece of writing. Particularly, the final assignment consisted of the composition of a story inspired by the Great Fire of London where students had to narrate their stories as eyewitnesses using the data that they have previously collected.

The background theories that have been used in this study are the theories of CSCL, flipped classroom, and inquiry-based learning. The tools that have been selected are a Moodle platform to assist the flipped classroom and the online synchronous collaborative tool Etherpad to facilitate the collaborative writing activity. Inquiry-based learning has been performed through the use of Chrome Browser and Google search engine, while a chat was available so that students could organize the research

Table 21.1 Independent and dependent variables of the study

Independent variables	Dependent variables
• Inquiry-based learning	• Students' behavioral engagement
• Blended environment	• Students' emotional engagement
• Collaborative writing	• Students' cognitive engagement
	• Students' social engagement
	• Learning outcome (fluency, grammar, vocabulary range, cohesion, and content)

and analyze their results. Some of the constraints are the limited time due to strict curriculum and the fact that during the two-week experiment, some unexpected events occurred (students' absences due to seasonal illnesses, power cut due to extreme weather conditions). The actors taking part in this study were the researcher, the students, the EFL teachers, and the tools (Moodle, Etherpad) that have been used to facilitate the learning process. During the classroom time, students had to collaborate, search, write a story based on a historic event (as previously described), and afterward answer a questionnaire.

Regarding CG, initially, the teacher presented in a traditional way the necessary syllabus (past tenses, sequencing words, story writing techniques) in the classroom and assigned some regular homework activities. Then, in the classroom, the teacher presented all the necessary information about the historic event which the students had to use to write their stories and encouraged the students to collaborate in order to complete their assignment. Students were not instructed to search for additional information online and used the computer lab equipment to collaborate face-to-face and produced a piece of writing.

After the end of the experimental phase, students of EG group answered a questionnaire reflecting on their sense of engagement during the learning experience. In particular, students' engagement was explored in terms of behavioral, emotional, cognitive, and relational (social) engagement. To assess the learning outcome, the writings were marked by two different teachers in terms of fluency, grammar, vocabulary range, cohesion, and content. The data collected by the questionnaires was analyzed quantitatively in order to explore the possible correlations among the different variables we defined for this research. Table 21.1 presents the variables used in the study.

21.3.3 Ethical Issues

In accordance with the ethical guideline issues by the European Union, privacy and confidentiality were respected. The participants were presented with the aim of the study and the nature of the research before the beginning of the experimental phase and were given a full description of the process, their rights, and their responsibilities.

Also, students were provided with copies of consent forms that their parents or guardians should study and sign for them (since all participants were under aged). All signed consents were obtained from the participants before the commencement of the study.

21.4 Findings

An analysis of research data gathered during classroom observations and the learning activities is presented here along with the research questions that have been posed in the beginning of the chapter that is addressed below.

RQ1: To what extent has a collaborative inquiry-based language learning blended environment achieved to enhance students' behavioral, emotional, cognitive, and social engagement?

The majority of the participants who answered the final questionnaire (Appendix) valued the learning activity as a good (53.85%) or a very good experience (46.15%). In order to evaluate all aspects (inquiry-based, flipped classroom, CSCL) of the learning activity, students were asked to answer questions regarding the different factors of engagement for each aspect separately. Particularly, regarding the inquiry-based learning, students declared that their behavioral engagement was moderately increased by 46.7%, very much by 33.3%, and extremely increased by 10%.

With regard to the emotional engagement, students answered by 53.3% that they felt much more interested in the topic and that their participation in the project made them feel very much content. The majority (71.4%) answered that they did not feel stressed because of the activity, and only one student answered that he/she felt very stressed and insecure because of the inquiry process. The cognitive engagement of the 44% of the participants was very much influenced, and the same happened with the 37.8% of the participants relatively to their sense of belonging (relational engagement). Figure 21.2 presents the trends in all four engagement aspects of the EG.

Regarding the blended learning parameter, 30% of the students were very much motivated (behaviorally, emotionally, and cognitively) to participate in the project. 73% of the participants answered that they felt no stress because of the nature of the flipped environment. As Fig. 21.3 displays, social engagement was the least influenced factor, with only 31.7% of the learners answering that they felt their sense of belonging growing.

Finally, as regards the collaborative aspect, students' answers appear to have a greater standard deviation. Once more the dominant trend shows that all aspects of engagement were positively affected according to students' answers to the questionnaire (Fig. 21.4).

RQ2: Is there a significant correlation between the above environment and learning outcome?

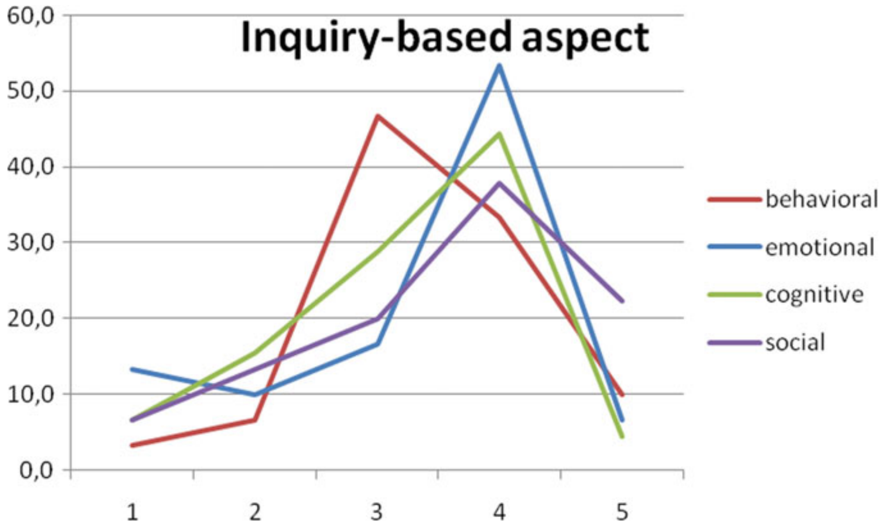

Fig. 21.2 How EG students' behavioral, emotional, cognitive, and social engagement was influenced because of inquiry learning

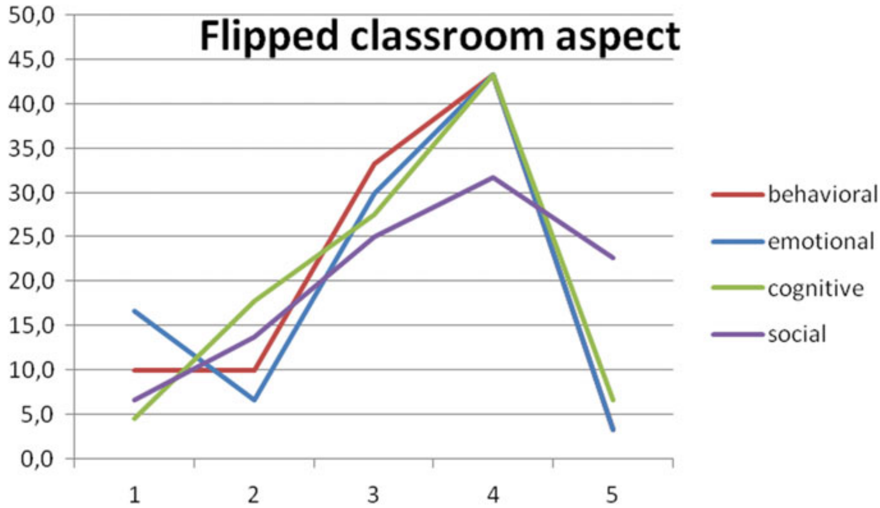

Fig. 21.3 How EG students' behavioral, emotional, cognitive, and social engagement was influenced because of blended learning

After evaluating the learning outcomes (stories) of both groups, it is evident that the EG appears to be better in terms of fluency, grammar, and vocabulary range. Particularly, in order to evaluate the learning outcome of the activity in both groups, the texts of the students were assessed by two qualified EFL teachers and assessed

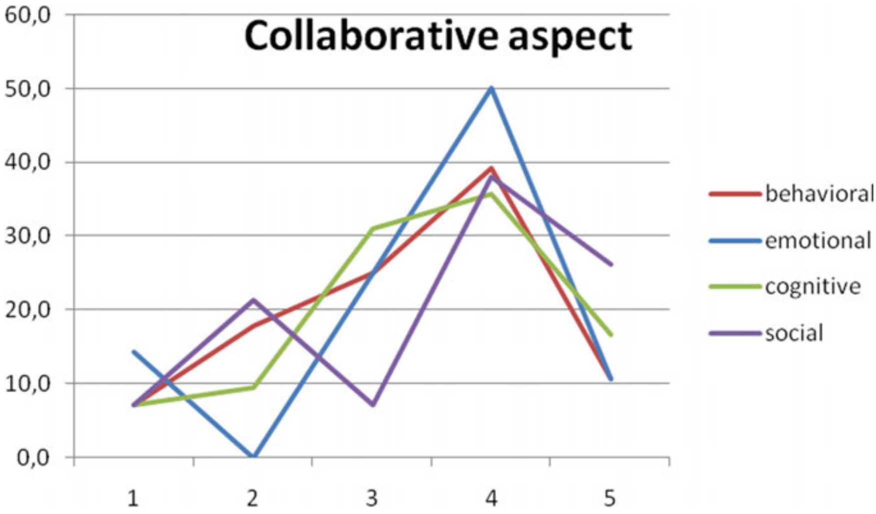

Fig. 21.4 How EG students' behavioral, emotional, cognitive, and social engagement was influenced because of collaborative learning

with reference to their fluency, grammar, vocabulary range, cohesion, and content according to the rubric shown in Table 21.2, which is based on the public IELTS writing band descriptors.

The descriptive statistics suggest that EG's texts achieved higher levels of fluency, grammar, and vocabulary range. Content did not appear to have any difference, while cohesion was reduced. However, the learning outcome in total was higher for the EG as shown in Table 21.3. Additionally, a *t*-test on comparison of the means of the two groups was performed in order to detect a possible statistical significance. Since our sample was small, a non-parametric Mann-Whitney *U* test was also performed which confirmed the results of the *t*-test. The difference in fluency and grammar is statistically significant, while in vocabulary range, cohesion and content are not. Hence, we can conclude that the learning outcome is overall enhanced in terms of fluency and grammar, while any differences in vocabulary range, cohesion, and content are not considered significant.

Table 21.2 Writing assessment rubric

Band	Fluency	Grammar	Vocab. range	Cohesion	Content
0	Does not attend Does not attempt the task in any way				
1	Fails to communicate any message	Cannot use sentence forms at all	Can only use a few isolated words	Fails to communicate any message	Unrelated answer to the topic
2	Lack of fluency	Cannot use sentence forms but only memorized phrases	Uses an extremely limited range of vocabulary	Has very little control of organizational features	Barely responds the topic
3	Lack of fluency but communicates a basic message	Attempts sentence forms but errors in grammar distort meaning	Uses only a very limited range of words; errors distort message	Does not organize ideas logically	Does not adequate address the topic
4	Minimal fluency for the task. Reader may not be able to understand the message	Uses only a limited range of structures. Errors predominate	Uses only basic vocabulary; limited control of word formation and spelling	Ideas are not presented coherently, and paragraphing may be confusing	Responds in a minimal way
5	Moderate fluency for the task. Reader may have some difficulty	Uses only a limited range of structures. Make frequent grammatical errors	Uses a limited range of vocabulary; noticeable errors	Presents ideas with some organization but paragraphing is inadequate	Addresses the task partially
6	Some inaccuracies that do not impede communication	Uses a mix of simple and complex sentence forms; some errors	Uses an adequate range of vocabulary for the task; some errors	Arranges ideas coherently but paragraphing is not always logical	Addresses all parts but some are more fully covered
7	Sufficient fluency. Awareness of style and collocations	Uses a variety of complex structures. Good control of grammar	Uses a sufficient range of vocabulary; occasional errors	Presents a clear topic in each paragraph. Logically organized ideas	Addresses all parts but with tendency to lose focus

(continued)

Table 21.2 (continued)

Band	Fluency	Grammar	Vocab. range	Cohesion	Content
8	Fluently and flexibly convey precise message	Uses a wide range of structures; occasional errors	Uses a wide range of vocabulary; rare errors in spelling	Uses paragraphing sufficiently and appropriately	Sufficiently developed task
9	Natural and sophisticated control of the language	Uses a wide range of structures with accuracy; rare minor errors	Uses a wide range of vocabulary; rare minor errors	Skillfully manages paragraphing	Fully developed task

Table 21.3 Quantitative results of the learning outcome for individual and collaborative groups

	Experimental				Control			
	Minimum	Maximum	Mean	Std. D.	Minimum	Maximum	Mean	Std. D.
Fluency	5	10	7.33	1.97	5	7	6	0.63
Grammar	6	10	8.17	1.72	3	7	5.83	1.47
Vocab. range	5	9	7.5	1.38	5	7	6.33	0.82
Cohesion	3	8	6.17	1.72	4	7	6.5	1.22
Content	4	9	7.33	1.97	5	8	7.33	1.21
Aveg. learn. out.	5.6	9.2	7.3	1.41	4.4	7	6.4	0.99

21.5 Conclusion

The current study presented an experimental study where students worked with a collaborative inquiry-based language learning activity in a blended environment. A quantitative analysis method was employed to collect and analyze the data from the learning outcome (stories) and students' answers to a questionnaire. Our results showed that EG students' behavioral, emotional, cognitive, and social engagement was increased in many aspects compared to the one of CG students. Moreover, EG students accomplished higher learning outcomes than CG students. Further research carried out over a longer time frame, a larger sample, and a different approach with a more holistic view based on mixed methods is needed in order to better understand the potential of inquiry-based CSCLL activities in blended learning environments regarding students' motivation.

Furthermore, it is considered necessary to conduct further studies in such complex learning environments in order to recognize the management problems that usually arise given that they are one of the main factors that teachers avoid using them in real classrooms. The next step will be to propose the appropriate orchestration strategies that should be applied in these environments so as to overcome those management problems and enhance students learning experience.

21.6 Appendix

Technology-enhanced language learning classroom—students' satisfaction questionnaire

1. Gender
   - Boy
   - Girl
2. Age
   - 12–13
   - 14–15
   - 16–17
   - Other
3. How will you evaluate your English proficiency?
   - Very Good
   - Good
   - Medium
   - Bad
   - Very Bad
4. How will you evaluate your ability to use a computer?
   - Very Good
   - Good
   - Medium
   - Bad
   - Very Bad
5. How much were you personally influenced due to the inquiry-based aspect of the project? (scale question)
   Behavioral engagement
   - I was more motivated to complete the project.
   - I was more willing to pay attention and participate in the class.
   - I became more interested in the topic.

   Emotional engagement
   - I felt happy.

- I felt stressed and insecure.
- I felt more self-confident.

Cognitive engagement

- I understood better and in-depth the topic.
- I thought that I could apply the same methodology to other projects.

Social engagement

- I felt an active member of a group.
- The relationship between me and my classmates was strengthened.
- The relationship between me and my teachers was strengthened.

6. How much were you personally influenced due to the use of a flipped classroom? (scale question)

   Behavioral engagement

- I was more motivated to complete the project.
- I was more willing to pay attention and participate in the class.
- I became more interested in the topic.

Emotional engagement

- I felt happy.
- I felt stressed and insecure.
- I felt more self-confident.

Cognitive engagement

- I understood better and in-depth the topic.
- I thought that I could apply the same methodology to other projects.

Social engagement

- I felt an active member of a group.
- The relationship between me and my classmates was strengthened.
- The relationship between me and my teachers was strengthened.

7. How much were you personally influenced due to the collaborative aspect of the project? (scale question)

   Behavioral engagement

- I was more motivated to complete the project.
- I was more willing to pay attention and participate in the class.
- I became more interested in the topic.

Emotional engagement

- I felt happy.
- I felt stressed and insecure.
- I felt more self-confident.

Cognitive engagement

- I understood better and in-depth the topic.
- I thought that I could apply the same methodology to other projects.

Social engagement

- I felt an active member of a group.
- The relationship between me and my classmates was strengthened.
- The relationship between me and my teachers was strengthened.

8. Do you think that the innovative methods used in this course helped you to improve your knowledge and learn easier compared to the traditional methods used in the classroom?

   - Yes—a lot
   - Yes—moderately
   - I did not see any difference
   - No—at all

9. How will you evaluate the whole learning experience?

   - Very Good
   - Good
   - Moderate
   - Bad
   - Very Bad

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Chapter 22
A Conceptual Framework for Learners Self-directing Their Learning in MOOCs: Components, Enablers and Inhibitors

Inge de Waard and Agnes Kukulska-Hulme

Abstract The conceptual framework presented in this chapter describes the learning components influencing the learning experiences of adult informal learners engaged in MOOCs offered on the FutureLearn platform. It consists of five learning components: individual characteristics, technology, individual and social learning, organising learning and context. These five learning components are driven by two enablers or inhibitors of learning: motivation and learning goals. For adult informal learners, motivation is mostly intrinsic, and learning goals are mostly personal. This research investigated the informal learning of 56 adult learners with prior online experience, as they studied various subjects in MOOCs. Literature on MOOCs, mobile and informal learning provides scientific support, in addition to literature clarifying the rationale for self-directed learning as a focus of investigation. The participants of this study voluntarily followed one of three FutureLearn courses that were rolled out for the first time at the end of 2014. Data were collected at three stages through an online survey (pre-course), self-reported learning logs (during the course) and semi-structured one-on-one interviews (post-course). The data were analysed using Charmaz's (Constructing grounded theory. Sage, 2014) method for constructing a grounded theory.

Keywords Informal learning · MOOC · Conceptual framework · Grounded theory · Adult learning

22.1 Introduction

This chapter reports on a study with adult informal learners using the Futurelearn MOOC platform and outlines a conceptual framework that was developed as part of this research. Bozkurt et al. (2016) analysed 51 theses and dissertations, and

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they concluded that “nearly half of the studies didn’t benefit from any theoretical or conceptual perspective” (p. 203), pointing to the lack of frameworks for MOOC research. The chapter reviews background literature before presenting the research questions, methodology, research findings and conclusions.

22.2 Literature Review

22.2.1 Adult Learners and MOOCs: A Gap

Adult learners across the world are taking advantage of widely available massive open online courses (MOOCs). Research concerned with MOOC demographics shows that most MOOC learners are already employed, well educated, from developed countries and have higher levels of formal education (Liyanagunawardena et al. 2015; Breslow 2016). This contrasts with the target groups of the majority of research studies investigating MOOC experiences, which look at experiences of students who have not yet graduated from higher education. For example, Kizilcec et al. (2013) investigated three computer science MOOCs and concluded that “the vast majority of active learners are employed full-time” (p. 171); other MOOC literature highlights the popularity of professional learning with MOOCs (Mori and Ractliffe 2016; Wong et al. 2018). Morris (2014) noted that “MOOCs attract an audience which is often not predefined, from 16-year-old school students, current undergraduate and postgraduate students, through to professionals and leisure learners. MOOC participants are all at different levels trying to reach a clear learning goal from the same materials within a defined learner journey” (p. 3). This chapter provides a conceptual framework which relates to the learning experiences of adult learners engaging in MOOCs and who already hold a first degree or a professional qualification.

