Perspectives on Rethinking and Reforming Education

Shengquan Yu
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Mobile and Ubiquitous Learning

An International Handbook

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ISSN 2366-1658 ISSN 2366-1666 (electronic)
Perspectives on Rethinking and Reforming Education
ISBN 978-981-10-6143-1 ISBN 978-981-10-6144-8 (eBook)
https://doi.org/10.1007/978-981-10-6144-8

北京师范大学教育学学科综合建设专项资金资助 Funded by Comprehensive Discipline Construction Fund of Faculty of Education, Beijing Normal University

Library of Congress Control Number: 2017948231

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Foreword

Advances in access to mobile technologies have been phenomenal in recent years. The UNESCO Web site reports that there are currently more than 1.75 billion smartphone users in the world, and over 6 billion people have access to a connected mobile device. For every three persons who access the Internet, two will do so from a mobile device. Such developments provide up-to-now unheralded connectivity and support various forms of interactions among people, as well as enable access to digital resources. They are transforming the technological landscape for living, work, play, and learning.

In the area of learning and education, mobile technologies enable learning anywhere and anytime. When mobile technologies are ready-at-hand as well as ubiquitous, there are more opportunities for learners to access, share, and construct knowledge readily in different settings and modes. Indeed, there is uniqueness in mobile and ubiquitous learning which makes it stand apart from access to traditional learning from desktop-bound computers. Informed by the fields of the learning sciences, educational psychology, and educational technologies, designers of learning can make use of such affordances, or design new affordances to create learning and instructional spaces, scenarios, tasks, and experiences that foster deep and meaningful learning.

Mobile learning can be happening in formal spaces of learning, or in informal spaces which are outside of the formal spaces. It can also integrate aspects or episodes of informal learning with formal learning, creating opportunities for seamless learning. Ubiquitous learning provides a notion of learning which is motivated or enabled by the mobility, ubiquity, and contextual awareness of digital and networked technologies. In ubiquitous learning, learners leverage on the pervasive and embedded technologies around us. Mobile learning enables learning in context with awareness of the context detected and supported by location-based and other sensor-based technologies.

While there is a lot of promise and potential in mobile and ubiquitous learning, this field is still very much understudied and undertheorized. The challenge for research is to develop these designs of learning, and use them to study mobile learning—what works and how it works—so as to provide an evidence base of theories, designs, and implementation challenges of mobile learning. In terms of implementation, there is still much ground to cover in terms of lowering the barriers to adoption, sustained use in learning practices, and scaling up. Mobile usage in everyday life is rife, but mobile usage for learning can still go a long way.

This book is a timely contribution on some of the latest research and development areas and trends for mobile and ubiquitous learning. The chapters focus on demonstrations and discussions of new designs and developments in the field of mobile and ubiquitous learning. There are chapters that share work on advances in technologies like wearables, and virtual and augmented realities for learning; advances in analysis methods like social network analysis; the application of mobile technologies in formal and informal learning; and implementation and ethical issues; and even a chapter that take in traditional psychological constructs like mindfulness and recontextualize them in a mobile learning context. The chapters provide a platform to readers elucidating current research work from taking some of these ideas to apply to building upon in their own research pursuits. The space of possibilities for enhancing or disrupting learning ecologies has never been greater than at any other point in human history. This book will prompt us to reflect on what this collection of research studies done internationally has informed us on where we are now in this journey of designing and implementing designs of mobile and ubiquitous learning.

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Acknowledgements

The publication of this book was made possible by the support of many individuals. Thanks to Ms. Xuanwei (Ada) Ma for providing excellent coordination support for the book, which paves the way for the successful publication of the book. Ms. Ma also assisted in proofreading of the book. Thanks to the Advanced Innovation Center for Future Education (AICFE) of Beijing Normal University and Mr. Tom Tang for his leadership and support for the book. Special thanks to the reviewers of the chapters and to Springer for publishing the book. Finally, thanks to the chapter authors from 15 countries who have contributed impressive chapters for the book.

Contents

Introduction

The smart phone has penetrated almost each of the societal sectors; from professionals, amateurs, consultants, tourists unto parents and children. In some countries, schools are one of the few places where in many cases the mobile phone has been abolished. Two explanations are as follows:

1. Learning is a vulnerable process; a process that easily suffers from distraction and sensation seeking.
2. Teachers hesitate on how the smartphone can help the learning process; essentially, they feel the threat of giving up the long tradition of expository teaching

The first explanation starts to become obsolete as more and more we accept the value of "Learning by Playing." Playing exceeds the potential of Gaming; Gaming aims at winning, while Playing is the absolute intrinsic motivation; the object of learning by playing is to satisfy a certain immersion and benefits from an altruistic mindset. In learning by playing, the learner likes a certain context, object, motoric skill, and convention on how to master, predict, and understand. In contrast, learning by being taught is the trust that following the preferred path is the shortest route to master a test. The chapters before you offer clear rationales why learning will always jump on new vehicles like recently the smartphone, new coming video games, immersive 3D virtual reality, learning analytics based upon big data, social media, MOOCs (Massive Open Online Courses), and the Web-based platforms for allowing teachers to share expertise and learning materials.

More essential is the latest trend to vitalize education by integrating societal themes in schools. From primary education until university-level curricula, this trend is clear; young people do not accept the certificate as incentive for sacrificing attention and time during their precious early years. As emerging theme, we see the thematic strand of sustainability, both ecological and societal and economical (fair trade) that "make youngsters tick."

In summary, we can say that media technology has worked out as catalyst in educational innovation; not only the access methods, contents, and assessment conventions have developed quickly; it is the teasing question "What values do we want to target in education?"

We will soon see that education can no longer escape from including ideology in adolescents' development; knowledge without value rationale is brittle and powerless.

May this book inspire you to transit the border from regarding education as societal-relevant rather than just intellectual. This book will make a difference in readers' thinking about the coming twenty-first-century skills, attitudes, and missions.

Dr. Piet Kommers
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Part I
Theoretical Foundation

Chapter 1
Mobile Digital Games as an Educational Tool in K-12 Schools

Helen Crompton, Yi-Ching Lin, Diane Burke and Alana Block

Abstract Games are one of the most elemental and basic of human activities that interest people of all ages. Mobile digital games can be used as a beneficial educational tool to enhance teaching, promote student learning, achievement, growth, and development as well as to cultivate students' twenty-first century skills. The aim of this chapter is to discuss how educators can use digital gaming as an instructional tool in their classroom, regardless of age level or subject area, and thus transform their students into active participants and increase their student achievement levels. This paper examines core aspects of digital gaming, the benefits of digital gaming as well as its limitations such as the challenge of determining the appropriate technology to align with pedagogy and age level. Suggestions are offered as to how the issues can be addressed and concluded with implications for future study.

Keywords Game-based learning · Digital games · Mobile digital games
Technological games · Digital gaming · Educational tools

Digital games can be used as educational tools to enhance teaching and learning in K-12 schools. Mobile digital games have become the way for young people to communicate and make connection to the world; therefore, educators have started to introduce mobile digital games to support teaching and learning in classrooms which provide students meaningful learning experiences (Parks, 2008). To achieve optimal success in learning outcomes, educators need to constantly evaluate their instructional practices, tools, and resources (Panoutsopoulos & Sampson, 2012). For instant, research shows that mobile games are beneficial for children's development and academic achievement. It is important for educators and researchers to evaluate and recognize the potential of using mobile digital games to engage learners in multi-sensory and complex learning processes (Parks, 2008).

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_1

The Federation of American Scientists (2006) reports digital games have several features attracting educators including higher-order thinking skills, scaffolding, and contextual bridging (Scientists, 2006). Mobile digital game-based learning (MDGBL) can also be tailored to fit the goals of the curriculum and the needs of the learner in different subject area. According to Deubel's study (2006), mobile digital game-based learning (a) provides deep engagement, (b) offers motivation for persistence in learning, (c) enables customized learning experiences, and (d) promotes long-term and working memories. Furthermore, mobile digital gaming can work interdependently to foster and encourage student learners to actively engage in academic learning as well as develop critical twenty-first century skills that are imperative for real-world success. An efficient and well-designed mobile digital game-based learning could enhance learners' planning and problem solving, expand vocabulary, improve mental agility (Clark, Tanner-Smith, & Killingsworth, 2016), improve computer fluency (Deubel, 2006), and develop eye–hand coordination (Drew & Waters, 1986). Other findings from a systematic review from K-16 students show that digital game-based learning approaches significantly enhance students' learning beyond nongame-based learning approaches. The effects of using mobile digital game-based learning were crossed visual, narrative, and quality characteristics of learning mechanics (Clark et al., 2016). More importantly, mobile digital learning environment provides opportunities to reach different needs of many diverse learners (Kim, Mims, & Holmes, 2006).