22.2.2 What Is the MOOC Learner Experience?

Liyanagunawardena et al. (2013) noticed a gap in research related to the learner experience and the reasons why learners participate in MOOCs: “it would be valuable to learn about the actual motivations in place, the percentage of participants taking up MOOCs for those reasons, and to know how those motivations might vary from one course to another” (p. 219). The interest in motivation is echoed in Kizilcec and Schneider’s (2015) conclusion that there has not been a systematic approach to identifying learners’ motivations or how they relate to subsequent learning. But understanding motivational factors is not enough, as Terras and Ramsay (2015) pointed out; researchers also need “to understand learners’ expectations and how they cope with the specific challenges that are associated with MOOCs” (p. 477).

Breslow (2016) indicates we need a better understanding of the actual learning experience in MOOCs. To explore the varying and shifting learners' intentions for participating in MOOCs, there is a need for new metrics in addition to more traditional benchmarks of certification such as grades or completion that are often used in traditional higher education. These new metrics will add to the understanding of what actually happens in a MOOC (Kilgore et al. 2015; Milligan and Littlejohn 2016). Milligan and Littlejohn (2016) concluded that completion and retention rates, as proxies for learning, are not the most appropriate measures to understand the rich nuances of learning taking place within a MOOC context.

Researchers have found that most MOOC learners do not learn in a linear fashion. Guo and Reinecke (2014) report that the most learners engage in nonlinear learning trajectories that they do not follow a pre-established, sequential progression through a MOOC. They also found that older MOOC certificate learners covered more course materials and repeated more lecture sequences than younger students. This led Guo and Reinecke to conclude that older learners follow nonlinear, self-defined learning paths and indicative of a field-independent learning style. Allowing learners to choose what they want to learn "allows individuals to choose how to engage with courses and is another strategy for supporting the diversity of learner needs" (Kizilcec and Schneider 2015, 6: 21). This was supported by Littlejohn et al. (2016) who investigated the learning behaviours of 788 MOOC participants, with follow up interviews with 32 learners. They found that learners' motivations and goals "shape how they conceptualised the purpose of the MOOC, which in turn affected their perception of the learning process" (p. 1). They also added that "research has not adequately addressed the unique nature of learning and learners in MOOCs" (p. 1).

Finally, Terras and Ramsay (2015) made a rational argument for priority research involving MOOCs and psychological elements: "The massive and open nature of MOOCs places the control of learning at the discretion of the learner" (Terras and Ramsay 2015, p. 472). They argue it is essential to evaluate the psychological challenges, barriers and enablers to effective engagement and learning in MOOCs. Gasevic et al. (2014) have emphasised the need to understand student motivation, metacognitive skills, learning strategies and attitudes. These priorities and the prior research findings all informed the design of the study reported in this chapter, which involved learners using the FutureLearn platform.

22.2.3 FutureLearn MOOCs

In December 2012, the MOOC platform FutureLearn was founded by The Open University, UK, as a company and within a couple of years it had attracted a large number of partners and three renowned non-university institutions (Scanlon et al. 2015). FutureLearn sets itself apart from the other major MOOC platforms with its outspoken focus on social learning.

This study uses the definition of social learning as offered by Sol et al. (2013) who define it as “an interactive and dynamic process in a multi-actor setting where knowledge is exchanged and where actors learn by interaction and co-create new knowledge in on-going interaction” (p. 36). FutureLearn has embedded social learning in its platform based on the conversational model of Laurillard (2013) which places conversation and social learning at the heart of the MOOC platform (Ferguson et al. 2015; Sharples 2016).

22.3 Research Questions

The literature pointed to a research gap and suggested the need for a study that would provide a conceptual framework representing the experiences of adult learners who engage in MOOCs, and where elements of characteristics, technology, social learning and overall self-directing of learning would be positioned. This study specifically investigated adult learners with two years or more prior online learning experience. The following research questions arose.

Central research question: What characterises the informal self-directed learning of experienced, adult online learners engaging in individual and/or social learning using any device to follow a FutureLearn MOOC?

The central research question is divided into **four sub-questions**:

- Which individual characteristics influence the learning experience?
- What are the technical and media elements influencing the learning experience?
- How does individual and social learning affect the participants’ learning?
- Which actions (if any) did the learners undertake to organise their learning?

22.4 Research Methodology

22.4.1 Data Collection

The participants of the main study followed one of three FutureLearn courses: “The Science of Medicines” organised by Monash University in Australia, “Basic Science: Understanding Experiments” organised by The Open University in the Uk, and “Decision Making in an Increasingly Complex and Uncertain World” organised by the University of Groningen in the Netherlands. These three publicly available courses were all rolled out for the first time in September 2014.

Three research instruments were used for collecting data in three stages: an online survey (at the start of the course), learning logs (during the course) and semi-structured one-on-one interviews with participants (post-course) carried out remotely. The online survey was sent to the participants at the beginning of the course, to be able to gather background information on prior online learning experience and the use of different devices (tablets, smartphones, laptops, etc.). Based on the information shared through the online survey the target group of experienced online learners was chosen. In this study, the term "experienced" means that the learner has had at least two years of prior online learning. The learners self-reported on their FutureLearn course learning experiences by filling in learning logs provided to them by the researcher. The semi-structured one-on-one interviews took place post-course to gain a more in-depth understanding of the actual learning experience of the learners based on their reflections on the experience. The questions for those interviews were derived from the sub-questions related to this study, as well as from the information shared in the learning logs (de Waard and Kukulska-Hulme 2019).

Once the data were collected, they were analysed using Charmaz's (2014) method for constructing a Grounded theory (GT). "Grounded theory is a rigorous method of conducting research in which researchers construct conceptual frameworks or theories through building inductive theoretical analysis from data and subsequently checking their theoretical interpretations" (Charmaz 2014, p. 343). Thus, GT provides a flexible way of conducting research that prioritises exploration of the given phenomenon in a predominantly inductive theory development paradigm (Birks et al. 2013), while also interpreting the results in an emerging theory, that was developed into a framework. The analysis included memo-writing to make the researcher's train of thought and possible prior assumptions transparent. The GT approach involved open coding, line-by-line coding and focused coding in order to construct a grounded theory that would provide insights into the self-directed learning experiences of FutureLearn participants.

22.4.2 Target Population

The target population for this study was selected in a number of steps, including recruiting volunteers for the study and selecting the participants based on their prior online learning experience. An overview of the procedure to select the participants can be seen in Fig. 22.1.

22.4.3 Data Corpus and Sample Size

The data corpus of the main study comprised the following:

- A pre-course survey, following signed informed consent sent back by the participants. 115 participants took the survey, all participants were selected to be part of the study, but not all of them started sending back learning logs.
- Participants who completed learning logs: 56 (4 SOM, 15 BSE, 37 DMCW participants).

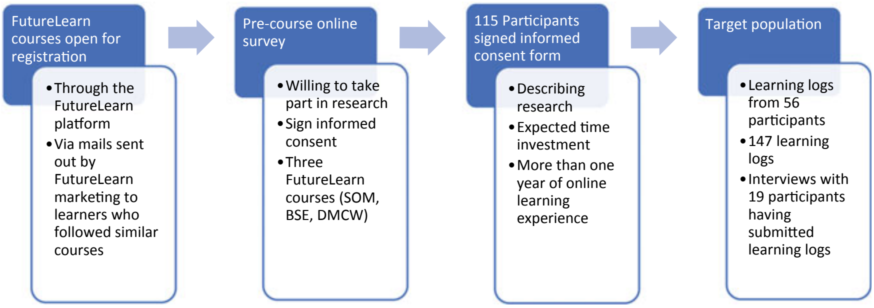

Fig. 22.1 Visual overview of the target population selection procedure for the main study

- Learning logs kept: 147 (15 SOM, 41 BSE, 91 DMCW; ranging from one to five learning logs submitted by a single learner).
- Semi-structured one-on-one interviews: 19 participants (1 SOM, 4 BSE, 14 DMCW).

22.5 Research Findings

To ensure participant anonymity and data transparency, the data from all participants were coded as shown in Table 22.1.

22.5.1 Which Individual Characteristics Influence the Learning Experience?

Two key aspects emerged when investigating individual characteristics: motivation and personal traits including emotion.

Table 22.1 Learner data coding description

Participant identifier: #DMCW/I/222	Description of each element of the participant's identifier
#DMCW	#Course, i.e. Science of Medicines (SOM), Basic Science—Understanding Experiments (BSE), Decision Making in an Increasingly Complex World (DMCW)
/LL$	/Learning log (LL) or interview (I)
/222	/Participant ID

22.5.1.1 Motivation

Motivation can influence what, when and how we learn (Schunk 1995). Intrinsic motivation refers to "doing something because it is inherently interesting or enjoyable", and extrinsic motivation refers to "doing something because it leads to a separable outcome" (Ryan and Deci 2000, p. 55). In this study, the learners' motivation is mostly intrinsic, considering the emotional connections and the personal interest that is expressed in the data.

Motivation prior to the course. 61% of the participants indicated they had a specific personal interest in the course. Of all the participants, 38% had a professional interest in their chosen FutureLearn MOOC. When interviewed, the learners with a professional interest in the course all indicated they had decided for themselves that following a work-related MOOC might increase their own professional knowledge. **Motivation as mentioned in learning logs and interviews**. The learning logs and post-course interviews revealed that the professional or personal motivations vary from course to course. The biggest difference in motivation based on coding the excerpts was in the DMCW and BSE courses. The DMCW course is mentioned more frequently in relation to the participants' professional motivation (65%), and the BSE course had more learners referring to motivation based on their personal interest (29%): "As a scientific dad and a geek, experiments and nature exploration are the ideal form of play with my children. We have a lot of fun together" (#BSE/LL/125). **Motivation for completing a learning episode**. Learners who were professionally motivated completed 74% of the learning episodes. Learners who indicated personal motivation to follow the course completed 38% of the learning episodes they started. Overall, the participants indicated that 79% of their learning episodes were successful. Success is described as being task-related, as well as a personal feeling of success either made explicit by an emotional remark or indicated directly as successful by the participant. Success does not mean that the task or course activity is done according to the expectation of the course organiser, but rather that it is successful as perceived by the participants.

22.5.1.2 Key Personal Traits and Emotions Influencing the Learning Process

Two personal traits related to individual characteristics emerged most frequently during the line-by-line data analysis: perseverance and self-confidence.

Perseverance. Perseverance was mentioned by 16 participants. Some learners had to reflect on whether or not to learn all the details of a course. Participants indicated their need to grasp all that they felt needed to be done and this was supported by their emotions. Learners can be particularly stimulated by unforeseen context or content, the satisfaction of having learned, and the affinity they feel with the course. Participant #SOM/LL/109 wrote "I'm finding the course more and more interesting as it goes on which is motivating me to spend more time on it".

Self-confidence. Self-confidence was mentioned explicitly by 15 participants. The data related to self-confidence ranged from the learner's views on their own learning: "I've found that my brain wasn't so stiff and still opened for some new knowledge" (#DMCW/I/167); learning within the course itself: "First I felt stupid but then I reminded myself that that is why we do experiments, to test our hypothesis and not just make assumptions" (#BSE/LL/132).

Self-confidence impacting social learning. Self-confidence plays a role in triggering social learning action. Hovering between individual and social learning are those learners that seem to be willing to interact with others, yet do not always feel certain enough (yet) to do so. Sometimes this uncertainty stems from a practical issue: "Connecting with others was a bit more difficult this time, because it was in English and I'm not a native speaker in English" (#DMCW/I/222), at other times it is related to a personal sense of esteem or pride.

Emotional language and learning. In both learning logs and interviews, the participants used emotional language to support accounts of their self-reported learning experience. The emerging data suggested that content and facilitators can inspire the learner. When the content of the course aligned with personal expectations or needs, it added to the pleasure of learning, e.g. "the idea of being able to visualize the stuff of life is very appealing!" (#BSE/LL/103). The timeliness in terms of content and tools was appreciated by learners wanting to stay on top of their field, e.g. "having access to very up-to-date information was very stimulating" (#DMCW/I/179).

22.5.1.3 Findings on Individual Characteristics

Intrinsic motivation seems to have a profound effect on learning within FutureLearn MOOCs. It makes the learner decide which course they want to follow, based upon their own interest. The usefulness of the course content in terms of their professional and/or personal interest also increases the learners' motivation, especially in terms of completing a learning episode. Once the course is rolled out, the content and information provided in the course can also alter motivation depending on the proximity of the course to the professional or personal context of the learner. The data shows that self-directed learning within FutureLearn courses is driven or held back by intrinsic motivation, ignited by the course content and personal interpretation of the usefulness of the course for the learner's benefit. This makes intrinsic motivation an important inhibitor or enabler of self-directed learning in FutureLearn courses.

Personal traits and emotions play a role in the FutureLearn MOOC learning experience. Specific personal traits such as self-confidence and perseverance let the learners self-direct their learning towards specific learning actions (engaging with content or peers). Emotions colour the learning experience; they can deter learners from learning or stimulate them.

Table 22.2 Devices used by the learners to access the course ($n = 147$)

Devices	Smartphone	Tablet	Laptop	Desktop	Other
Percentages (%)	13	12	45	26	4

22.5.2 *What Are the Technical and Media Elements Influencing the Learning Experience?*

Technology is a necessary component of online learning, as learners need technology to access the learning material. This section pertains to the devices used, FutureLearn course elements, and learning new tools suggested in courses.

22.5.2.1 Multitude of Devices

FutureLearn courses are only accessible online, although some of the resources (e.g. videos, transcripts and texts) can be downloaded to be used offline as well. This means that all learners must have access to the FutureLearn platform with a Web-enabled device in order to learn. Table 22.2 gives an overview of which devices were used to access the courses.

Depending on the demand of the course resources (e.g. processor-demanding tools, or visually complex tools) different devices were chosen, where the more demanding parts of the course were mostly accessed via laptop or desktop. Learners worked with a preferred device, but depending on the context learners switched to other devices, mostly mobile devices as these allowed them to engage with the course from a different location.

22.5.2.2 FutureLearn Course Elements

The FutureLearn platform uses different features to create the course environment. In the learning logs participants, often referred to their use of FutureLearn features: selective use of media, the conversational commenting option and videos were mentioned as easy learning material. Experienced learners understand the benefits related to specific media: e.g. the benefits of captioned videos: pausing, reflecting, having another look and looking at the behaviours in the video (real cases, possibly authentic settings). Learners watched the same videos at different moments in their learning episode to increase their understanding of the content.

By gradually building solutions for working with the online tools the experienced online learner creates a practice that enables learning with the old and new technology. The study found that the new features of a platform can disrupt this familiar practice, or it can open up new found opportunities, such as this positive reference to FutureLearn's feature "mark as done" button: "To finish the course and not leave any areas undone. I like to see the pink colour and not the blue for undone" (#DMCW/LL/114).

22.5.2.3 Learning New Tools Suggested in Courses

Learners shared remarks on specific tools that were part of a specific FutureLearn course. In the case of the Decision Making in a Complex World course, the facilitators referred to tools that are used to demystify complexity in networks: Lightbeam was mentioned by 11% of the learners, although it was not a mandatory tool to explore. This tool triggered interest because of its personal as well as professional potential. Lightbeam is a tool to visualise who is following your own writing or any electronic actions on the Web.

22.5.2.4 Findings on Technology Influencing Learning

Technology plays an unavoidable role in learning within FutureLearn courses. Learners have to connect to the course through an Internet-enabled device, and then learn to navigate through the content using the course tools as well as topic-specific tools provided in the course. It is the learner who self-directs their learning and who decides which parts of the technology might be beneficial to their learning at present, as well as for the future (e.g. considering the benefits of learning new tools). Admittedly, this learners' choice is confined to the boundaries set by the course designers as well as the technical limitations or affordances of the FutureLearn platform.

22.5.3 How Does Individual and/or Social Learning Affect the Participants' Learning?

This section presents and interprets the data regarding individual and social learning, starting with the individual learning experiences and moving to the social learning experiences. The main categories that emerged were: individual learning actions, social learning: connecting and sharing and social learning actions.

22.5.3.1 Individual Learning Actions

The 63% of the learners completed the learning episodes by themselves, learning individually, and subsequently are addressed as individual learners in this section. Individual learners take the following actions: viewing and reading course media, reflecting on content, looking for answers on the Internet, linking to prior knowledge (de Waard and Kukulska-Hulme 2019). Although individual learners refrain from engagement in any discussions, or in commenting, they did testify that they looked at those FutureLearn spaces to find answers to their course-related questions: “If I have not understood something I will read or listen to it a couple of time. Alternatively, I will take a look on the forum to see if there have been any useful comments” (#DMCW/LL/125). Lurking seemed a deliberate action, following unresolved questions: “I really only look to see what others have written if I don’t know the answer” (#SOM/LL/104).

Individual learners did not want to interact with others based on time considerations as well as their own personal preference: “I live by myself so tend to solve my own problems by myself” (#SOM/LL/102). In order to find solutions by themselves, the individual learners include resources outside of the course: “[I] like to try to figure it out on my own when possible unless I am really stuck. Then I might look at the forum or online via a search engine or in my reference books” (#BSE/LL/132).

22.5.3.2 Social Learning: Connecting and Sharing

The 37% of all participants indicated they connected and/or shared their learning with others (course participants, family, friends, partner and professional colleagues).
Looking for answers versus experience sharing. This study revealed that participants turn to different people when looking for answers, or when sharing course experiences. In Table 22.3 only the quantitative data from BSE and the DMCW course were considered, as there were only four SOM participants and those were mainly individual learners.

Table 22.3 provides an overview of who learners interacted with, either to look for answers or share their course experiences with. These data come from the learning logs where learners were asked to indicate who they interact with, which was then cross-tabulated with the two options of either looking for answers or sharing experiences. Most interactions involved engaging with course peers. 49% of the participants from the BSE course connected with people inside the course, but remarkably 45%

Table 22.3 Who people turned to in order to find answers and who people connected to in order to share their FutureLearn course experiences

		Mostly inside course (in %)		Mostly outside course (in %)				
Looking or sharing answers with others ($n = 147$)	Course	Course facilitators	Course peers	Professional colleagues	Friends	Family	Partner	Other (%)
Looking for answers	BSE	12	37	11	4	19	11	6
	DMCW	17	45	10	8	5	8	7
Sharing experiences	BSE	2	35	13	13	30	7	2
	DMCW	1	32	17	16	19	15	0

of them were also looking for answers with people outside the course. For the participants from the DMCW course, the percentages were 62% connecting with people inside the course and 31% outside the course. In the case of sharing experiences, the interactions with others outside the course outnumber the interactions inside the course.

The course facilitators were mainly contacted by learners in order to find answers to learners' questions, and they were barely contacted when it came to sharing experiences. Facilitators were seen as part of the formal side of the course. This meant that facilitators were contacted to solve specific difficulties with learning episodes, but also for technical reasons, e.g. "I would only contact Course Facilitators something didn't work (like videos)" (#DMCW/LL/152).

There seemed to be specific triggers to enter into social learning interactions inside or outside the course while looking for answers, e.g. "seeing parallels with my partners work problems", #DMCW/LL/154, people close by or familiar (e.g. "My friends and cousins mostly help me", #DMCW/LL/178), and the professional network was used consciously by the learners for their content expertise, e.g. "Subject Knowledge from their work in financial services industry" (#DMCW/LL/106).