This chapter provides a brief review of history of mobile digital game-based learning, its essential features, and its benefits in different subject areas. Researchers also focus on examining mobile digital games to be utilized in K-12 classrooms to help students' success in different subjects.

1.1 History of Mobile Digital Game-Based Learning

Games are an integral part of peoples' lives (Stramel, 2016), and they are one of the oldest human activities in the world (Grove & Schaller, 2007). Playing games is not a new concept (Annette, 2008; Grove & Schaller, 2007), but also it is a period for children to master the structure of the surrounding world. Older children and adults are continually using games to entertain and educate themselves. Therefore, mobile digital games should be good educational tools implemented in the classroom (Annette, 2008). Mobile digital game-based learning became popular in the last decades of the twentieth century while a global technology booming. Newer generational learners are digital natives as they have experienced their entire life with the ability to access and utilize technology such as video games, mobile phones, and tablets. Prensky suggested that contemporary learners think and process information fundamentally differently than digital immigrants; therefore, teachers from digital immigrants' generation should learn how to adapt digital natives learning styles

(Coffey, 2009; Prensky, 2001). Teachers and educators must constantly review their instructional practices so that they are not obsolete. Thus, being aware of the dramatically beneficial digital games could impact students learning.

1.2 Essential Features of Mobile Digital Games for Learning

Deubel's (2006) study categorized games into action, adventure, fighting, puzzle, role playing, sports, and strategy types. Mobile digital games can be as simple or complex depending on the educational goals; therefore, teachers must have clear goals of using mobile digital games. For instance, *Food Force*, developed by the United Nations World Food Program in 2005, is mainly to put players in a famine-affected country learning context. The goal for player is to recover from famine and become a self-sufficient country again. This game could help players develop deep understandings of complex and dynamic systems and then use logic, memory, problem-solving skills to reach goals. Those skills which learners will develop are needed to be successful in twenty-first century (Annette, 2008). Because each game has different goals and purposes for different types of learners, choosing appropriate digital games should take into considerations a range of factors including learners' characteristics (i.e., age, gender, and competitiveness, and previous gaming experience), learners' special needs, and number of players. The role of teacher in the game is also important to take into consideration when choosing digital games.

Mobile digital games for learning also must have clear rules including choice and chance elements to let stronger to weaker learners have a chance to win such as *Shoots and Ladders* virtual digital game. Specifically, rules are built underlying model structure in accordance with cognitive objectives. Stramel suggested that teacher should understand the model behind the game and explain various strategies for learners (Stramel, 2016). Furthermore, games should allow learners to record data for revisiting and reflecting what they have learned. Teachers could use questions and prompts to render learners reflecting what they learned from a game. For instant, teachers could ask learners the following questions: "What is the most important aspect about mathematics you learned from this game? What strategy did you use to help you to play this game? What was tricky about this game? Can you connect the math that you learned in this game to something you learned in class? How is this knowledge useful outside the classroom? What was the most fun thing about the game? How did you feel when you played the game? What were your strengths when playing the game? What advice would you give to someone to play the game in the future?". Researchers suggested that the reflection process is a crucial element of allowing learners to fully engage in a meaningful way; otherwise, they will have wasted an opportunity to learn (Stramel, 2016). Finally, games should be modifiable so that they fit different educational need and meet the needs of diverse learners (Stramel, 2016).

1.3 The Benefits of Digital Game-Based Learning

1.3.1 Engagement

Panoutsopoulos and Sampson (2012) noted that digital game-based learning can engage and motivate people of all ages. One of the reasons for mobile digital games promoting learning and engagement is that they provide learners an escape opportunity from the real world. Digital gaming world does not have bad consequences or lasting real repercussions in the games world (Stramel, 2016). Learners can recover within game and use what they have learned to successfully complete tasks. Furthermore, mobile digital games provide activities within authentic or meaningful contexts to help learners solve problems and provide learners opportunities explore new knowledge through playing games. Digital games provide learners strategies, resources, and opportunities to transform traditional learning modes from the classroom into relevant contexts.