To find answers learners consider who would be able to help them, indicating an overlap of interests or contexts within their personal relationships: with friends and partners. Friends were more frequently interacted with to share the FutureLearn experience. Learners also simply shared what they are doing with others, without necessarily wanting answers to questions. Although less learning goal oriented, the sharing does have a learning effect, adding to the grounding of the course content: "I will explain what I have learned to my partner in future as a way of consolidating my learning" (#SOM/LL/101).

Learners were not only looking for answers, they also shared their own knowledge. The social learning happened inside as well as outside the FutureLearn course.

22.5.3.3 Social Learning Actions

Social learning involves learners interacting with each other, either online or in real life (de Waard and Kukulska-Hulme 2019).

Choosing who to interact with. In a classroom, be it digital or face-to-face, the first few weeks allow learners to assess who they need to talk to in order to find answers. In a FutureLearn course, learners need to decide who they want to connect to within a short timeframe, i.e. more or less within the first week. FutureLearn offers the option to "follow" other learners or indicate which comments you "like", both options being used by learners to facilitate their learning. However, because of the size of the learner group this selection procedure does not always feel exactly right, as the following learner testifies:

> The comments in a MOOC of this size are really difficult to keep track of….I am afraid that if I filter comments by whom I "follow", I will miss out on the few people whose comments are neither "liked" nor "followed" but which I might find very deep and meaningful. (#DMCW/LL/124)

In order to achieve the best possible social learning option, the learners build on their familiar practices and test out new course options.

Reflective actions. Reflecting on the content was a recurring action in the learning logs, ranging from individual reflecting to openly social reflecting. Reflective actions are an essential part of learning, and due to the social learning availability within FutureLearn courses, extra reflections are triggered from the social interactions. These additional reflections might be triggered by previously unknown peers, or known people in the social circle of the learner (e.g. partner, family).

Cohort learning. FutureLearn courses have a clear starting point, thus offering the opportunity to move forward in a cohort of learners. Cohort learning can add to the group feeling for learners. Cohort learning also drives learners forward due to its social learning benefits: "I wanted to complete the 2nd week of the course before next week so that I am not behind, as otherwise you are not part of the discussions" (#DMCW/LL/164).

22.5.3.4 Findings on Individual and Social Learning

The majority of learning within FutureLearn courses happened individually. In order to fully understand the course material and/or to fulfil personal learning needs, the individual learner moves in and out of the course to find answers. Although not actively engaged in any discussions, or in the commenting sections of the FutureLearn courses, the individual learners engaged in lurking or deliberately looking for answers in social spaces without engaging in these social spaces. Whether or not an individual learner decides to enter into social learning depends on the perceived time investment needed, their personal preference to be either social or not and its perceived benefit, as well as their willingness to contribute. Once social learning is part of the learning process, different social actions are undertaken to achieve additional learning success which was not (yet) attained by a learner's individual learning. Learners look for answers inside and outside FutureLearn courses, they also share their experiences with peers inside and outside of the course. Because of the increased amount of learners inside the courses, more reflective triggers are available.

22.5.4 Which Actions (If Any) Did the Learners Undertake to Organise Their Learning?

The FutureLearn participants self-directed their learning based on the following main categories related to organising learning: scheduling, taking notes and personal goal setting.

22.5.4.1 Scheduling

The learner schedules their learning depending on available time and considering the return on time investment in social learning.

Available time. Time is a reoccurring influence on organising learning. The learner mediates the time they are willing and able to put into the course throughout the duration of the course and will re-evaluate that time investment depending on new factors (e.g. workload increase, relevance of content). When less time is available, they look for solutions that permit them to follow the course despite the new time restrictions: "work has been very busy and so the course has taken a bit of a back seat. Previously, if learning episodes have been difficult I will sometimes just move on an[d] accept I may not understand or complete that particular challenge" (#DMCW/LL/125).
Time investment in social learning. Learners referred to the time investment of social learning or time they were willing to dedicate to discussions. Time seems to limit or increase willingness to collaborate: "When I am away lots of work builds up, and I have a queue of tasks awaiting my attention. I watched the videos, including the two external links, and completed the quiz. However I did not read any of the comments from the other learners, nor did I contribute to the discussions" (#DMCW/LL/100). Considering whether or not to invest time also takes place in relation to additional information provided by course peers, especially additional links to resources. Willingness to dedicate time stands in close relation to the usefulness of the content as perceived by the learner.
Keeping notes. Keeping notes was a frequent action to organise learning, and it occurred in all three courses. 70% of the participants indicated that they kept a personal learning record, either digitally or on paper or a mix of both. Of all the participants taking notes, 48% of the learners indicated that they used some sort of personal notebook (which in one course—Basic Science—was provided by the facilitator to all learners as an "activity booklet").

Notes were kept to highlight useful content, to reflect upon more complex material, and to be able to recall content later on. Keeping notes emerged as a very common way to self-direct and organise learning. The way learners keep notes is related to their previous familiarity with certain note-keeping tools.

22.5.4.2 Personal Goal Setting

The reasons to register and be active in a FutureLearn course can originate in both personal and professional motivations. Some learners are motivated to enrol in specific courses based on personal learning goals. Looking at the nature of the learning goals, some learners only referred to the course at hand as a form of continued professional development, e.g. "[I want to] understand what entrepreneurship is and reflect on how it might apply to my work (director in a local authority)" (#DMCW/LL/111), or a way to further their personal goals, e.g. "The main impact is that I'm now putting together my Ph.D. proposal on Network models, thanks to the course" (#DMCW/I/220). In total 9% of the participants referred to studying other courses on top of the investigated FutureLearn course.

Range of personal learning goals. The learning goals set by the participants vary from specific, personal, to a more general interest, and include specific time-related content actions. Twelve learners indicated not having specific learning goals. The idea of having a clear learning goal or not was often aligned with learner testimonies on their approach to learning. There are participants that have a clear learning plan, and those that "take it as it comes" (in terms of timing, sections covered and learning interactions undertaken). However, when looking at the learning goals the learners set for themselves, 83% of the answers paralleled the course objectives. This included the participants who said they take the liberty of learning whatever strikes them as interesting, but still they follow the predefined learning journey as set by the course designer.

Selecting content. The way learners select content is part of their personal learning goals (based on learning needs they self-define), but also based on prior online learning experiences (de Waard and Kukulska-Hulme 2019). Whether a learner decides to put extra effort into understanding specific content, which depends on the perceived benefit of the content in view of their own learning goal. Once content is selected based on a learning goal, the learner structures the learning depending on available time: "Breaking down learning into smaller parts over a period of time enables me to complete the workload and increase my effectiveness at managing multiple learning goals" (#BSE/I/115). The learning goals of the learner self-direct them to select and structure specific content from the course to reach their own goals, which are not necessarily the goals of the course facilitators.

Curated content benefit. MOOCs offer curated quality content, selected by the course organisers. The content is selected and organised by people who are experts in a particular field and supported by their institutions. Open searches for information are time intensive as the right information needs to be found and selected, but with the emergence of MOOCs finding relevant content has become easier. This reality was reflected in the learning logs: "I wouldn't really know where to start on the internet to investigate the metronomes as an illustration of emergence. It's quicker and simpler to ask others on the course" (#DMCW/LL/121). The fact that the course content is curated does not prevent learners from searching for additional information outside of the course. 31% of learners searched for additional information on the Internet, and 21% searched for additional information in non-digital resources. Because the information in FutureLearn MOOCs is curated, the content is consistent with the thinking of the course content experts. This consistency gives a feeling of trust, which can be brought out of balance by new, external course content made by others: “I followed a couple of the external links suggested in the discussions, but generally stopped if I felt that it was taking too much time or I was straying too far from the main syllabus” (#DMCW/LL/120).

The quest to achieve personal learning goals can vary from simple one-step learning goals where what is learned is immediately relevant to a specific learning goal, to more elaborate ways to reach a personal learning goal, e.g.: “[From the discussions] I already realised last week that in my subject (history), understanding the networks is critical. This learning episode reinforced that. I intend to use social network analysis software such as Gelphi in the future, but I must first learn how to use it.” (#DMCW/LL/129). In this example, the learner starts from a FutureLearn discussion about a topic (History), identifies a need to reflect on the structure of social networks, which leads to a personal goal to learn a new software tool which will result in additional knowledge related to their own context. The latter remark also shows that once social learning has happened, integrating the new knowledge in the personal context happens individually, adding to the personal aspect of the learning experience.

Personal goals direct the learner towards specific learning actions. Depending on the return on expectations of following or taking action in a FutureLearn course, participants decided to invest more or less time in specific parts of the course.

22.5.4.3 Findings on Organising Learning

Learning within FutureLearn courses is organised by scheduling time, note taking during the learning process and selecting what is learned depending on personal learning goals. The learner plans their learning in accordance with available time, the relevance of the content, the social learning benefit and related time investment. Note taking is done primarily to ground what is learned, and to be able to retrieve information later on. Notes are kept by learners mostly using their preferred tools, even if alternative note taking options are provided by the course organisers. Learners shape their learning based on learning actions that are guided by their personal learning goals. Learning goals have an important impact on the self-directed learning as it makes learners select specific content, mediate whether they want to invest more or less time given the perceived results, and attaining bigger goals, for example in relation to careers. The personal learning goals of the learner also affect the action he or she takes with regard to engaging in social learning or which tools or technologies they want to use and learn. This means that personal goal setting is not limited to organising learning, but it affects other learning components as well. This makes personal learning goals important inhibitors or enablers of self-directed learning in FutureLearn courses.

22.5.5 Context

Context was a reoccurring category emerging from the data analysis, but which was not directly reflected in the research sub-questions. Context is interpreted here as defined from the perspective of the learner and related to three personal environments: "the learner's external environment (workplace, learning space, social relations, etc.), internal environment (prior knowledge, philosophical views, learning goals, etc.) and digital environment (prior technological experiences, online tools, etc.)" (Downes 2004).

22.5.5.1 Contextualising Content

The contextual relevancy is a basis for selecting specific parts of the course that are skipped or studied: "I choose the topics that seemed relevant in relation to my personal interests and/or as teacher; I skipped the 'ICT-exercises' playing with the computer models" (#DMCW/I/222). Context has an effect on the learning experience; it enables learning once the learner feels that the content is in some way related to their context. Content which is applicable to the learner's own profession or interest, works as an extra motivation. This could be content with a direct link to the learner's profession, or related to a parallel process: "as a teacher and developer I apply the concept of emergence in curriculum development and in my lessons social sciences at the University of Applied Sciences" (DMCW/I/222). This perception of proximity of the content and its impact on learning was also found in relation to selecting peers to interact with.

22.5.5.2 Proximity of Context as Motivator

References to personal or professional context emerged frequently, and in relation to being motivated or not. Context emerged while learners referred to their working or personal environment and the impact of circumstances on their learning. The content-related data revealed that a learner's context, whether personal and/or professional, influences their motivation. Motivation changes with the learner's response to a feeling of contextual proximity to the examples and/or content of the FutureLearn course. When the content seemed to fit a personal/professional purpose, their motivation increased, e.g. "[the content was] closely related to my own skills, mathematics and computer programming, for example. This inspired me to write my own agent based models or cellular automata." (#DMCW/LL/140). The proximity of the context can also be induced by personal experience "I discussed what I had learned with my son as he has experience of me being on medication for depression" (#SOM/LL/101). Whatever the reason behind the connection, there is a relation between the context of the learner and the resulting motivation to learn.

22.5.5.3 Findings on Context Relevance

The learner's perception of any contextual similarities between their own context and the context proposed in the course, or shared by course peers impacts the learning experience. This perceived similarity of context can be related to the learner's external environment (e.g. workplace, peers that have similar interests), the internal environment (e.g. personal learning goals) and the digital environment (e.g. online tools). The familiarity with the course context has a stimulating effect on self-directed learning, as it enables the learner to bring the information within a contextual reach, linking it to the learner's prior knowledge or experiences.

22.6 Conclusion

This study reveals a conceptual framework consisting of five learning components: individual characteristics, technology, individual and social learning, organising learning and context. Each of those learning components harbours key categories that have a major impact on the learning processes within that particular component. Each of the five components is influenced by the other components. In addition, there are two major enablers/inhibitors of self-directed learning within MOOCs: motivation and learning goals, where motivation is mostly intrinsic in nature, and the learning goals mostly personal. A visual representation is given in Fig. 22.2.

Motivation and personal learning goals have a major impact on each of the five learning components. Motivation (in most cases intrinsic) keeps participants wanting to keep on learning. If the learning goals are not addressed by the course content, learners stop engaging with the course. If the content inspires, the learning goals (either professional or personal) are what make learners move above and beyond the barriers that each of the components might induce in them, e.g.: they will solve technological problems, they will connect to others despite having a preference for individual learning, they will overcome lack of self-confidence as a learner characteristic, or they will organise their learning against any time constraints they encounter.

The results of this study provide a conceptual framework for the informal learning experience in MOOCs offered through the FutureLearn platform, specifically from the learner's perspective as this research emerged from the voices of the learners who shared their self-directed learning experiences through self-reported learning logs and interviews. Veletsianos and Shepherdson (2016) already emphasised the importance and need for more qualitative research as "learners' voices were largely absent in the literature" (p. 17). The fact that Charmaz's constructing GT approach was used, added to the ability of the study to give an outlet to the voices and experiences of the learners, as the learners self-reported their learning (in multiple instances all through their FutureLearn course experience), and added additional meaning to their learning logs by engaging in one-on-one interviews.

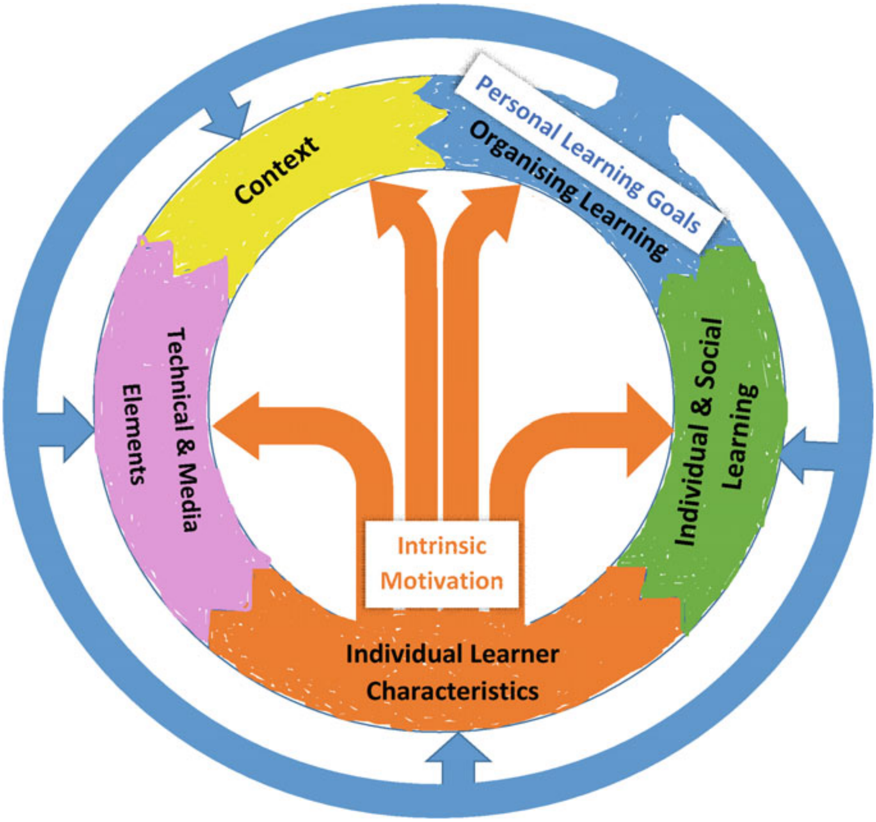

Fig. 22.2 Five learning components and two key inhibitors/enablers of learning

Glossary of Terms

Learning episode A period of time during which a learner is engaged in learning.

MOOC A massive open online course, available to all on the Web.

Social learning Generally, understood to be a theory of learning and social behaviour which proposes that people learn by observing and imitating others. However, there are other definitions, such as the one adopted in this chapter: "an interactive and dynamic process in a multi-actor setting where knowledge is exchanged and where actors learn by interaction and co-create new knowledge in on-going interaction" (Sol et al. 2013, p. 36).

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Inge de Waard (PhD) is leading a project which combines machine learning, artificial intelligence (AI), learning analytics and data science. This project combines the expertise of people working for InnoEnergy, The Open University, UK and FutureLearn (MOOC platform). As an early adopter, Inge has been on the forefront of new educational developments, including mobile learning (also in low resource areas), MOOCs, and AI. In the past 15 years, Inge has set up, coordinated and developed several online and mobile learning projects, always with a focus on participation of all stakeholders and durability. Her work always merges training and learning with research, to ensure evidence-based project development. These projects have involved partners and individuals from both the Northern (Canada, USA, Italy, Belgium, Ireland, Germany, UK) and Southern regions (South-Africa, India, Peru, Morocco). Inge has an extensive research background in investigating and implementing Innovative Educational Technologies (The Open University, UK, EIT InnoEnergy, EU; Institute of Tropical Medicine—Belgium; Athabasca University—Canada).

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Chapter 23
Best Practices Using Flipped Classroom in Teaching a Second Language in Different Learning Environments

Ismael Rumzan

Abstract This chapter will look at the lessons learnt in the application of the flipped classroom method to several learning environments. It will cover the teaching of Arabic as a second language to mostly English native speakers in a face-to-face environment using a variety of flipped technologies and teaching coding to Arab native speakers (mostly Syrian refugees) in a project-based and blended learning environment. In the case of learning Arabic for native English speakers, the challenge arose out of Arabic teachers at lower levels (beginner or intermediate) having difficulty teaching concepts related to Arabic grammar. Through flipped classroom with videos that had been recorded by an English native speaker, instructors overcame this difficulty such that these videos are now part of the normal curriculum for these two levels. In the same learning context, but at higher levels, interactive flipped classroom videos were employed to increase the comprehension of students prior to class and decrease their frustration, thereby improving the level of engagement and active learning in class. For the teaching of coding using flipped videos and coding platforms, these were applied for some time in class in order to train the students to become proficient at learning independently. The challenge remains of having the refugee students develop and implement their own learning plan and a proposal is made for an onboarding and mentorship program to help accomplish this goal.

Keywords Flipped classroom · Language learning · Educational technology · Arabic teaching · Scaffold · Foreign language teaching

Flipped classroom (Wikipedia 2018) is an instructional strategy that changes the traditional learning process of lecture in class, assignments at home and review in class to delivering instructional content, often online, outside of the classroom prior to the face-to-face class. Some of its benefits are improved grades at the end of the course (Luttenberger et al. 2018), increased mastery (Bergmann and Sams 2012) in the core concepts as well as better preparedness for lifelong learning (Rotellar

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and Cain 2016). Furthermore, as mentioned by Bergmann et al., (Flipped Learning Global Initiative 2018), the most important reason why any teacher should consider flipped classroom is teacher to student relationship. By increasing the amount of time that active learning and student to teacher interaction can happen during the face-to-face class with the flipped classroom, a stronger teacher to student relationship is developed which then results in more effective learning. In communicative language learning classrooms like those at Qasid Institute (Qasid Arabic Institute 2016), this directly impacts the learning goals of the class.