To highly engage learners, digital games must include rules, goals, immediate feedback, outcome evaluation, competition, and interaction. Clear rules prevent confusion and help students determine clear goals and strategies for attaining their goals. Providing immediate feedback to learners helps them to understand their areas of strength as well as their areas of weakness that are problematic and need further strengthening (Coffey, 2009; Deubel, 2006). Mobile digital games facilitate learners' engagement in their coursework and cultivate their learning as they become authentic learners actively seeking to deepen their understanding. For instance, the digital game-based learning environment found in simulation video games can enhance learners being autonomous, self-directed, goal-oriented, and successful which help learners understand the direct correlation between their effort and outcome performance. Researchers also found that mobile digital games such as educational simulations allow learners to play, make decisions, and see the consequences for their actions which are critical and associated with learners' engagement (Simpson, 2009).

1.3.2 Cognitive Skill Development

Researchers also showed the tangible benefits of using digital games to increase and enhance students' cognitive and skill development. Specifically, mobile digital games will increase learners' memory capacities such as short-term memory, long-term memory, working memory, and logical reasoning. To successfully navigate and strategically to win the games, learners are required to memorize rules, essential information, and specific sequences to complete tasks. Not only learners' cognitive skills and performance outcomes will be improved, but they also gain practical applied learning experiences.

Digital games have the added benefit of teaching students to quickly, critically, and strategically develop thinking processes (i.e., problem-solving skills). Simpson (2009) found that the digital games provide an opportunity for learning relevant content through situated role play, problem solving, and goal attainment. Therefore, mobile digital games encourage learners to foster their desire of challenging themselves that deepen their knowledge pool. Digital games even facilitate learners' mental enhancement (Coffey, 2009).

Digital gaming takes place in a fast-paced environment that requires the learners to think and act quickly in response to situations. They also place a significant emphasis on using logic to project possible occurrences in the game, and thereby learners are required to think ahead. This is an extremely valuable tool as it is important for students to develop cognitive skills for success in school activities as well as in their future lives in the real world. As Parks (2008) states our classrooms should be the places where new media forms like digital games could be discussed, debated, analyzed, generated, refined, recycled, and played, and then they provide students with a rational and logical approach to find accurate solutions that may foster problem-solving skills in their future and require immediate attention.

1.3.3 Computer Skill Development

Digital gaming also increases learners' computer skill development which is a critical skill embodied in twenty-first century learning. Griffiths suggested that digital games can help students develop computer skills that they may need in a society (Griffiths, 2002). Mobile digital games can also benefit learners' motor development because they often involve movement, stimulate precision, coordination of movements, and speed (Simpson, 2009). Playing games allows learners effectively to use principal aspects of the computer such as the mouse, the keyboard, a controller, or joystick, as well as functional tools such as browsing and searching engines, navigating the internet, and setting up usernames and passwords. In addition, digital games can also benefit K-12 students with developing eye–hand coordination because learners must control their eyes as well as his/her and hands while playing games (Drew & Waters, 1986).

1.3.4 Supporting the Needs of Diverse Learners

Mobile digital games allow teachers to satisfy the needs of diverse learners and help all students to achieve the course goals through helpful feedback (Coffey, 2009). For instance, mobile digital interactive games help children with diverse needs such as students with attention disorders. In Griffiths' study (2002), adolescents with attention-deficit disorder showed improvements in grades, sociability, and organization after using interactive mobile digital games. Stramel (2016) also found that mobile digital games could help those learners with learning, intellectual, emotional, behavioral, and physical deficits. Digital games provide a dynamic and complex environment that can capture and retain the interest of learners.

Researchers suggested that the more time students spend engaged in learning the more they will learn. Thus, if students can become engaged participants in their learning, then academic achievement levels will be positively affected which may reduce the need for labels of disability in the future because inability to participate or successfully learn in the classroom often leads students being identified with learning disabilities (Simpson, 2009).