23.1 Teaching Arabic as a Second Language

At Qasid Institute, one of the leading institutes worldwide for teaching Arabic as a second language to adults, students are taken from no skill level to advanced levels of near-native proficiency. The institute has partnerships with Arabic language or Middle Eastern studies departments from several universities worldwide such as School of Oriental and African Studies (SOAS), Oxford University, Brigham Young University and Northeastern University such that students are sent as a group to complete an immersion program for one or several terms. The main program taught is Modern Standard Arabic using the communicative language learning approach.

23.1.1 Teaching Arabic Grammar

Teachers at lower levels have difficulty with teaching concepts related to Arabic grammar. Based on the communicative approach, grammar topics are taught gradually to support the learning of the four skills. From the beginning, students are immersed in the language so that fall back on English is avoided as much as possible. Teaching of grammar concepts normally requires a higher level of language use which results in students either struggling to understand the higher level of Arabic or teachers not having the level of English required to explain these concepts. I lead a small unit at Qasid Institute that supports the teachers with instructional technology and training.

Flipped Videos as the Solution for Teaching Arabic Grammar. Since Qasid had contracted an expert Arabic grammar teacher who is an English native speaker to record videos on all the grammar topics of levels 1 and 2, it was proposed to use them to flip the grammar lessons. The Learning Management System (LMS) Canvas (2018) was used to add quizzes to the videos and give students access so that teachers can review student performance on the quizzes which was implemented in the summer of 2013. The initial implementation did not work too well as I tried it across the board with all the teachers using institute level training through face-to-face workshops. Most teachers found the idea interesting but were not ready to use the resources with their students without individual coaching. A few terms later, I followed up with teachers who had been excited by the idea and had really tried to use it with their students. I then worked with them individually to help them improve student adoption. One of the key success factors was making the completion of all online quizzes related to the videos part of course credit, even if they counted toward a small percentage of the total grades. Since then, adoption by other teachers has organically increased every term and for the last 2 years, it has become a standard that all students of levels 1 and 2 are added to Canvas with the flipped classroom videos and quizzes. Furthermore, most teachers now follow-up with their students without the need for administrative intervention as they have seen how it facilitates their work and allows them to have more active learning in class.

23.1.2 Developing Listening Skills at Intermediate Level

Teachers at intermediate and intermediate-high levels (levels 3 and 4 in Qasid's curriculum) often struggle with teaching the language skill of listening based on real-life sources, i.e., non-scripted media pieces. The learning situation involves teachers asking students to listen to a chosen media piece of specific length from Web sites like BBC Arabic (BBC News Arabic 2019) at home and answer a few general questions as they are listening. The goal is that students obtain a general understanding prior to class so that they can discuss the listening more in detail in class and hence achieve a higher level of understanding in terms of Bloom's taxonomy (Wikipedia 2019). However, the following problems are regularly faced by teachers:

1. It takes a lot of time for the students to listen to the media piece at home to get a general understanding as they need to repeat the listening many times. It was noted by teachers that the number of listening repetitions needed varied quite a bit among students of the same group.
2. Some students come to class unprepared to get into the discussion about the listening because they did not grasp the core concepts for different reasons, such as the lack of listening repetitions or unsureness of how many repetitions are needed to achieve the correct level of understanding. Therefore, in class, the teacher has to go back to review the general understanding and is not able to discuss the meanings at a higher level.
3. Students have a hard time answering the general questions and are also not able to identify the location of new vocabulary in the media piece.

Flipped Classroom with Interactive Listening. In implementing education technology solutions, I follow the general principles of the LEAN startup approach (The Lean Startup 2019), focusing on the phase of developing a Minimum Viable Product (MVP) and the use of the build-measure-learn feedback loop. The research for this project arose from the customer (in my case a teacher) approaching me with a real problem within the context of a workshop on the use of an existing tool (SWIVL 2018). The SWIVL tool is a small robot that rotates to follow the teacher using a remote marker carried by the teacher that records the teacher's audio while the video is recorded using a mobile device placed on the robot. It is designed to facilitate teacher self and peer observation and feedback through a cloud-based commenting system where the videos are automatically uploaded. The teacher explained the difficulties she faced with teaching listening skills as described above and proposed the following ideas:

- Being able to prepare the listening media so that sections where the answers to general questions are to be found are highlighted with the text of the question in context. Then, the student can focus on these sections with repetitions if needed to find the answers rather than having to listen to the whole piece over and over again, the latter not providing additional learning value but instead frustration. A point to note here is that often, the same listening is used for different levels of students (intermediate and advanced). The teachers expect that the intermediate student focuses on only some areas and the advanced students on others. Therefore, if the intermediate students try to understand the listening in its entirety, they will get frustrated.
- Highlighting important new vocabulary that the teacher would like the student to learn during the listening so that the student does not struggle to find the word but rather focuses on grasping its meaning in context.

Since I was already using the SWIVL tool, I looked at trying to solve the problem with it so that I could measure and learn as quickly as possible the potential problems and challenges. The solution presented relates to the learning concept referred to as scaffolding. Scaffolds are used when students are provided with a tool as assistance during learning until the student is independent such as training wheels in a bicycle. The child builds a level of confidence and balance when using training wheels until he or she feels confident enough to ride without them, rather than going directly from a tricycle to a bicycle. Currently, at Qasid, the student goes directly from scripted listening at the right speed and comfort level at low levels to unscripted real-world media at intermediate levels. The in-context focus for questions and vocabulary provides the scaffold over a certain period of time until the student feels confident enough and can listen without them. Ideally, the teacher would progressively decrease the number of highlighted questions or vocabulary words and may be increase the highlighted length of time.

Results of Flipped Classroom with Interactive Content. The teacher uploaded her listening videos for several lessons in SWIVL cloud and added comments at specific times in the video that either pointed out specific vocabulary words or asked questions in context. Students were asked to review these before class and answer the questions by replying to the comments. The teacher reviewed the answers before class and was able to engage the students with higher-level discussions after a short review time. After several lessons, I gathered feedback from both students and teachers, which can be summarized as follows:

- Students who answered the questions prior to class in the system were prepared to engage in a higher-level discussion in class, which was not the case before with viewing uncommented videos.

- Although students on average spent around the same amount of time preparing for the class with the time-commented videos as they did with uncommented videos, they did not feel frustrated as they considered this time to be well spent. Before, they were spending quite a bit of time scrolling back and forth and not being able to focus.

Although the method achieved the goal, some of the technical problems encountered by the students triggered me to look for a different tool. After an initial research for tools that would have the right features, two were shortlisted, GoReact (2018) and CritiqueIt (2017). I moved forward with CritiqueIt as it supported direct integration with our LMS Canvas and was within our budget.

One of the Qasid teachers has implemented the CritiqueIt tool as scaffold of interactive listening with highlighted questions and vocabulary for more than two years now in levels 3 and 4. The teacher has seen significant increase in understanding for the students who review using the interactive listening resource compared to those who review using the standard media playback when they discuss the listening in class. Furthermore, over the course of a specific term, she has seen a higher listening skill level during graded assignments for those students who use the interactive listening resource regularly and according to the teacher's instruction. She also experimented with using the same tool for the other three skills, reading, writing and speaking. The biggest challenge has been students not utilizing the resource either due to not being comfortable with the use of technology or having technical problems often due to Internet connectivity issues. The latter were mostly overcome if these classes were provided a small workshop at the beginning of the term from the student support team on how to use the tool and following up with them if they faced any barriers.

The teacher also used the web platform Quizlet (2019) to embed vocabulary flashcards and games inside Canvas to help the students prepare for the vocabulary of weekly lessons. She has found significant increase in the ability of the student to use these vocabulary words or expressions even after they continued to other levels, one of the reasons being that the students could continue using them for revision.

With interactive reading, she did not find clear benefits. Through experimentation over the terms, she found that students found it useful if she linked certain sections in the text to external links that provided more explanation or context.

For interactive writing and speaking, the main advantage was for her to be able to find all the submissions of the students in one place, instead of scattered paper assignments or recordings spread over her desk, e-mail and phone communication. Similarly, for students who used the platform, they could review their feedback for all their assignments in one place. Regarding the recordings, she could easily submit feedback at specific times in the recording.

Regarding interactive listening, there was a general pattern in terms of student use where most students used the platform, but some used it only to review the listening prior to class without submitting any feedback while others used the full experience of reviewing and submitting answers to questions in the platform. These students helped the teacher identify which sections of the listening were most difficult and he or she could address those directly through a specific reply in the system or a general address in class. One of the main benefits students found from the interactive listening technique was the perceived decrease in the amount of time needed to complete the listening before coming to class. Without it, many students would often not complete the assignment as it would take too long going back and forth or cause too much frustration. Furthermore, they would often find it quite difficult to locate the lesson's vocabulary in the listening by themselves due to several factors such as talking speed of the speaker and context of use. When the location of the vocabulary was identified for them, they could focus on the lesson goal which is the understanding of the use of the vocabulary in context.

23.1.3 Best Practices for Flipped Classroom with a Second Language

Below is a list of best practices extracted from the feedback of students and teachers:

1. The flipped content needs to address a specific learning problem faced by the students, for example, difficulty with attaining the right level of understanding required with the class listening at the beginning of the class.
2. Appropriate training and support should be provided to the students for the first few weeks when the flipped content is implemented for the first time such as a class demonstration completing the full workflow and ensuring everyone has proper access to the content and there is appropriate Internet and device access at home.
3. Work initially with a small group of early teacher adopters who are often technology enthusiasts who understand the learning goals and standards well and believe in their value.
4. If possible, include the work to be done with the flipped content, such as submission of answers to questions, as part of total course credit, even if it is a small percentage.
5. The teacher should review students' feedback related to the flipped content prior to the class and comment on their work via the system as well as general feedback in class.

23.2 Teaching Coding Skills to Syrian Refugees

Lifelong AI (2018) is a non-profit organization based in California, USA and working in Amman, Jordan. It was established in 2018 with the mission to empower the most vulnerable refugees, the majority of whom have never used computers and technology before. They provide a step-by-step learning approach to introduce, utilize and tap into the power of technology in education and employment. They believe that having English proficiency and computer skills will open doors to employment and education for the refugees.

23.2.1 Using Web Resources to Teach Coding to Students with Basic English Skills

Coding is an essential skill in our current economy. Furthermore, it is an attractive skill for refugees to pursue as it opens the potential of remote work which is a clear advantage for a population of displaced people. It has also been shown to help develop and enhance problem-solving skills through computational thinking (InformED 2017), which has been identified as one of the important learning domains (PISA 2012).

In January 2018, I volunteered with Lifelong AI to teach coding through web development to 10 teenage Syrian boys and 10 Syrian girls aged 15–30, many of them being widows or orphans. The main challenge was that the students were only available for an average of 5 hours a week as they needed to either work or go to school during the rest of the time. Most programs that teach coding, specially to beginners, are based on the code boot camp model where the students are immersed in the subject for 2–4 months such as Rebook Kamp (RBK) (2013).

One of the main goals of Lifelong AI is to empower refugees to become independent learners so that they can constantly improve their skills and be more employable. With the wealth of resources available on the Internet, especially for teaching coding and technical skills, I decided to use a flipped classroom approach to make the face-to-face class focused on active learning and practical problems. However, the challenge was that most of the resources are available in English and it was not possible for the students to review the flipped content by themselves at home before the class. Therefore, I chose to follow a model recommended by Flipped Learning Global (2018) when delivering flipped classroom for the first time. The strategy is described below, following the Direct Instruction, Guided Practice and Independent Practice teaching method for hands-on skills:

- Direct Instruction: Show students how to use the web resource by projecting the content to a large screen or projector and act as a student, selecting the topic or problem, talking aloud and demonstrating the learning strategy by pausing the video to take notes or write questions or solve a practice problem in front of them.
- Guided Practice: Have the students repeat the same topic or problem but using their own computer and account. Walk around the room to help them, specifically related to the process of using the web resource.
- Independent Practice: Once you feel that the student is confident with repeating the same process on several topics, you would ask them to complete the task by themselves at home and would be able to then extend to higher-level learning in class such as the application of problem-solving techniques.

Overcoming the Barrier of Basic English Skill. The main challenge was with the difficulty of moving to the Independent Practice mode since the level of English of the students was too basic for them to be able to understand the instructions in the web resource by themselves. At the beginning, I used the Hour of Code (Khan Academy 2014) in the Direct Instruction and Guided Practice modes and this generated a lot of momentum and excitement as the projects involved were real-life and simplified to the right level. I was even able to perform Independent Practice by asking the students to work in groups to perform an extension task. I included an element of competition with a reward that went very well.

However, since the Hour of Code projects are limited in scope, I moved on to using the freeCodeCamp coding platform (freeCodeCamp 2015), as most of the students were interested in learning web development. I followed a Direct Instruction and Guided Practice method in class and asked the students to first try to understand by themselves using Google translate. FreeCodeCamp focuses on interactive exercises where each page tackles a very specific subtopic, on which there is small explanation and example on the left, the ability to type your own code in the middle and displaying the output of the code on the right. This worked well and developed a good momentum within the group and students felt a level of accomplishment with moving through bite-sized lessons. However, asking them to complete a lesson at home would have only a few students complete it due to the strong barrier caused by their basic English level.

Later, I enrolled them in a free online initiative started in the United Arab Emirates (One Million Arab Coders 2016), where the goal was to train coders through a translated version of Udacity's (2012) platform. Unfortunately, the video content was a subtitled in Arabic version of the English and it was challenging for the students to understand the Arabic subtitles, especially with more complex technical jargon.

During the Fall of 2018, after receiving a grant from the US Embassy, Lifelong AI was able to set up two classrooms with laptop computers and daily evening classes as well as a Saturday full day class for computer skills and coding. For the students interested to learn coding, most of them had previous programming experience. Since some students had web development exposure, I decided to offer an introductory course in mobile app development based on a project-based learning approach where we would work from the beginning toward building a real mobile app together. Several students dropped out during the course due to a combination of reasons such as having too many other commitments, lack of time during the week to practice the concepts and fairly steep learning curve for students with no recent programming experience. I recorded flipped videos in Arabic by recording my computer screen and stepping through developing the application in the coding environment and explaining the steps and the code. In class, I divided the students into two groups, as recommended by the Flipped Learning Global Initiative where one group would review the recorded videos and try it out, as they did not have time to do it at home, and the other group, who completed the flipped video homework, was engaged to understand the inner workings of the code. The students who worked regularly were able to complete the project within a few weeks. However, after gaging their ability to re-use the techniques applied in the project (levels 5 or 6 of Bloom's taxonomy), it was clear that they needed more scaffold and practice to reach that level.

Finally, I was introduced in late Fall 2018 to the Massive Open Online Course (MOOC) by the Queen Rania Foundation in Jordan, Edraak (2013). This was a good solution for my main barrier of low English skills with my students. After introducing my students to the concepts of effective learning techniques (Learning how to Learn 2015), I helped them design their daily learning plan and identify which courses they would add to their learning path from the Edraak platform. Thereafter, my main task was as a coach, checking with them regularly where they were at related to their learning plan and suggesting tips when needed. I was now moving toward Independent Practice which I am forecasting will take a minimum of 3–6 months until the student is able to design his or her own learning plan and be faithful to it. Academic counseling may still be needed at specific checkpoints when students need to select new courses. In the next section, I will describe my recommendation for a program for refugees that could potentially scale and be implemented with a minimum amount of funding and resources.

23.2.2 Recommendations for a Flipped Classroom-Based Student Development Program

From the above-mentioned program and experimentation with different web resources and methods, we can extract the following lessons:

- In order to use flipped learning videos in English for Arab or non-English native learners, a minimum of intermediate English skill level is recommended.
- If there is no time to ramp students up to a proficient English skill level, flipped videos taught by a teacher in the native language of the student should be used. Ideally, the videos should be recorded by a teacher to whom the students have a relationship with, as recommended by Flipped Learning Global Initiative.
- For teaching coding skills, combining a topic-based approach with a project-based approach can be very powerful. The students could be asked to review content related to a key topic like the IF statement with applied examples they can try in the flipped classroom model at home. Then, in class, they would be engaged to discuss how they would apply the IF statement in the context of a specific part of their project and start working on it while the teacher is available to help in this higher-level task. This would require appropriate planning of the topics in relation to the project and may change the typical flow of how topics are delivered in a topic-based only approach.

Based on these lessons learnt, I would like to propose the following program that could be implemented using existing free digital resources. Other resources would be needed for the onboarding and follow-up aspect of the program, the goal of which would be to develop independent learners.

Independent Learner Development Program for Arab Refugees. This program is based on the Edraak platform. It would be conducted using the following process:

1. Conduct an online or face-to-face English placement test.
2. Have a counselor, trained for the program, meet with the student to help him or her prepare a learning plan that will include as the first step, the Edraak beginner English program, if needed according to the placement test results. The plan would include the number of modules to work on daily, weekly goals and a reporting sheet for the counselor to review. A meeting would be scheduled on a need basis if the student is not keeping up with the plan.
3. As the student progresses through different courses in the learning plan, the counselor's role would move from the creator of the plan to the reviewer of the plan until eventually, the student is independent in creating and following an effective plan, at which point, the student graduates as an independent learner.
4. The student would receive career guidance to choose a career that would fit his or her personality and strengths as well as allow him or her to be a freelancer, possibly working from anywhere. He or she would then be able to plan his/her own learning using available Massive Open Online Courses (MOOCs) such as Edraak to achieve these skills.

23.3 Conclusion

In trying to encourage more teachers to use the flipped classroom method, Qasid is looking into developing a standard for each type of flipped content, such as the appropriate number and type of questions per 5 min of listening or types of vocabulary to highlight, for each level or group of classes. Then, they are thinking to develop a repository of flipped content that all teachers can use when needed, instead of having each teacher prepare content for each of their classes. I am also exploring other tools that provide more interactivity and metrics related to how the student interacted with the video content. One example is PlayPosit (2018), which allows the teacher to include multiple choice quizzes, discussions and rich content submissions at specific times in the video and view statistics such as a graphical summary of correct answers per video and the amount of time spent by each student on each question. I have started prototyping this tool with a couple of instructors and the results are very promising.

Related to the work with the Syrian refugees, I am planning to apply the Independent Learner Development Program with a prototype group of students and train a few mentors who will be supporting the students with their learning plan.

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Glossary

Active Learning Type of learning strategy that focuses on keeping students engaged throughout the class in order to increase learning effectiveness.

Arabic Teaching Teaching of Arabic as a second language to non-native speakers.

Blended learning Learning method that combines multiple modes of delivery in the same course, such as live online, face to face and asynchronous (not live) online.

Bloom's taxonomy Taxonomy of learning originally proposed by Benjamin Bloom that classifies the learning process as six steps as follows: Remember, Understand, Apply, Analyze, Evaluate and Create.

Calm Technology An approach to using and designing technology that is minimalist and where the focus is using the minimum amount of technology needed to solve a problem.

Coding Skill that computer programmers develop and master as they use a computer programming language to solve real problems.

Communicative Language Learning An approach to learning a language that focuses on developing proficiency in using the language using the four skills of reading, writing, listening and speaking.

Computational Thinking A process that is applied to real-life problems so that a computer solution can be used to try to solve them.

Educational Technology A technology in the form of an electronic device such as a mobile device or robot that helps in achieving a learning goal.

Face-to-Face Environment The physical location, context and culture in which students learn by being physically present with each other and with the teacher.

Flipped Technologies Different types of technologies used to create and deliver the Flipped Classroom content.

Immersion Program Language program that puts the language learners in an environment where they always interact in the language being learnt.

Instructional Designer A learning professional who works with content matter experts to design and create learning experiences that are effective.

Instructional Strategy A learning technique that the teacher uses to help the students learn more effectively.

Instructional Technology A technology in the form of an electronic device such as a mobile device or robot that helps in achieving the learning goal. It can be used by the teacher, student or both.

Interactive Flipped Classroom Flipped Classroom content that has interactivity such as quizzes built into it.

Interactive Listening Listening of audio passages for language learning that gives the students the ability to interact with the audio piece in different ways such as being able to answer questions on the timeline or viewing additional content at specific times.

Interactive Reading Reading of digital text passages for language learning that gives the student the ability to interact with the text such as viewing a question on a highlighted area and replying to it inside the passage.

Interactive Speaking Students having the ability to submit recordings of speaking prompt assignments and the teacher being able to submit feedback at different points of the timeline in the recording.

Interactive Writing Students having the ability to submit their writing assignments in a digital format and the teacher being able to provide specific feedback on specific areas of the writing.

Lean Startup A method that guides entrepreneurs through the process of a startup company so that they can change it quickly and effectively and reach success faster.

Learning Domains The five domains that the Programme for International Student Assessment (PISA) uses to assess student competency which are reading literacy, mathematical literacy, scientific literacy, problem-solving and collaborative problem-solving.

Learning Goals Goals developed by teachers or instructional designers to help focus the learning experience.

Learning Management System An online system that has tools to help the teacher create digital content and assessment in an organized way to support learners learn digitally.

Learning Plan A document used by the learner to study for a specific subject or course over a certain amount of time. The learner can be responsible for creating his or her own learning plan.

Lecture An oral presentation where the content expert presents the content to the audience.

Lifelong Learning The ongoing process of learning to gain new knowledge for personal or professional reasons.

Massive Open Online Courses Free online courses that anyone can enroll in.

Minimum Viable Product As part of the lean startup model, it is the first version of the product with the minimal core features that can be tested with real customers.

Mobile App Development The programming involved to create a mobile application from a user interface design to a functional product that can be tested.

Modern Standard Arabic The standard literary and communicative language of the Middle East and North Africa.

Near-native Proficiency Highly proficient language speakers who are distinguishable from native speakers only in small ways.

Online Learning Learning that happens through the Internet using electronic devices like computers and mobile devices.

Problem-Solving Skills They allow someone to identify the source of a problem and create an effective solution for it.

Project-based Learning A teaching method in which students gain knowledge and skills by working for a period of time on a specific real problem.

Remote Work The ability for people to work from home.

Scripted Listening A listening assignment for language learners that has been recorded based on a script that will be appropriate in terms of vocabulary, complexity and speed for the students of that level.

Traditional Learning Learning that is centered around the teacher directing and imparting knowledge to the students.

Web Development The process of taking user interface designs and making them into functional Web sites for delivery on any device using current web technologies.

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Chapter 24
Open Universities in the Future with Technological Singularity Integrated Social Media

Serap Sisman Ugur and Gulsun Kurubacak-Meric

Abstract The term "singularity" was first used by John von Neumann, in the 1950s to refer to "technological advances that cause change (Ulam in Bulletin of the American Mathematical Society 64(3, part 2): 1–49, 1958)." According to Kurzweil (The singularity is near: When humans transcend biology. New York, NY: Viking, 2005) and Yampolsky (Information 9(8): 190, 2018), the singularity is near. Moreover, such as Marc Zuckerberg and Bill Gates unlike the "dangerous" rhetoric of dystopian, he argues that singularity will make people more improve. In the future, Kurzweil develops a hypothesis that artificial intelligence will go beyond human intelligence to radically change civilization and human nature. According to him, the discovery of artificial super intelligence will trigger a sudden technological growth. A leap will result in unimaginable changes in human civilization. Social media, which has become the platforms that people cannot give up in their daily lives, will be the main means of communication connecting people in the process of singularity. At this point, education systems and institutions will also be in the process of change. Especially mega universities and Open Education Systems, where technology is the main tool, adapt to this change. In this research, it is tried to determine how mega open universities can benefit from social media in their preparation processes for technological singularity. As a result of the interviews conducted with the field experts, it was concluded that the social media platforms will have a high level of interpersonal communication and interaction and that the institutions will play a role in determining the limits of their place in human life. During this process, the determination of the needs of the program, the determination of the technologies to be used, and the research for the organization of personnel resources are important for the mega universities to be prepared for the singularity period.

Keywords Technological singularity · Social media · Mega university · Open university · Open and distance learning

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24.1 Introduction

Although there is a huge debate about the pros and cons of technology and learning as well as intelligence, technological singularity integrated social media will be a big impact in the development of the human race. Therefore, it is crucial that open universities need to position themselves strategically for the future, considering the potential of technological singularity integrated social media, and focusing on its relative strengths. Open universities driven by cutting-edge technologies will be able to provide their learners with seamless democratized and dematerialized learning environments and services.

24.2 Literature Review

Von Neumann uses the term singularity, though it appears he is thinking of normal progress, not the creation of superhuman intellect (Shanahan 2015). According to Vince, the post-singularity world does fit with the larger tradition of change and cooperation that started long ago (perhaps even before the rise of biological life). While mind and self will be vastly more labile than in the past, much of what we value (memory, knowledge, thoughts, information, etc.) needs never be lost (Vinge 1993, 2013).

The set of concepts today commonly referred to as "technological singularity" has a long history in the computer science community, with early example such as "One conversation centered on the ever accelerating progress of technology and changes in the mode of human life, which gives the appearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue." (Callaghan et al. 2017) According to Sandberg (2010), technological singularity definition is multidimensional structure and including a lot of features such as accelerating change, self-improving technology, intelligence explosion, emergence of superintelligence, prediction horizon, phase transition, complexity disaster, inflexion point, and infinite progress. One of the results that in Sandberg's research, which about technological singularity:

> There is a notable lack of models of how an intelligence explosion could occur. This might be the most important and hardest problem to crack in the domain of singularity studies. Most important since the emergence of superintelligence has the greatest potential of being fundamentally game-changing for humanity (for good or ill). Hardest, since it appears to require an understanding of the general nature of super-human minds or at least a way to bound their capacities and growth rates.

Vinge refers that when people speak of creating superhumanly intelligent beings, they are usually imagining an AI project. Computer networks and human–computer interfaces seem more mundane than AI, and yet they could lead to the singularity (Vinge 2013). Yampolskiy (2015) stated that developments in artificial intelligence are a preparation stage for technological singularity, because they may permit AI to recursively self-improve (Sotala 2012), advanced communication (ability to share cognitive representations complex concepts). Artificial intelligence also provides new cognitive modalities (sensors for source code), ability to analyze low-level hardware (e.g., individual registers), and addition of hardware (ability to add new memory, processors, etc.) (Yudkowsky 2007) and possibly succeed in this challenging domain:

- the ability to work uninterruptedly (no breaks, sleep, vocation, etc.),
- omniscience (complete and cross-disciplinary knowledge),
- intersystem communication speed (chemical vs. electrical),
- duplicability (intelligent software can be copied),
- greater speed and precision (brain vs. processor, human memory vs. computer memory),
- editability (source code unlike DNA can be quickly modified),
- near-optimal rationality (if not relying on heuristics) (Muehlhauser and Salamon 2012).

According to Potapov (2018), artificial general intelligence (AGI) as a singularity technology will also have a shorter doubling time, because knowledge of its design principles will enable easier self-optimization or extension with additional modules, sensory modalities, and so on. Thus, whether we want this or not, AGI will emerge earlier and evolve faster than brain uploading or whole brain emulation (if either of these is ever possible). Also, one can claim that artificial super intelligence can provide it.

These predictions pointed that there is a need for the spread of singularity. Social media can be considered in order to overcome this deficiency. The artificial superintelligence applications can be used in social media, and this will be able to be an effective method in both data collection and configuration. Also, this use can be effective in the spread of technological singularity (Eden et al. 2012).

Considerable competition for students exists in the marketplace as institutions compete for students. Universities are aware of the importance of their reputations; hence, they utilize branding activity to deal with such competitive threats (Rutter et al. 2016). These branding studies are now widely carried out in social media. According to a research about that influence of social media and using it with blockchain technology that are evolving and upgrading continuously, there are many untapped opportunities for disruptive innovation in current and future ecosystem of social media in order to rebuild a more trustable, reliable, transparent, and secure fundamental fabrics for our modern society (Jing and Murugesan 2018).

Social media is a widely used platform for communication and learning. With these features; while the future is shaped, social media can be considered as a specific tool. People use social network to spread news or information very quickly. It can also provide instant access to information. Given the characteristics of technological singularity, the importance of social media for this period which about changing information spread with social media can be foreseen. Therefore, universities that offer open and distance learning services should use these features of social media. When structuring their reorganization., these universities can benefit from the power of social media.

24.3 The Purpose of the Study

The aim of this study is to foresee a futuristic view of how open universities can achieve their sustainability in the context of technological singularity integrated social media. Technological singularity predicts that artificial intelligence will prevent human intelligence in the future (Moravec 1988). Not only can artificial intelligence radically change human habits, but also learning practices. The foundation of a revolutionary transformation on humanity learning will be established for both the open universities and for the technological singularity and social media. Thus, open universities are not only sustainable; at the same time, but transformed into ecological learning environments. Within the framework of the internalizations and predictions of the study, participants on open and distance learning environments help us how to save open universities in the future.

24.4 The Importance of the Study

The idea that human history is approaching a singularity that ordinary humans will someday be overtaken by artificially intelligent machines or cognitively enhanced biological intelligence, or both. This idea is not science fiction anymore, it is a fact. Von Neumann uses the term singularity, though it appears he is still thinking of normal progress, not the creation of superhuman intellect. Vinge (2013) asserts that mankind will develop a superhuman intelligence before 2030. To Ray Kurzweil (2005), Google's chief of engineering, robots will reach human intelligence by 2029 and life as we know it will end in 2045. Kurzweil defines this transformation as technological singularity that all the emerging technologies first reach the subtleties of human intelligence, then knowledge-based technologies will pass human intelligence increasingly, and sharing knowledge rapidly. Therefore, it is no longer a dream that the cybernetic community will exist in the future.

The acceleration of radical transformational technological progress must be the central feature of open universities in this century, while we are on the edge of change comparable to the rise of human life on earth. Open universities, therefore, must keep pace with these rapid changes in technology and society in order to sustain their assets. The precise cause of this change is the imminent creation by the cutting-edge technologies of entities with greater than human intelligence. There are several means by which open universities must achieve this breakthrough and integrate new improvements into their systems:

- Because of the development of computers, which are "awake" and superhumanly intelligent, open universities must develop advancements in artificial intelligence (AI) as learning environments.
- Because of dense and extensive computer networks and their associated users that "wake up" as a superhumanly intelligent entity, open universities must establish the networks that somehow become self-aware.

- Because of computer/human interfaces, which become so intimate that users may reasonably be considered superhumanly intelligent, open universities must focus on advanced computer/human interfaces that users must essentially evolve into a new learners.
- Because of the improvements in both biological science and social science that find ways to improve upon the natural human intellect, the advancements in open universities must allow users to engineer their intelligence.

In this context, it is also important to discuss in detail that social media platforms, which their popularity, interest areas, number of users, etc., have been increased dramatically for the last decade, can be used in open and distance learning programs, where artificial intelligence applications are integrated. All of these advancements make it easier to process the World Wide Web's endless amount of data which has in turn increased the accuracy of social media and online learning. The perspective of online media services, such as Google and Facebook, having AI programs that understand users' personal interests and feelings help improve the online experiences and enjoyment with technology in open universities. Social media, therefore, can be all about learners connecting with each other; sharing information and interacting; making their presence social; and impacting each other in an interactive way only straightforward via artificial intelligence. Open universities must transform themselves to understand learning their users' tactics, which will be an inherent part of how social media evolves into social ecosystems that exhibit intelligent behavior, learning, demonstrating, explaining, and giving advice to its users. Thus, open universities must be in the social platforms, methods of sharing, services offered, benefits to people, benefits to brands, and of course to the society at large. In short, what social media brings in is that it demands a reconceptualization of open universities.

24.5 Methodology

This study is a qualitative research and has been designed by adopting an individual and dialogical phenomenological approach model to identify phenomena through perceived by the actors in the situation. This will translate into gathering deep information and perceptions through individual interviews, discussions and participant observations, and representing it from the perspective of the research participants. This study will experience from the perspective of the individual, bracketing taken-for-granted assumptions and usual ways of perceiving based in a paradigm of personal knowledge and subjectivity, and emphasize the importance of personal perspective and interpretation.

The researchers will use their own actual and imaginary experiences and others' factual and fictional written accounts and theories to develop a thematic description of the phenomenon through individual phenomenology. This will involve introspection, which is a method of inner observation which involves assuming an external viewpoint toward oneself, stating the facts about oneself as others might if they could observe what the introspector observes. Besides, through dialogical phenomenology, each researcher will interview the co-researcher, and involving the co-researcher in thematizing during the interview. Each researcher will explicitly pay attention to and refer to observations of the co-researcher's behavior as well as to the co-researcher's descriptions of experience.

The research site of this study is one of the mega open universities in where the researchers have been working for over 15 years. The participants of the research was selected by utilizing the purposeful sampling method: The experts/faculty/researcher who teaches open and distance courses, or design, implement or implement open and distance courses, or work as an administrator in open universities for at least 5 years are the participants of this study. There are four participants, including two researchers themselves of this research.

In this context, a variety of methods have been used in this phenomenologically based research, including interviews, conversations, participant observations, action research, focus meetings, and analysis of personal texts. Those participants have been answering about how open universities will position themselves strategically for the future with technological singularity integrated social media.

The following four types of triangulation will be used in this research:

1. Triangulation Methods (checking out the consistency of findings generated by different data collection methods)
2. Triangulation of Data/Sources (examining the consistency of different data sources from within the same method)
3. Analyst Triangulation (using multiple analyst to review findings or using multiple observers and analysts)
4. Theory/Perspective Triangulation (using multiple theoretical perspectives to examine and interpret the data).

24.6 Findings

Table 24.1 illustrates the main themes and concepts of the participants' responses to the first question: "What kind of Open Education System can be structured with social media while Mega universities are organized in the context of new technologies in the future?"

When we look at the concepts that the participants use for answering the first question such as "What kind of Open Education System can be structured with social media while Mega universities are organized in the context of new technologies in the future?" we can say that the first participant especially focuses on the features of the

Table 24.1 Answers for question one

	Participant 1	Participant 2	Participant 3	Participant 4
Program development	• Program variety • Target audience • Quantity • Quality	• Need identification • Access to information • Time and space independence	• Informal learning • Experience tracking	• Need identification
Content	• Quality • Compatibility	• Content tracking • Interaction • Entertainment	• Smart content • Interaction	• Entertainment • Content sharing • Dynamic structure
Analysis	• Network analysis	• Content analysis	• Experience analysis	• Interaction • Network analysis
Learner	• Quality • Heterogeneous	• Interaction • Effective • Communication • Entertainment • Group work • Peer review	• Personal learning environments • Learning styles • Learning habits • Learning experience • Interaction	• Learning roles • Peer learning
System/institution	• Usability	• Integration with Open Education System • Learning management system • Mobile technology	• Augmented reality • Mobile technologies	• Longer and more active use • Commitment • Learning management system
Social media	• Social network • Strengths • Weaknesses • Analysis	• Environments • Tools • Facilities	• Virtual worlds • Smart assistant applications	• Entertainment • Sharing • Interaction

target audience for which the Open Education System will be prepared. However, the participant emphasizes the importance of determining the strengths and weaknesses of the social media environments to be selected in terms of the Open Education System. The second participant sees the choice of social media tools as a priority theme and underlines the integration with content management, learning management system and Open Education System. The participant also emphasizes the importance of structuring the communication and interaction features of the social media for the purposes of the Open Education System and addresses the importance of access to information. The third participant speaks about learner-centered learning and speaks about virtual worlds for an organized Open Education System for the use of personal learning environments. The participant, who emphasizes the importance of interaction for the Open Education System to be structured, addresses the use of experience tracking technologies. The fourth participant, on the other hand, indicates that the time allocated by the individuals for learning will increase especially depending on the time spent on social media. However, the participant observes that peer learning activities through social media can also take place.

Underlining Kurzweil's definition of singularity (Reedy 2017), "the increase of knowledge-based technologies and rapid sharing of information" emphasizes cybernetic society and addresses the future of virtual reality, virtual worlds, and social media platforms. We can say that it may be necessary to structure Open Education System that allows for entertainment elements as well as socialization by shaping the experiences of the learner, especially during the technological singularity period, which emphasizes the use of individual-centered technologies, and addressing the new learning structures, which have emerged with the developing technology, on the dimension of the learner. With this structure, mega universities that will offer learning services will also be able to follow the learning data and provide contents integrated with the appropriate learning management system and can provide effective communication as well as interaction. Considering the length of time learners spend on social media platforms, it can be said that these systems will be used effectively and efficiently with the correct structuring of a non-formal learning environment. Furthermore, considering the anticipation that artificial intelligence will be available in every field during the singularity period, the importance of artificial intelligence can be understood in restructuring Open Education System.

As the second question, "What is the role of social media in the future when the mega universities are regulated under new technologies, how can social media be used in the management or when management is restructured?" these are the main concepts that participants particularly focus on: execution, coordination, corporate identity, belonging, and artificial intelligence.

Table 24.2 illustrates the main themes and concepts, emerging out of the answers to the second question: "What is the role of social media in the future when the mega universities are regulated under new technologies, how can social media be used in the management or when management is restructured?"

Table 24.2 Answers for question two

	Participant 1	Participant 2	Participant 3	Participant 4
Corporate identity		• Marketing • Corporate • Identity	• Corporate renewal	• Corporate account • Corporate identity
Learner	• Service	• Reinforcement of belonging • Assignment • Peer review	• Personalized content • Collaborative and scalable applications • Effective group work • Lifelong learning • Social media integrated with learner experience • Learner profile	• Interaction • Belonging
Implementation	• Execution • Coordination	• Student support service	• 3D technologies • Artificial intelligence • Virtual media technologies	• Student support system
Promotion and advertising	• Effectiveness	• Staff interaction		• Promotion • Advertisement • Announcement
Institution	• Organizing • Coordination	• In-service training • Network analysis • Role identification	• Open source software • The organizational structure	

The first participant emphasizes that the social media can be used effectively in organizational structure and coordination for this question, while the second participant emphasizes the formation of corporate identity and the arrangements to be made with the aim of creating a sense of belonging in individuals. At this point, the second participant also indicates that the use of social media could be effective and productive in such areas as personnel interaction and peer assessment, indicating that a new structuring could be realized with the use of social media for student services and support services. When the responses of the third participant are examined, the participant observes that the use of collaborative and scalable applications, especially enabling collaborative work, and integrated virtual media technologies can be effective in using social media efficiently. The participant notes that the individual-specific contents to be produced by artificial intelligence will be effective if they are structured through social media and suggests that corporate renewal is required. The fourth participant agrees with the third participant in that sense; social media will be useful for establishing the corporate identity and reputation. What's more, the participant emphasizes the importance of the announcement of services, teamwork, and the structuring of student support services.