In addition, digital games have great diversity, so they attract and engage students of various demographic backgrounds (Griffiths, 2002). It is interesting to know that not only digital games are motivating teaching tools, but they also have been shown to serve subgroups that are typical in science education (Angelone, 2010). Research has shown that girls are just as interested and invested in engaging in digital games as boys. However, their interests do differ as they are more focused on relational and cooperative gaming (Angelone, 2010). Mobile digital games can incite learners' self-determination and provide them with a way to engage and participate in class activities which they would not have been able to engage in. This is especially important for students with disabilities because some skills such as self-determination are not usually incorporated in the general curriculum, and these students often lack these specific skills. Hence, students with disabilities can significantly benefit from digital games.

Finally, mobile digital games are highly adaptable, modifiable, and flexible to meet the needs of each learner. They have the ability to inspire and encourage learners to be active participants and customizable in their learning. Therefore, these games can be tailored for specific learners' characteristics to aid students with certain skills and abilities.

1.3.5 Collaborative Skill

Digital collaborative learning environments have shown to foster meta-reflection and higher-level cognition among learners as well as to cultivate the spirit of collaboration and support positive social relationships with others (Chen, Wang, & Lin, 2015). Digital games often benefit learners' intellectual development because they involve understanding how things work, resolving problems, and devising strategies. Although learners should be interactive with games, they also need to interact with other learners (Deubel, 2006; Coffey, 2009). Mobile digital interactive games can benefit affective and social development due to their fictional attributes. The nature of digital games includes (a) the opportunity to act out a role, (b) being a member of a group, and (c) making decisions within predominant values and attitudes in a society; digital games can enhance learners' social skill development (Gee 2003; Simpson 2009). Particularly, it is easy for learners with disabilities to feel disconnected and alienated from others, which may lower their self-esteem, self-confidence, and decrease their academic achievement and performance levels. Therefore, if a learner with a learning disability plays digital games with others who have the same interests, the students may be less likely to be stigmatized for his/her learning differences (Simpson, 2009). This is echoed by Angelone (2010), learners with physical disabilities are often unable to play as other kids do, and the digital games create an equal access environment. In conclusion, mobile digital games could promote teamwork and communication at various subject areas and grade levels of learning. Specifically, it helps learners at various performance levels to work together in small groups or pairs toward a learning goal. Digital games provide great opportunities for learners to develop collaborative skill required in the twenty-first century.

1.4 Mobile Digital Games in K-12 Education Subject Areas

The various digital games and platforms can be integrated in all subject areas as they have demonstrated some substantial or suggestive benefits for student achievement and development. It is crucial to understand that digital games in the classroom are not a replacement for good teaching. Instead, it is a supplement of engaging learners in the content and provides an avenue for them to learn difficult concepts of the real world in an environment in which they are comfortable (Annette, 2008).

1.4.1 History

The use and involvement of digital games could support learners to gain a greater understanding of the nature and complexity of historical problems (Bysshe & Gould, 1975). Christesen and Machado (2010) examined how video games such as *Rome: Total War*, *Glory of the Roman Empire*, and *CivCity: Rome* could be used as instructional tools in the classroom providing students with enriching knowledge and excitement when learning about the ancient world. Before making decision whether to use the game to support teaching history or not, teachers should analyze the benefits of playing game how to influence students' academic achievement. For example, *Rome: Total War* is a strategy game; players attempt to become ruler of the Mediterranean world in the late Roman Republic by efficiently allocating financial and military resources (Christesen & Machado, 2010). Learners engage in historical battles during the times of ancient Greek and Roman history. This game not only helps students' engagement, but it also provides numerous pedagogical uses in learning Rome history and problem-solving skills. Further, Christesen and Machado (2010) postulate that the value of this game can help students to visualize battlefields, plan to move unites and fought, and provide several kinds of compare-and-contrast exercises. In the end of game, students could learn the historical accuracy of the game through reflecting, thinking, and writing critically.

McCall (2012) voiced the explanation for interest and engagement in historical simulation games by explaining games through offering immersive, interactive, and multimedia representations of the past in different forms of media. It will allow active participation and excitement to engage in learning provoked by players' engagement through multiple modes of communication such as visual, textual, aural, and tactile which invite the player to engage and make world-changing decisions (McCall, 2012). Students are therefore able to learn about intricate and dynamic situations and subjects through immersive environments that simplify the understanding through role playing. As McCall (2012) said, simulation games are powerful learning tools because they enable students to make meaningful choices and challenge learners to overcome deficiencies. This allows students to increase their academic achievement levels as they can deepen their conceptual understanding and investigate the implications surrounding specific historical moments.