We can observe that social media used for peer assessment and group work will be important in order to provide communication and interaction between individuals as we head toward technological singularity. Social media environments can be considered as the most obvious platform that can be used in the context of the establishment of the "large human networks" specified by Vinge (2013). Corporate personnel communication, business process flows, coordination, job definitions and identification of roles, decision process organization, activity planning, internal and external communication, social media analysis for internal training, and defining and interpreting the actors and roles will be accessed after such analysis is completed.

Table 24.3 illustrates the main themes and concepts according to the answers of the participants to the third question: "What is the role of social media in terms of human resources in this structuring?"

The final question to the participants is "What is the role of social media in terms of human resources in this structuring?" The first participant focuses on the workforce. The participant, who expressed the social media will be effective and productive for increasing the employee performance and communication between the employees, notes that social media will be effective for promotion and announcement of the services, communication with learners, personnel recruitment, personnel selection, and personnel training. Social media also provides access to stakeholders and accessibility to all network users. The second participant also stated that social media would be particularly effective in announcing the corporate identity, being an informal source of information, defining roles on the network and determining locations. However, the participant noted that social media specialist, marketing specialist, and visual communication specialist should be included for personnel structure, who will work in social media. The third participant focuses on the provision of staff communication and interaction, the identification of learning experiences everywhere and the

Table 24.3 Answers for question three

	Participant 1	Participant 2	Participant 3	Participant 4
• Labor • Force/personnel • Duties	• Labor • Force • Analysis • Efficient • Working	• Role definition • On the network	• Efficiency • Staff experience	
Social media staff	• Effectiveness • Personnel recruitment • Staff training • Services to be provided			
		• Social media expert • Marketing Specialist • Visual communication specialist		• Communication specialist • Information technology specialist • Data analyst • Social media expert • Graphic specialist
Access and communication	• Access to stakeholders • Student access • Accessibility • Feedback	• Positioning • Informal information access	• Communication • Virtual world • Personnel communication • Access to learning • Inter-learner interaction	• Social media announcements • Service Ads

artificial intelligence, the learner profiling and the interpretation by experts and efficiency in services. For the fourth participant, human resources to training of internal staff, analysis of social network, and training data analyst for learner profiling are significant for structuring the human resources. The participant specifies that social media will be effective for communication and information specialists and social media experts should work in coordination. The participant also noted that social media will be effective for conducting the promotion and advertisement activities of the institution.

When the answers to this question were analyzed, we observe that the individual characteristics, experiences, and network analysis were highlighted, and upon analyzing such answers under singularity period, we can say that a particular focus must be given to the use of technology and social media integrated with artificial intelligence for the individuals. The use of social media, in which video in-game purchase or disseminating online fake news are considered as criteria in citizenship/social credit system, can be seen as one of the footsteps of singularity period of in the future. In this context, structuring a human resource, which feeds on the social media use of the individuals, makes it easier to perform many functions from personnel selection to assigning duty or role to the individuals. In this sense, it is important to raise and select the personnel, who will conduct the necessary social network analysis. We can say that it is required to be prepared for the future processes by reshaping the human resources organization of the institution via the correct interpretation of the data acquired through network analysis.

24.7 Results

From a futuristic point of view, it is clear that open and remote learning systems should be ready for the period of technological singularity that we will live with in the near future. The mega universities, which are prominent with their student profile, quality and quantity, should determine research and development activities for investment and structuring processes from now on by foreseeing the needs of singularity period and should be able to shape their strategic plans within this scope. Social media integration is one of the issues that organizations need to consider when planning their managerial processes. In the new processes that will be structured by taking into consideration the use of social media platforms that has become addictive today, open education programs can be prepared by benefiting from many technologies such as virtual worlds, 3D platforms, artificial intelligence, and hologram technologies; this will be an opportunity to open new employment fields in the upcoming singularity period.

Within the organizational structure of mega universities:

- Artificial intelligence applications,
- Learner-oriented learning systems,
- Tracking the learning experience,
- Social media integrated learning management system,
- Smart content, even smart assistant applications,
- Program and need analysis determinations with social network analysis are needed to be carried out.

In addition, activities such as:

- Corporate identity and reputation operations,
- Service announcements, advertisements, and promotions and
- Informal information access will be more effective and efficient with the use of social media platforms.

The importance of social media is inevitable given the ability to communicate in different bandwidths without talking or writing in the human networks that are included in the term "singularity." At the same time, these platforms will ensure that interpersonal communication and interaction take place at a high level and will play a role in determining the boundaries of institutions' place in human life. Throughout this process, determining the needs of the program, determining the technologies to be used, and research for the organization of personnel resources are important for mega universities to get prepared for the singularity period.

24.8 Conclusion

Universities are needed a restructure for the future with technological development and technological singularity. This restructure and transformation will affect not only management process but also human resources. At the same time, universities should consider with social media and the current technologies such as artificial intelligence, augmented reality, virtual reality, and blockchain.

Each mega open university must establish its own scenario based on this matrix to make a solid connection between technological singularity and social media.

Theoretical Basis of the Study					
OPEN UNIVERSITIES		Technological Singularity			
		Single Collective Intelligence	Super Intelligent Machine	Communicate in ways which make it indistinguishable from natural language	Cyber So ciety
Social Media	Stories Ad				
	Live Video				
	Focus on Messaging				
	Location and Hashtag Instagram Stories				
	Platform integration				
	monitoring and listening				
	Scheduling				
	Engagement				
	Analytics				
	Collaboration				
	Content library and sources				
	Tool integration				

- Establishing the theoretical foundation of the research questions and data tools according to the matrix.

Terms/Glossary and Abbreviations

Artificial General Intelligence (AGI) AGI is the intelligence of a machine that could successfully perform any intellectual task that a human being can.
Technological singularity Technological advances that have led to change.
Social media It is a media system that provides two-way and simultaneous information sharing instead of one-way information sharing.

Augmented reality A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.

Virtual reality The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.

Virtual world Virtual worlds are three-dimensional environments in which you can interact with others and create objects as part of that interaction.

Interaction Communication or direct involvement with someone or something.

Blockchain A time-stamped series of immutable record of data that is managed by cluster of computers not owned by any single entity.

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Chapter 25
Smart Literacy Learning in the Twenty-First Century: Facilitating PBSL Pedagogic Collaborative Clouds

Margaret Aker and Luis Javier Pentón Herrera

Abstract Prevalent in the literature are the components of smart education, learning, and literacies; smart pedagogies are encouraged, but practical examples are scant. A gap between education and the workplace has been acknowledged; how can smart pedagogy fill the void? This chapter provides an example of an innovative educational process bridging the interval utilizing an online problem-based service learning (PBSL) instructional approach and a pedagogic collaborative cloud, a *smart* pedagogic collaborative cloud (PCC). Educators collaborating together are a crucial component of the changing praxis. In a university course using a PBSL approach, students collaboratively identified a problem—lack of time. A literacy pedagogic collaborative cloud was identified as the solution to the problem. A pilot study was performed ($n = 12$) to ascertain interest in the idea and warrant conducting a study. A triangulated qualitative study ($n = 45$) was implemented; a broad constructive theoretical framework provided support for smart education, PBSL, and the pedagogic collaborative cloud. The research questions were: (1) Does the interest or need exist to create a literacy collaborative cloud for graduate students and alumnae? (2) What was the best format to encourage participation? Four types of data were collected and quality checks instituted. The findings revealed 80% of the participants agreed with the creation of a literacy pedagogic collaborative cloud (LPCC); 100% of the participants preferred to collaborate with a group of professionals in their field, and 100% agreed collaboration improved teaching practice. A private literacy PCC was created on Facebook; the implications are clear—smart pedagogy can fill the university/workplace void.

Keywords Mobile learning · Pedagogic collaborative clouds · Smart learning · Problem-based service-learning

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25.1 Introduction

In the *Oslo Manual*, published by the Organisation for Economic Co-operation and Development (OECD), the definition of innovation is a novel product or process different from one previously in use (OECD 2018). Following the definition guidelines, an educational process innovation occurs when either a new or changed process for delivering services, such as "new pedagogies" or new mixes of pedagogies, is presented or new ideas are introduced, such as "changing the way educators communicate" (Vincent-Lancrin et al. 2019, p. 17). Accordingly, the literacy pedagogic collaborative cloud (LPCC) represents an example of an innovative educational process with the goal of improving education.

The OECD seeks to improve the well-being of individuals globally concentrating on solutions to common problems which in education focus on knowledge and skills needed in the future. In most OECD countries, encouraging the twenty-first-century skills represents a crucial curricular component. It is imperative educators understand how they can adjust their practice using professional development as a resource (Vincent-Lancrin et al. 2019). However, changing one's teaching and learning practices may require a change in knowledge, beliefs, or attitudes. To accomplish this, some investment is needed in the form of new knowledge production, communication, or the facilitation of peer learning through a variety of means. Fortunately, providing professional development opportunities can help educators learn new pedagogies, which is especially beneficial when the acquired knowledge is applied in their courses.

The bad news: From 2007 to 2015 innovation in formal teacher training reflected low levels of change (Vincent-Lancrin et al. 2019). The good news: According to the OECD, innovation has been robust in peer learning professional development for educators "often considered as more effective than formal training, partly because it is more strongly connected to teachers' needs. By coming together with their peers to discuss and collaborate, teachers have the opportunity to develop professionally" (Vincent-Lancrin et al. 2019, p. 238). Indeed, the largest diffusion of innovation experienced by students has been through their teachers participating in teacher peer learning professional development (Vincent-Lancrin et al. 2019). The literacy pedagogic collaborative cloud is an example of an innovation in peer learning professional development.

Illeris (2009) discussed the importance of modifying current educational practice to create a better future for the world. Now moving into the third decade of the twenty-first century, both the OECD and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) are focusing on the area of new pedagogy (Lorenzo and Gallon 2019). As cited by Scott (2015), "moving towards new pedagogy is not simply a matter of offering learners technologies they are likely to use in the knowledge society… twenty-first century pedagogy will involve engaging learners… for different kinds of knowledge practice… enquiry, dialogue and connectivity" (p. 4). Utilizing inquiry, collaboration, and connectivity, the smart world is infiltrating the field of education and impacting learners around the globe (Uskov et al. 2017).

Today, smart education, learning, environments, and pedagogy are ubiquitous. So, why not connect smart pedagogy to the smart workplace?

A Gallup–Lumina poll (2014) revealed only 11% of 623 American business leaders believed higher education graduates have the necessary skills to be successful in the workplace. The number one answer from leaders was bridging the gap between education and employment at 76.9% (Marmolejo 2018). A report from the G7 summit in Canada focusing on the new world of work stated, "educational institutions aren't… preparing students for the jobs of the future…. we are having a quiet crisis…" (Canada 2017, p. 4). To maintain focus on the smart perspective, UNESCO recommended increasing innovative smart learning environments (SLEs) (Singh and Hassan 2017) while the European Commission (2018) challenged educators to take the lead. Global leaders urged connecting higher education to the workplace (Ornellas 2018). In higher education, facilitators are the key to linking pedagogy to the workplace.

Today, educators need to be more than facilitators (Hattie 2012); they are expected to be activators (Fullan 2013b). Fullan contends assisted by digital technologies educators must assume the role of activators of innovative pedagogies. However, becoming an activator can be a challenge because broad, efficacious integration of digital technologies with professional development has not been accomplished (Gamage and Tanwar 2017). This chapter provides an example of connecting education to the workplace utilizing online problem-based service learning (PBSL) instruction and a pedagogic collaborative cloud, a *smart* pedagogic collaborative cloud.

25.2 The Smart World

Smart education is social, mobile, adaptable, and uniquely designed for the twenty-first century. The definition of smart education proposed by Zhu and He (2012) described a synergistic platform of intelligent environments utilizing smart technologies affording facilitators the opportunity to integrate smart pedagogies to empower learners. The purpose of smart education is to cultivate a workforce that discerns twenty-first-century knowledge and skills to meet the needs and challenges of the future (Zhu et al. 2016). Five aspects of smart education were identified by Kim and Oh (2014) including "comprehensive education innovation, twenty-first century teaching methods, twenty-first century skills, IT convergence, and an adaptive reform agenda" (p. 139).

Taylor (2016) identified twenty-first-century skills as "liquid skills" with the qualities of fluidity, malleability, and adaptability (p. 90). These three qualities are imperative to incorporate into the preparation of students for the changing workplaces. The workplaces of the future will change throughout students' working lives; most of the future jobs currently do not exist (Taylor 2016). Liquid skills comprise teamwork, communication, critical thinking, interactive learning, and lifelong learning. Infosys (2016) noted these skills were more important in the workplace than academic achievement. Through the adaptation of innovative new pedagogies, students will acquire the necessary twenty-first-century skills for their future employment (Lorenzo and Gallon 2019).

Although consensus has not been reached concerning a definition of smart learning (Zhu et al. 2016), the phenomenon is often defined by the elements of collaboration, socialization, problem-solving, and critical thinking, which are also components found in twenty-first-century learning and problem-based service learning (PBSL) (Aker et al. 2018; Pentón-Herrera et al. in press). A smart learning environment (SLE) utilizing innovative technologies supports the learner by adding flexibility, interaction, adaptation, and reflection (Spector et al. 2015). SLEs allow for the needed space for the expression of innovative ideas concerning teaching and learning (Byrne et al. 2019). Ten years ago, a shift of emphasis was noted in smart environments toward learner-centered platforms (Radenković et al. 2009). Technology platforms bridge the smart learning environment and the real world through collaborative learning and knowledge exchange; in essence, the classroom is the world (Kim and Oh 2014). Utilizing a smart environment, educators can broaden their learning space using mobile devices as hardware, virtual reality as software, and the Internet. Professionals can communicate, exchange information, and progress through collaboratively learn with and from colleagues around the world.

Smart literacies, sometimes known as digital literacies (Weiland 2015), provide one component to the process which Rheingold (2012) noted can be learned. Similar to smart learning, smart literacies are also defined by component parts; Martin (2005) suggested the literacies comprised the skills of constructing new knowledge, communication, collaboration, social action, reflection, and critical thinking. Importantly, smart literacies are not a one-size-fits-all proposition; the literacies need the guidance of trained facilitators to meet the unique needs of learners. The key for facilitators activating the smart world is to construct educational encounters balancing the activity, technology, and the educative value.

Smart pedagogy is viewed as a combination of smart teaching and smart learning (Borawska-Kalbarczyk et al. 2019). Pedagogy represents the relationship between teaching and learning; pedagogical elements include content, and pedagogical and technological knowledge (Gros 2016). The intersection of the pedagogical factors provides unprecedented opportunities for teaching and learning. Technology has forever changed the role of educators who now must rethink the dynamics of the educational system in order to facilitate, coordinate, enable, and lead learning into the digital age (U.S. Department of Education 2016). Focusing on smart pedagogy affords an opportunity to highlight the importance of integrating digital tools, mobile technology, and learning platforms into the curriculum (Kaimara and Deliyannis 2019). An example of smart pedagogy is a pedagogic collaborative cloud.

Hwang (2014) provided a note of caution, “new learning modes will raise new pedagogic issues, and smart learning is a brand-new concept of learning” (p. 11). For clarification, Fullan (2013b) proposed four criteria a new pedagogy would have to meet: “(1) irresistibly engaging, (2) elegantly efficient and easy to access and use, (3) technologically ubiquitous 24/7, and (4) steeped in real-life problem solving” (p. 24). Conducting an analysis of instructional strategies, Uskov et al. (2018) forecasted the implementation of smart pedagogy both on-site and online at institutions of higher education *in the near future*. New is often popular. It appears students possess a "strong interest in smart pedagogy" (Uskov et al. 2018, p. 3); it appears smart pedagogy will be an essential research topic over the next ten years. The future is now.

Teaching and learning have changed in format and purpose (Fullan and Langworthy 2014). The role of a facilitator is seen as leading the "students' journey through the world, not as infallible sources of knowledge" (Borawska-Kalbarczyk et al. 2019, p. 37). The aim of a facilitator is to build rapport based on trust and respect (Žogla 2019). Fullan and Pinchot (2018) advised activators to focus on pedagogy. Auerbach and Andrews (2018) delineated a framework of pedagogical knowledge for active-learning instruction including mentoring and responding to student thinking, increasing equity, motivating students, promoting metacognition, building links between tasks, and managing logistics.

Pedagogy may be the driver, but "technology is the accelerator" (Fullan et al. 2017, p. xiii) and faculty are the catalysts, the activators (Hattie 2012). Hattie analyzed over 1000 studies and found that although a *facilitator* was a more dynamic term than lecturer, the most effective term was *activator* which had an effect size of 0.72 or three times greater than the effect size of a facilitator. The relationship between a facilitator and the students was "too passive" (Fullan et al. 2017, p. 67). The preferred role for an instructor is an activator, a co-learner in an active partnership with students (Casey 2012; Newport 1906). As the key determinant in learner outcomes (Yates and Hattie 2013), educators need to learn to work together in cooperation and dialogue to get the best outcomes from learners (Caena 2014). Collaboration and sharing are a crucial part of the changing praxis; an activator accelerates change.

Change is ubiquitous in the twenty-first century; in a smart world, educators must adapt to smart pedagogy, literacies, learning, skills, and education which taken together afford students the opportunity to acquire the skills, the lifelong skills, to be successful in the future (Kaimara and Deliyannis 2019). Fullan (2007) explained the nonlinear and iterative qualities of the change process and described change as a complex labyrinth of intrinsic components. The nonlinear, interconnected world is changing educational practice. Three factors illustrate the rapidly changing nature of education: (1) concentration on twenty-first-century skills; (2) increased technology; and (3) student collaboration, mobility, and self-reliance (Žogla 2019). Higher education is recommending courses incorporate authentic problems and encourage internships (Juaneda-Ayensa et al. 2019). In K-12 education, an instructional shift is moving from focusing on individual disciplines to instructing key competencies and twenty-first-century skills (Byrne et al. 2019). Educators, by combining pedagogy and technology, move to the driver's seat to create change (Fullan 2013a). However, there is a problem; education incorporates change slowly, and smart pedagogy changes even slower (Kinshuk et al. 2016). Pressure on pedagogy is being applied by the fast-paced world.

Smart education reinforces learner-centered, constructivist learning (Bognar et al. 2019). Indeed, many current smart educational reforms concentrate on instructional strategies from a constructivist perspective (Cuban 2013). When instructors adopt constructivist pedagogy, learning becomes student-centered, collaborative, and focused on solving real-world problems (Zhao et al. 2015). In constructivist learning environments, facilitators guide students constructing knowledge through inquiry, reflection, and experience.

The roots of farsighted smart education are reflected in the past—in the works of Freire (2009), Vygotsky (1978), and Dewey (1938). Freire, Dewey, and Vygotsky recommended placing pedagogy in the hands of skilled facilitators, while Dewey advised educators that students learned best by adding to their own experience and constructing shared experiences. This foundation provided by the trio supports not only smart learning, PCCs (pedagogic collaborative clouds), but also twenty-first-century learning. The theoretical framework supporting PCCs is built on specific types of constructivism: cognitive, social, transformational, and nonlinear (Aker et al. 2018). Cognitive constructivism supports collaborative learning (Ng et al. 2010); social constructivism supports mobile learning (Luckin 2010); transformational constructivism supports the facilitation process (Kroth and Boverie 2009); nonlinear constructivism supports twenty-first-century learning (Aker 2018, 2019) and taken together provides broad support for pedagogic collaborative clouds.

The literacy pedagogic collaborative cloud represents an online mobile collaborative community. As higher education works to preserve and develop the online student sector, optimizing courses for mobile learning is imperative. According to Magda and Asianian (2018), 36% of potential online college students desire to complete their studies online using a mobile device; 44% of online students conduct most of their research on a mobile device; and 99% of online college students own a mobile device. Assessing the data, “it is no longer a question whether we should use these devices to support learning, but how and when to use them” (Trotter 2009, p. 1). Mobile social media provides seamless learning (Seifert and Har-Paz 2018) by innovatively offering extended collaboration by combining learning and technology (Yeh and Swinehart 2018). Finally, in a study of social media collaboration, Razmerita and Kirchner (2014) found students had no difficulty using online collaboration sites and benefitted from the experience. Additionally, collaborative mobile learning provides flexibility (Sulaiman and Dashti 2018), spontaneous learning (Ariyanto et al. 2018), and social interactivity (Hernández-Lara et al. 2018). Unfortunately, a dearth of the literature exists in the area of pedagogic collaborative clouds; the literacy pedagogic collaborative cloud fills a gap. According to the AEA 267 (2007), ascertaining gaps between the current reality and the desired state facilitates the process of change.

25.2.1 Pedagogic Collaborative Cloud (PCC)

Social media is transforming the dynamics of informal professional development with Facebook being the most popular social networking site (Staudt et al. 2013). The Facebook platform is communicative, collaborative, and user-centered (Limbu 2012) and conducive to finding solutions to given problems (Lampe et al. 2011). Concerning social media, Lopez (2012) posited, we have entered “a new frontier of human experience… [in a] rapidly changing world” (p. 28). Facebook not only enhances collaboration, but also builds trust (Chang and Lee 2013). Facebook can be used as a tool to facilitate discussions, distribute resources, make announcements, provide peer feedback, and achieve educational success (Mazman and Usluel 2010). The role of educators is changing not only in the classroom, but also in pedagogic collaborative environments (Issa and Kommers 2013).

Patahuddin and Logan (2019) investigated Facebook as an information professional learning platform focusing on pedagogical and mathematical knowledge. The study provided evidence that Facebook supports informal professional development. Van Bommel and Liljekvist (2016) posited "teachers [can] initiate and orchestrate their own professional development on the Internet" (p. 1). Rutherford (2010) explained social media offered teachers an encouraging, participatory, practical, collaborative, and dynamic environment helping teachers' professional development. Finally, Manca and Ranieri (2017) stated, "Social Media tools are seen by many… as powerful drivers of change for teaching and learning practices" (p. 216). Staudt, Clair, and Martinez found Facebook not only was the most popular place for socializing, but could provide long-term professional development and continuous support, becoming a "notable professional forum" (p. 68).

25.2.2 Background of the Study: Problem-Based Service-Learning

The idea of creating a Facebook professional forum began simply as a problem. Smart education reinforces learner-centered, collaborative learning, which often focuses on solving authentic problems. Problem-based service learning represents an instructional strategy incorporating student-centered instruction, collaborative learning, and solving authentic problems guided by service learning and civic engagement reinforcing twenty-first-century workplace skills (Aker et al. 2018; Pentón-Herrera et al. in press). Due to the flexibility of the approach, PBSL (problem-based service learning) can be incorporated in practically any course. In a PBSL class, the students collaboratively identify and select a problem, learn about the problem, conduct research, reflect, find a solution, and take action. The problem the PBSL collaborative group focused on was time or rather the lack of it as K-12 educators. The literacy pedagogic collaborative cloud was identified as the solution to the problem.

25.2.3 Literacy Pedagogic Collaborative Cloud

While instructing the second to last class in a Midwest University, Master of Arts in Reading Education program, the students—all of whom were practicing K-12 teachers—still had many questions concerning literacy. Due to rapid changes affecting pedagogy: Common Core State Standards (CCSS), Next Generation Science

Standards (NGSS), multiliteracies, multimodalities, and new literacies, more collaboration concerning literacy was needed; this realization became the genesis of a pilot study. The participants taking the pilot survey were the first twelve graduate students who volunteered. It should be noted most of the students were millennials who adapt well to collaborative learning, prefer online learning, and adjust quickly to mobile learning (Tabor 2016). Figure 25.1 illustrates the concerns of the graduate students; the largest problem identified by the participants was lack of time. It appeared creating a literacy pedagogic collaborative cloud would solve the problem by enabling literacy professionals a mobile learning platform to communicate ultimately to benefit their students, the profession, and themselves. The pilot study indicated further investigation was warranted.

The purpose of this online triangulated qualitative study was to verify a perceived need for the development of a mobile literacy pedagogic collaborative cloud. The research questions were: (1) Does the interest or need exist to create a literacy collaborative cloud for graduate students and alumnae? (2) What was the best format to encourage participation? The participants included 45 master's/doctoral students and recent alumnae from the literacy program at a Midwest University. The qualitative study utilized an ethnographic methodology to study a subculture who not only

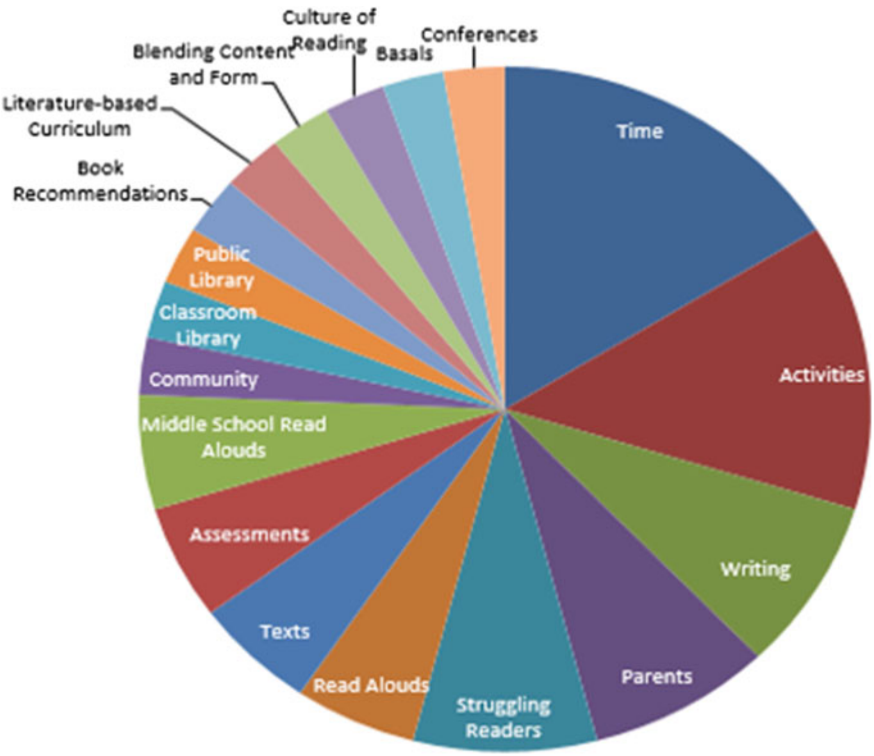

Fig. 25.1 Time crunch: concerns of graduate students ($n = 12$)

shared some of the same features (Muecke 1994), but also emphasized common experiences and behaviors (Morse and Richards 2002). The ethnographic approach was particularly appropriate because it was based on the immersion of the researcher in a distinctive social context, specifically online higher education (Hammersley and Atkinson 1983; Spradley 1980). The study included four sources of data: a questionnaire, semi-structured interviews, artifacts, and a researcher journal. Quality checks utilized in the study included using information gleaned from the questionnaire to refocus the interview questions and incorporate respondent feedback.

Eighty percent (80%) of the questionnaire participants agreed or strongly agreed with the creation of a literacy collaborative cloud. Focusing on the concept of literacy, 100% of the participants preferred to collaborate about literacy; many of them shared they did not have colleagues in their school or district to discuss current literacy issues. Indeed, fifty-seven percent (50%) *always* had unanswered questions concerning literacy. Concerning the concept of collaboration, 100% of the participants agreed collaboration improved teaching practice. One hundred percent of the participants preferred to collaborate with a group of professionals in their field. With respect to the concept of learning online, ninety-eight percent of the respondents concurred learning online improved teaching practice. Ninety-one percent of the participants agreed that online learning by teachers was enriching and worth the time.

When choosing content for a literacy pedagogic collaborative cloud, 89% of the respondents would like to focus on different content areas as well as literacy. What do the respondents view as the purpose of the LPCC (literacy pedagogic collaborative cloud)? Ninety-five percent (95%) of the participants would like to find out what others are doing; 93% would enjoy sharing ideas; 88% would appreciate the ability to learn new strategies; 65% would pose additional questions.

The findings of the LPCC study demonstrated the value of engagement in learning tasks consistent with the work of Razmerita and Kirchner (2014) who discussed the importance of groups sharing concerns and interacting together. In addition, the study supported Dewey's (1938) assertion that the teachers must take an active role in knowledge construction. The findings reflect the constructivist theories of Dewey (1938), Piaget (1970), and Vygotsky (1978) whose theories suggested learning involves "constructing, creating, inventing and developing our own knowledge" (Marlowe and Page 1998, p. 10) and highlight the concept that new knowledge was actively acquired (Brooks and Brooks 1999). Constructivism suggested new information, in the case of this study information concerning the need of a literacy pedagogic collaborative cloud, was actively assimilated into previous knowledge structures while simultaneously changing the structures. Finally, the quality of the collected artifacts and of the interviews supported Vygotsky's (1978) thoughts concerning the strong relationship between social interaction and high-level learning.

25.2.4 Professional Shift

The main intention of this study was to understand the needs of the graduate students and recent graduates of reading programs, fill the perceived gap if warranted, and improve practice (Shagoury and Power 2012). According to the participants, the creation of the literacy pedagogic collaborative cloud would fill the need for online informal collaborative professional development. Clarke and Hollingsworth (2002) examined the shift in professional development which encouraged educators to become active learners shaping their own professional growth through reflective participation and taking responsibility for their own learning. The aim of the LPCC study was to determine if a group of driven graduate students and recent graduates would be interested in creating a collaborative vehicle to build a community of professional educators so they in turn could facilitate their own learning concomitantly determining their path for change; the answer was a resounding yes! A literacy pedagogic collaborative cloud was created on the students' choice, Facebook. Figure 25.2 displays some of the participants' comments during the study.

An invitation to join a private Facebook group was extended to students and recent graduates; the mobile Facebook app was recommended. Communication has never stopped; group members sustain conversations over long periods of time on Facebook. The site is busiest in the evenings and over the weekends.

25.3 Conclusions

This study began by systematically examining the responses to a discussion question of an online reading class which ultimately became the genesis of this research study. Noticing the graduate students, soon to be graduating students, still had many questions concerning literacy combined with the knowledge of the rapidly changing field of literacy, this study sought to discover if an interest or need existed to develop a mobile literacy pedagogic collaborative cloud. Lessons learned included learning is not a straight path and flexibility is critical. Additionally, insight was gained from the qualitative work of Margaret Mead who posited the world changes through the work of small groups of dedicated people (as cited in Wheatley and Frieze 2011, p. 9). In the end, after confirmation from the study results, a literacy pedagogic collaborative cloud was created and is going strong. The LPCC reconfirms the findings of the OECD (Vincent-Lancrin et al. 2019) who found at a time when formal training for educators has grown only moderately in the past decade, informal professional development is seen as an "encouraging trend" (p. 3). The teacher is indeed the learner (Dewey 1916).

Student Y^1 I would like to help my students; most of my students live in poverty.

Student Y^3 responded: "…mobile technology fits my lifestyle."

Student Y^2 stated: "If I had access to a mobile collaborative platform, I would be living the dream! Three nights a week I have to wait for my kids at sports practice, with a mobile collaborative group I could be chatting.

Student Y^1 I use my phone all the time, by using a PCC I could be getting something done.

Student Y^2 stated: "I have a friend who I know would like to participate in a collaborative cloud; he is a business student."

Fig. 25.2 Comments of the participants

25.3.1 Recommendation and Final Thoughts

Encourage the development of informal peer learning professional development using social media focusing on three areas: mobility, sustainability, and badges. As Hargreaves and Shirley (2009) noted, "when teachers have structured opportunities to explore the nitty-gritty challenges of their practice through thoughtful exchanges with colleagues…. they rediscover the passion for learning and their own personal and professional growth that brought them into teaching in the first place" (p. 93). It seems educators collaborating with colleagues in an online literacy pedagogic collaborative cloud driven by mobile social media may ignite not only learning, but also personal and professional growth. Educators hold the key to unlock the future of learning; but there is still much to accomplish.

Glossary of Terms

Collaboration A group of two or more people learning together.

Collaborative learning cloud Cloud-based learning supported by collaborative tools including the Google platform, Padlet, social networks, and forums.

Community cloud A cloud location designed specifically with a group possessing one or multiple shared concerns which is managed and operated either internally by the group or externally by a third party.

E-learning collaborators Collaborators in the e-learning environment possessing the dual emphasis of providing and consuming.

Informal professional development Informal activities established to engage interaction, learning, and growth among educational professionals focused on practice.

Literacy Today, the definition of literacy incorporates and transcends functional literacy; literacies include the interactive, complex application of the skills, knowledge, and abilities needed to meet the social, cultural, political, technological, and economic challenges of the nonlinear twenty-first-century world.

Online collaborative learning Online collaborative discourse designed to promote knowledge building to incite learning and action.

Online community A formal or informal group situated in the online environment focused on a common purpose.

Peer professional development A group of peers linked by a similar professional practice sharing, creating, and reflecting; learning together.

Private cloud communities A cloud community is designed to provide support for a specific group of individuals.

Problem-based service learning A collaborative approach to instruction based on finding solutions to authentic problems and incorporating a service-learning component.

Smart "Smart" reflects logical, individualized, and flexible education, learning, environments, or pedagogy.

Smarter A "smarter" education or pedagogy emphasizes changing instruction for the better linked to incorporating twenty-first-century skills.

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Chapter 26
Considerations for Implementing Emerging Technologies and Innovative Pedagogies in Twenty-First-Century Classrooms

Jessica Rizk

Abstract How can we understand the role of new emerging technology (i.e. robotics kits, interactive whiteboards, iPads) in facilitating student engagement in today's twenty-first-century classrooms? What considerations must educators, policymakers, and researchers alike make regarding how to best implement technology today? While technology integration is growing to become a mainstay in many classrooms worldwide, it is imperative that research highlight some of the concerns and challenges to using technology in today's classrooms. This chapter is based on research exploring technology use and integration in elementary classrooms (K-8) across ten school boards in Ontario, Canada. Interviews and observations with educators and students utilizing various technologies highlighted four major considerations for implementing new technologies today in a way that may enable long-term engagement with materials: (1) teacher pedagogy; (2) teacher training; (3) collaborative learning environments; and (4) greater access of digital tools across schools. As this chapter suggests, the *how* and *why* of technology can be thought of as the real markers of whether digital tools alone can transform student engagement in twenty-first-century classrooms. Such contingencies highlighted can be seen as a way to ensure that teachers avoid failed digital rituals (Collins 2004) and ensure that they are able to align rituals utilizing technology and digital cultural capital with school goals (Bourdieu 1973). This research provides new efforts to understand where educational practices and processes may be reconfigured by new technological practices, along perhaps, more empowering lines, if they are properly implemented.

Keywords Digital technology · Student engagement · Twenty-first-century classrooms · Pedagogy · Training · Collaboration · Access

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26.1 Introduction

For decades, there have been many reform agendas aimed at increasing student engagement in the classroom—in hopes to transform teaching and learning, to make schools more efficient and productive, and to also prepare students for the future workplace (Cuban 2001). Over the years, the reliance of print-text to teach students has remained quite stable (Tyack and Tobin 1994), which has meant that student engagement with curriculum has been wide-ranging. Student disengagement with schools has often been considered *the* most persisting issue for both students and teachers (Newmann 1992). Increasing technology in the classroom has been one way that policy makers have sought to transform education. Today we are witnessing perhaps the largest wave of technology entering schools, at an enormously rapid rate. Yet, technology is not new—the first wave of technology to hit schools (i.e. blackboards, projectors, desktop computers), while introduced with much anticipation to revolutionize schooling, ultimately failed to transform learning. Nearly two decades ago, education scholars (see Apple 1991, 2004; Cuban 2001) warned about the dangers of using technology to reshape our education system, arguing that despite the push towards technology-infused teaching, there had yet to be a technological revolution in the vast majority of American classrooms. Twenty years later, much has changed, and many are rethinking what we know and how we think about technology today, and how it can reduce disparities in **student engagement** based on **socio-economic status (SES)**.

While emerging technology integration (i.e. robotic kits, iPads) are becoming an important piece to twenty-first-century learning, and in facilitating what is commonly known as '**twenty-first-century classrooms**', it is not without its concerns and challenges. Interviews with educators across Ontario school boards have shed light to many policy implications that are important for those concerning themselves with technology's presence in today's classrooms. The following chapter will address some of the issues and obstacles teachers in this research highlighted in their quest of navigating technology. A fundamental question I considered throughout this research is whether technology alone can facilitate longevity in student engagement. My interviews with teachers and observations of classrooms suggest that the answer to this question is *maybe.* In this chapter I argue that from a policy perspective, technology's ability to really transform student engagement depends largely on a number of *contingencies.* In other words, I argue that digital technology can effectively boost student engagement depending on technology's ability to, among other things: be embedded in a mindful pedagogy; be adequately supported by teacher training; be used to promote group collaboration; and lastly, be rolled out uniformly or at least, equally in schools.

26.2 Twenty-First-Century Classrooms and Competencies

Classrooms in the twenty-first-century are the topic of much discussion surrounding global education and policies. This global boom of communication technology has made it possible to expand and expedite learning for children in the classroom (Kenney 2011). The popular expression, 'twenty-first-century classrooms' has now become synonymous with a larger general shift in educational pedagogy. This shift includes a variety of learning tools and skills that vary amongst and between classes and schools. The expression, 'twenty-first-century classrooms' is most often used to signal educational changes in pedagogy, policies, and practices that have arisen in the era of a new or 'next' generation of learners (Jenson and Taylor 2010). In particular, this educational shift is geared toward preparing students with 'twenty-first-century competencies' (i.e. knowledge, skills and attributes) that will enable them to face complex challenges and reach their full potential. Some examples of such competencies include, but are not limited to, critical thinking, communication, collaboration, creativity and of course, digital literacy (Ontario Ministry of Education 2016).