The significance of conceptualizing these problem spaces and these systems operating with limited and enabled certain action is being a highly effective learning tool for learners in the modern world, where action continues to be contextualized by digital games (McCall, 2012). However, in a traditional history class, it is all too easy to divorce humans from their systemic contexts. Therefore, digital gaming or simulated historical experiences are essential for students to engage in as it will demonstrate to them how interwoven the concepts and systems are and provide them with an understanding of human actions and events. Simulation games play a powerful role of helping learners studying historical systems because games are systems themselves, so it is vital to keep representations of systems as analogous as possible. Unlike traditional learning environments using text to present aspects of the past than games using images, learners can virtually experience the historical systems by being able to control and manipulate aspects of the system.

1.4.2 Science

Angelone (2010) articulates that digital games with teacher facilitation can rich students' skill and knowledge in the science classroom. For example, in the mobile digital game-based science classroom, students practice taking on a new identity as scientists in laboratory and become a part of a virtual world not possible in the traditional science classroom. This allows the students to engage more deeply in the material world as they are discovering things for the first time. Digital games allow students to engage in exploration, discovery, gathering new data, and reformulating hypothesis through playing, and outcome performances could be measured and rewarded (Angelone, 2010). Such games provide students with an opportunity to become excited and motivated about learning through self-directed exploration and trial and error (Annette, 2008). Through using digital games as educational tools, a player learns to think critically about the games while at the same time gaining embedded knowledge through interacting with the environment (Annette, 2008).

There are many digital games that exist that could be used in the science classroom. One example for use in the middle school science classroom is *Zoo Tycoon*. The results have shown multiple benefits that align with pedagogy and content that can be learned through participation in digital gaming. In this game, students are to maintain and design a zoo to take care of the various animals (Angelone, 2010). Through participating in this game, students gain an understanding about how to integrate concepts, processes (such as their order and organization), scientific inquiry, life science (such as reproduction, heredity, populations, and ecosystems), and science and technology (Angelone, 2010).

1.4.3 Art

Art education has been undergoing a transformation from comprehensive approaches to a range of approaches that recognize the increasingly visual world where we are living (Parks, 2008). This re-envision of art education provides for a visual culture approach that allows learners to understand art how to affect and be affected by the broader world. Although limited studies have been conducted on the effects of digital game usage in the art education classroom, researchers believe that the processes of production, visual characteristics, content, and processes involved in digital games could make art education become more compelling. Using digital gaming in the art education classroom suggests potential benefits of creativity, imagination, and innovation as well as engagement in critical reflection. Digital games allow art education to be a catalyst for transformative learning experiences related to students lived worlds (Parks, 2008). Digital games encourage learners to experience roles and situations which are inaccessible (Frasca, 2004).

1.4.4 Literature and Language

Researchers believe that digital storytelling could capture the imagination of both students and teachers. The act of crafting meaningful stories has elevated the experience for both students and teachers (Robin & Pierson, 2005; Sadik, 2008). The digital storytelling is defined as:

> A modem expression of the ancient art of storytelling. Throughout history, storytelling has been used to share knowledge, wisdom, and values. Stories have taken many different forms. Stories have been adapted to each successive medium that has emerged, from the circle of the campfire to the silver screen, and now the computer screen. (Sadik, 2008, p. 490)

Interactive storytelling through digital gaming allows students to become active learners as they can influence and manipulate the story. Through digital storytelling and the use of these skills students can develop stronger understandings pertaining to the literature (Sadik, 2008). There is an increasing attention of using digital games in language learning and teaching. Researchers found there are benefits to language learning by using digital games such as learning repetition and mechanics of language learning as well as vocabulary (De Juan & Laborda, 2013). Sadik's (2008) study found that integrating digital storytelling into the language curriculum is a creative language learning technique that can improve student's level of learning in reading, writing, speaking, and listening. This surge of interest and integration of digital games in this area is largely due to the notion that learning and gaming are both circular processes. Both processes require the continuous reconstruction of the learner's knowledge through interactions and collaborations with others (De Juan & Laborda, 2013).