Scholars are increasingly making reference to the rapid use of technology such as computers, laptops, iPads and smartphones in schools and classrooms across the globe (Churchill and Wang 2014; Cuban 2018; Goode 2010; Haste 2009; Kerr 2004; Mao 2014; Selwyn and Facer 2014), which have certainly revolutionized the elementary education experience. Research has shown that utilizing technology—from preschool, right through higher education—can have many benefits for learners. Most often, technology is often considered a way to increase student motivation and engagement (Kenney 2011; Kinash et al. 2012; McKnight et al. 2016), but it has also been thought of as a tool to decrease discipline problems and dropout rates (Cardon and Christensen 1998; Yard 2015); provide greater communication and collaboration among students and between teachers and students (Hutchinson et al. 2012; Kenney 2011; Keser and Özdamli 2012); facilitate more stimulating work environments (Costley 2014; Kenney 2011; Kurt 2010); expand teaching strategies and flexibility in classrooms (Fernández-López et al. 2013) and foster greater independence and individualized learning (see Kenney 2011; McLanhan et al. 2012). Thus, there is no shortage of literature documenting some of the implications that technology may have on students when introduced in classroom settings. However, as we enter this new era of digitalization in schools, it is important research highlights how to best integrate such tools in education in a way that can help students maximize their benefits.

26.3 Methodology

Data collection derived from a large research project that examined technology use and integration in elementary classrooms (K-8) across two different sites in Ontario, Canada. The first site of data collection consisted of observations of students and teachers in 16 classrooms across the Spencer District School Board (SDSB)[1]—classrooms that used general technology in a variety of educational settings (mainstream classrooms, ESL, library and special education rooms). Observations were conducted in two schools in the SDSB—Summerville and St. Helena[2]—both located in relatively middle-class neighbourhoods, with a diverse student population. Observations were done between spring and fall 2016 and over 50 h of observations were completed.

Interviews were conducted during the 2016–2017 school year with teachers. 32 interviews with K-8 teachers in the SDSB were conducted—normally in classrooms either before or after school hours, sometimes even during breaks. Interviews ranged from 30 min to 2 h and were recorded on an iPhone device. Participants were assigned numbers to remain confidential. Although guiding questions (i.e. *why and how do you use technology?*) were used, most of the interviews occurred organically.

The second phase of this research consisted of data from 38 in-depth interviews with teachers, 10 focus group interviews (95 participants including teachers and administrators), and 11 classroom observations in 9 different school boards (separate from SDSB) with a particular focus on **robotics kits**. Between January to June 2017, I began research for a Council of Ontario Directors of Education (CODE) project on robotics (Aurini et al. 2017). As part of the Ministry of Education's initiative to support twenty-first-century learning, all 72 Ontario school boards received robotics kits during fall 2015. Participants chose kits depending on grade levels and subjects to be used in (most often, math and science). The aim of this project was to look at the connections between robotics and teaching practices—can robotics be a viable tool to support student engagement in twenty-first-century classrooms? As a researcher in this study, I had the opportunity to observe multiple classrooms across school boards and conduct interviews with teachers and students.

The design was created to compare a broad coverage of technology (i.e. mainstream vs. special needs student population), and different types: those that are widely established in classrooms (i.e. Smart Boards), and one that is emerging—robotics kits. Observational notes for SDSB and the robotics project were coded using both Microsoft Excel and NVivo and stored on a password protected USB. Interviews from both SDSB and the robotics project were transcribed, uploaded and stored on the same USB. Both sets of interviews were imported into NVivo and coded for existing and emerging themes.

[1]School Board name has been changed.

[2]Names have been changed.

26.4 Results

As technology begins to make its way into classrooms worldwide, it is important educators employing technology become mindful of *how* and *why* they are embracing new digital tools. My prior research has suggested that while technology does, in fact, have strong potential to increase student engagement and reduce many of the SES divides that were evident with print literature (Rizk 2018), technology use on its own may not be sufficient enough to truly create longevity in student engagement and learning. What is needed is a more tactical approach to integrating new digital tools that moves past merely just exposing students to technology. The next section outlines four contingencies that emerged as necessary considerations for utilizing various kinds of technology in the class.

26.4.1 Teacher Pedagogy

The strength of technology's ability to transform classrooms, engage students and facilitate longevity in learning hinges upon first and foremost, an informed pedagogy. Interviews with educators suggested that one of the main driving forces forecasting whether technology could truly create new classroom experiences was based on pedagogy. In other words, *why* are teachers using technology in the first place? Is there a purpose? Do they have expected outcomes for students, or is it used as a tool to just pass the time? Often times, teachers would share their learning goals with me, and explain how technology enhanced them. Teachers noted that only when educators really embrace technology can it truly 'shift' teaching roles:

> The pedagogy piece hands-down comes first. You have to think in terms of what is the greater learning goal when using technology. Don't just give your class a bunch of iPads and think that is enough – Grade 6 teacher, St. Helena.

While technology has encouraged many changes in the classroom, it alone cannot be conceived of as the 'holy grail' to transforming twenty-first-century classrooms. Thus, it is not enough to merely introduce technology with the expectation that it will magically transform classrooms overnight. A traditionalist teacher will likely still honour a traditional classroom even in the face of new technologies. While it may encourage a more progressive attitude, without the right mindset, it alone may not be enough to truly make a difference for student engagement in the long term. As one teacher stated:

> I can give my kids a really engaging lesson without tech and they'll be super engaged. Because it would be meaningful and purposeful. And then, I can do the same thing with technology, and for sure, they will be more engaged, but the technology only helps you give that push forward. – Grade 5 teacher, St. Helena.

Thus, teachers must recognize that before handing over a digital tool to a student, it is key to consider what kinds of instructional approaches and planning may contribute to greater engagement. As the majority of future jobs will likely require some digital fluency, educators must recognize digital skills as becoming a new type of valued **cultural capital** (Bourdieu 1973; Rizk 2018) that is vital to student success. However, informed pedagogy often rests upon adequate teacher training, which is the next major contingency we must be aware of.

26.4.2 Teacher Training

Implementing a mindful pedagogy rests heavily on the type of teacher training that is being provided to teachers. It remains important to ask whether teachers are given proper technology training. Are teachers being provided with enough training sessions, resources, and overall support to foster successful interactions with technology? While the majority of teachers in this study did relish and embrace technology, there still remained a level of concern and awareness that perhaps not all teachers are in fact already comfortable with utilizing technology, particularly if it places them in a position of uncertainty with their students. These same teachers however, expressed a willingness to tackle technology, and an eagerness to attempt to integrate it more if they had 'proper' training beforehand—training that could demonstrate, for instance, links to curriculum, appropriate apps, or lesson plans teachers could use that would alleviate some of the burdens they feel venturing in this new direction.

One of the most reoccurring responses regarding teacher concerns with technology was the need for implementing more professional development or 'PD' days, to give teachers the chance to learn, play, and explore technology:

> Good PD has to be structured. It can't be "come down, sit, and watch me do this". It has to be intensive and interactive enough so that you can come away with some kind of knowledge that you can take back with you to your class. Allow them to play with it and relate it to their lessons. Don't just give them a manual and say go back and do that—it will fail. – Junior/Intermediate teacher, Robotics Project

Many of the participants in this study urged for more interactive PD days with technology that could allow them to have more hands-on experiences and contribute to their 'personal development with technology' as one teacher put it. Taking it a step further, many suggested that implementing technology into the existing curriculum—linking it with grade-level expectations or providing examples of *how* to use it within an already existing framework—could help entice more educators to utilize it, and ensure proper training:

> I think the problem is that teaching is not regulated. Technology is expected, but not enforced. So, you will have some teachers tell you like what is the point? There is just so much inconsistency between the kind of technology being used that it is easy for teachers to skip it altogether. It would help to have solid examples of how to integrate it into the curriculum—like how can robotics or programming be used to teach science for instance? - Special Education Resource Teacher, St. Helena

Too often teachers are volunteering their time to 'keep up' with technology via drop-in luncheons, or after-school PDs—a lot of which happened on their own time, and through their own self-initiated interests. Policy makers should thus continue to consider the extent to which technology is being given to teachers, and whether teachers are properly trained, and/or given the option to become more proficient in using these digital tools. If we contend that digital skills are becoming a new valued type of cultural capital (Bourdieu 1973) today, it is reasonable to assume that boosting teacher training with technology can be seen as a way to nurture educator's own kind of cultural capital and allow them to use that knowledge to facilitate successful interactions with technology in their classrooms. Perhaps without the necessary skills or awareness of implementation strategies, many educators have suggested that there becomes a greater risk for negative group interactions with digital tools to occur.

26.4.3 Technology and Group Collaboration

Previous work has highlighted that technology can foster successful interaction rituals as Collins (2004) would claim—interactions that center around technology whereby students are mutually focused on the symbolic element of technology are able to generate emotionally energized rituals in group settings (Rizk 2018). However, if digital technology is truly to be effective in facilitating deep learning amongst students, it must then, whenever possible, become embedded into more group activities as opposed to isolated rituals. Otherwise, there is a strong likelihood that class rituals guided by technology can become negative or as Collins (2004) suggests, 'failed' rituals, whereby interactions can be insufficiently social. In failed rituals, there is little or no feelings of group solidarity. Instead, individuals feel flat or bored, with a desire to escape. Such failed rituals could be due in part because of insufficient teaching training or pedagogy (as highlighted above), or as well, because of how connected students have become to the internet today, leading some to be dependent on digital tools. When group membership is used to target victims (i.e. online bullying), this can certainly be classified as a negative effect of technology. In classroom settings, educators remained cognizant of how important it becomes to monitor *how* technology is used amongst students, in particular, when used in isolation from their peers:

> Sometimes students are just on their own…they are on an app or doing their own thing when you just tell them to use technology. They are not really playing together. The loss of social skills is there when you give students the option to just sit on their phones. Sometimes the most technologically advanced kids are the less social, so it is really important as a teacher, you think about the ways in which technology is being implemented in your class— Grade 8 teacher, St. Helena

Many educators stressed that if students relied too heavily on technology, there remains a strong possibility that social skills may become compromised as a result. One negative effect of using technology without a guide or purpose in mind is that there is an increased risk of students deviating from the task at hand and searching inappropriate content for example—further contributing to the importance of thinking about *how* and *why* we use technology.

My observations of classrooms sometimes shed light to the potential negatives of technology: times when inappropriate material would find its way into the classroom, or when teachers used it as a method of control to calm students down as noted in this field note:

> The kindergarten classroom today is very busy—with 30 students ranging from different learning needs, to behavioural issues, to some with unidentified special needs. The teacher seems to be at her wits end—there are students crying, others running around, some constantly vying for the teacher's attention. She seems overwhelmed. As she attempts to gather them all on the carpet for a lesson, she quickly senses her voice being lost in a sea of thirty students. She begins turning on the Smart Board and puts on a Sesame Street video. Like clockwork, the students settle in and become mesmerized on the screen.

Not every encounter with technology will necessarily facilitate a positive or successful learning opportunity that extends beyond the immediate moment; but what can contribute to successful interactions is more collectivity amongst students using technology:

> If it is just the student and the tech, then they won't be interacting with one another. But if you use that tech tool for group work, for projects, for research…it makes a difference. It's not just the tool, but how you use the tool – Grade 6 teacher, Summerville

In short, depending on how we employ technology in the classroom, it can have the potential to strongly engage students, be used as a tool to regain control over students, isolate them, or even lead them to experience negative interactions. Technology does have the power to become socially isolating, and less oriented towards deeper learning if not used appropriately. However, I posit that the potential for technology to engage students is largely contingent on the manner in which we expose and employ technology to youth. Even if teachers are relatively successful in promoting engaging classrooms with a strong pedagogical focus and a collaborative element, there still remain concerns regarding access. One of the barriers that impacted educators ability to properly engage students and use technology in a purposeful manner in this study was concerns with access. The next section will unpack some educator qualms regarding the lack of institutionalized technology across schools.

26.4.4 Equal Division of Digital Technologies

In order for teachers to properly plan informed and engaging lessons that engross their students in a collaborative manner, there must be some uniform access across schools and grade levels. Coleman's (1966) classic report argued that much of the inequality imposed on children by their home, neighbourhoods, and peer environments were carried into school contexts. However, a host of research over the last decade has documented schools' roles in essentially narrowing learning discrepancies (Alexander et al. 2007, 2016; Davies and Aurini 2010, 2013; Downey et al. 2004; Downey and Condron 2016). In other words, schools today may not be great producers of inequality, as previously thought. Technology may have the potential to truly engage students of different SES as suggested elsewhere (Rizk 2018); however, since the use of digital technologies is relatively new, it has not yet become fully institutionalized (i.e. embedded into funding formulae and standardized curricula). This can (and does) have some implications, as new technologies are currently being rolled out unevenly across schools.

First, there remains an unequal distribution of technology in schools. Ontario boards have long relied on funding from the Ministry of Education for additional support to aid in student learning, which has been increasing over the years to support growth of new programs (Ontario Ministry of Education 2009, 2012; People for Education 2006, 2012). However, since technology is a relatively recent addition to modern-day schooling, there is less regulation surrounding technology's placement and funding in schools, as some schools are capable of securing more technologies than others. This 'unequal distribution' of resources was certainly not surprising to educators, as many of them were cognizant of the challenges to making the transition to the digital world without the appropriate resources in place. According to a Grade 2/3 teacher, 'the problem is that not all the schools have money to buy technology. If you don't have the money, how can you say to teachers, use the technology?' While most schools do have access to technology in some capacity (i.e. shared computer labs or rotating iPad carts), it is worth considering what steps could be taken to ensure that teachers are able to access technology more readily.

Similarly, we must be mindful of fundraising gaps. A central concern for educators is the continued disparity in use of, and access to technology, as more affluent schools may be able to provide *more* enhanced experiences for their students, and a richer variety of skills that could not only positively impact a child's education, but also enhance outcomes for an already advantaged social group (Froese-Germain et al. 2006; Milani and Winton 2016). While there exists a host of potential sources, everything from local community members to not-for-profit organizations (Winton 2016), parent-teacher organizations (PTOs) have been found to play a large role in giving upper-middle-class communities an advantage for new educational resources and opportunities (Cutler 2000; Evans et al. 2015; Lareau and Muñoz 2012; Posey-Maddox 2013; Wells 2002), often putting pressure on educators in prosperous schools to teach new digital skills and remain up-to-date with current technologies (Rafalow 2014). Teachers in this study were also beginning to note the potential effects of having strong PTOs on the availability of technology in schools. A Grade 8 teacher at St. Helena mentioned that 'our parent council fought for more technology. They raised enough money to buy more laptops. So, parents really play a large role in student access to technology here more than other schools'. Broadly speaking, educators in this study recognized that funding disparities could be a potential barrier in providing students with similar educational-technology training, as the richer neighbourhoods were able to garner more money for the latest technologies to educate students. They were mindful that while they may be fortunate to be placed in a school with adequate technology and training, this may not be the case for everyone:

> I think it just depends on how the board wants to spend their money. Our principal was very willing to spend money on new technology. But other schools…it depends on what their priority is. Schools in lower-income areas have different focuses. They might be spending money on running breakfast clubs instead– Grade 2/3 teacher, Summerville

Alongside concerns about access and fundraising new technology, some teachers in this study also expressed their worries about being able to provide students with enough resources so that even those without any access at home can benefit. Some school boards in Ontario have been mindful of this and have begun to take steps through providing lower-income schools who have students facing external challenges (i.e. students living under the median income, from lone-parent families, etc.) additional funding and resources (see Toronto District School Board 2017). As one Grade 5 teacher said, 'if you start saying how many of you can bring in your own iPad tomorrow and only ten hands go up… that puts those students in a bad position because they don't have that choice.' Ultimately, as more jobs of the future will require digital skills and twenty-first-century competencies that are thought to come with increased technology use (i.e. creativity, perseverance), such discrepancies in access to technology and proper training could have serious implications for divisions among youth. Not only are technological skills (i.e. coding, programing) important kinds of capital that are required for many employment opportunities (Paino and Renzulli 2013; Peng 2017), but research supports the notion that it is essential for students to be equipped with digital skills early on (Trilling and Fadel 2009; van Laar et al. 2017). If future professions increasingly necessitate digital skills, it is important that we address the extent to which such opportunities are being given to *all* students and consider the various ways in which this can occur. As we move forward with technology, it remains imperative for policy makers to consider how to best create an equitable division of technology across all schools, so that all students may gain the proper digital skills for their future. Many educators suggested that ultimately, a full implementation of technology in classrooms is needed—proper funding, resources, access, and training—in order to truly achieve an equitable arrangement in schools.

26.5 Conclusion

This research investigated whether technology integration in classrooms has potential to transform student engagement in twenty-first-century classrooms. Drawing on interviews and classroom observations across ten school boards in Ontario, Canada, the answer to this question remains, *possibly.* As suggested through this chapter, facilitating a classroom with engaged students largely depends on *how* technology is utilized—or the various contingencies highlighted throughout the chapter. In other words, to create more engagement amongst students, it is imperative that we consider how to: (1) develop a purposeful pedagogy with technology; (2) support and encourage greater teacher training with various digital tools; (3) when possible, embed technology more into group collaborations rather than as an isolated learning tool; and (4) attempt to create a more equal division of access to digital technologies across schools in different neighbourhoods. Thus, the real marker of difference as to whether students are more engaged lies in the way technology is being integrated and accessed. This will ultimately define whether students become engrossed with technology. As one teacher said:

> Apps and technology in general are only as good as the lesson that the teacher brings to it. It really comes down to how you use it. So, if you tell the kids just to take out a piece of paper and write about their weekend, you can see most of their eyes roll. But, now introduce book creator app for example, and tell students to be creative—pictures, fonts, colours, the works. Then the excitement and the fun go up because the teacher introduced it with a purpose in mind. It was not like here play on the iPad…it was here, let's do this lesson on the iPad. The difference is in how you use technology. – Itinerary teacher, SDSB

In short, it is not enough to simply provide access to technology without effectively considering the different ways in which it can be applied to learning. This can encompass many factors, but as stressed in this chapter, teacher pedagogy, training, facilitating collaborative mindsets, and availability of resources seem to be among the most important contingencies. While examining the extent to which such factors can truly impact technology integration, and whether proper implementation can facilitate 'deep learning' (Mehta and Fine 2019) remain beyond the scope of this work, I have attempted to provide some preliminary thoughts concerning student engagement and technology. It is my hope that future research continues to unpack the intricate relationship between technology and education in twenty-first-century classrooms.

Glossary of Terms

Twenty-first-century classrooms a pedagogical approach that aims to promote new forms of learning that are more collaborative and creative.

Cultural capital a term that originated from Bourdieu (1973), though it has been extended and elaborated on in different ways over the years (Davies and Rizk 2018). Usually thought to refer to particular kinds of knowledge and skills that are recognized and rewarded in various settings.

Robotics kits a special type of construction kit used to build robots in different capacities.

Socio-economic status (SES) referring to the economic aspects of social ranking. Usually measured with a series of related attributes, including family income, parental employment and education, and/or poverty level.

Student engagement refers to the degree of interest, passion, and attention that students may show (observable) when they are learning or being taught.

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