1.4.5 Mathematics

Stramel (2016) focuses on how games can be used to promote student achievement in mathematics specifically. With rapidly evolving technology, using digital games in the classroom to promote students' achievement in mathematics is increasingly made possible. A study from Joint Position Statement (2002) found that children should experience research-based learning curriculum to be successful later as it forces them to solve real problems in the world. Digital games help them construct a foundation for success in and out of school, and earlier experiences have long-lasting outcomes on the children' future success. Abramovich (2010) illustrates children developing computational fluency required a balance and connection between conceptual understanding which provides the opportunity for meaningful practice. Digital game-based for learning mathematics must be made adaptable and modifiable to the ages, interests, languages, and cultures of the learners' diverse needs. It will allow learners to explore counting sequences, computation strategies, etc., and form deeper understandings, reasoning abilities, and encourage strategic thinking. Stramel exemplified several different digital games that could be used in the mathematical subject area such as *Connect Four*. This game could be adapted easily while teaching multiplication, addition, and subtraction. For instance, players could add up the sum of two die that they roll, strategically choose which number they will cover, and once they have four in a row that player wins. This game also tests their addition strategic problem solving. Games can be used to promote learning and lay the foundations for future learning of mathematics. Even the basic level of problem solving in this game could be expanded beyond school years.

1.5 Conclusions

Mobile digital games have become popular because they are fun. Since the 1980s, it has increased to 60% of children and 97% of young people playing digital games. This demonstrates their pervasive nature and thus the importance of educators considering their integration as an educational tool to benefit student learning in the classroom. Specially, teenagers often lack interest in curricular contents. The disengagement from course material has a significant impact on students' learning. For a mobile digital game to be successfully utilized in the classroom, educators should decipher the match between a game and the objective of the lesson (Shah & Foster, 2014). It is imperative for teachers to find how to use mobile digital games to transform disengaged learners into authentic and engaged students. Therefore, it can be implied that digital games have advantages from a pedagogical perspective.

Research has shown that digital games contain rich potentials for academic gains for students in the classroom. Students who play digital games are typically engaged, persistent, and succeed (Simpson, 2009). Such benefits cannot be overlooked, and mobile digital games can be utilized as an educational tool to bolster learners' cognitive and many skills development. Digital games motivate learning through providing curiosity, fantasy, fun, and social recognition (Annette, 2008). Coffey argues that if teachers want to effectively use game-based learning in the classroom, they must first find nonviolent games that facilitate planning and problem solving and relate to the curriculum. Specifically, some mobile digital games such as simulation and adventure games are highly advocated for use in the classroom because they often appeal to the development of more than just skills (Coffey, 2009).

According to previous theoretical frameworks, it suggests that learning is more effective when learning is active and problem-based which is accompanied with immediate feedback in a meaningful learning context which a traditional learning environment may not able to support learning digital natives. It is necessary to implement mobile digital games to become relevant and relatable to students' learning. Digital games used for educational purposes could foster students being the part of learning environment rather than being a passive recipient listening to a teacher. Learners are no longer observers, but are protagonists who make decisions that affect the game world (Saez-Lopez, Miller, Vazquez-Cano, & Dominguez-Garrido, 2015). De Juan and Laborda (2013) noted that digital games can promote self-directed learning which is facilitated by the adequate support, scaffolding, reflection, and critical thinking. Therefore, by engaging in digital games, students develop twenty-first century skills such as self-governance, critical analysis, self-evaluation, and strategic problem solving which are vital skills for their future success.

In conclusion, mobile digital game-based learning in educational settings has become a common practice. This common usage of digital games in the classroom is because educators realize the immense beneficial effects that games can have on student achievement. Therefore, it is vital to continually develop the positive potential of digital games and be aware of possible unintended negative effects (Griffiths, 2002). Also, it is essential for teachers to consider the cognitive and physiological effects that the game may have on their student learners (Deubel, 2006). Digital natives play games on their own to understand their world from outside of formal education structures. When games are properly used and deployed in education, students' performances will improve (Chen et al., 2015).

1.6 Limitations and Future Direction

Some people believe that digital games in the classroom can prove to be detrimental to the learning and development of students. Such advocates believe that digital games as an educational tool ultimately are too distracting for the learner and thus obscure the academic goals of the game. Another criticism of the inclusion of digital games is that it is difficult to find a game that closely identifies with the pedagogy (De Juan, & Laborda, 2013) or the use of digital games as educational tools exist (McCall, 2012). Additional limitations and challenges do exist in other studies of digital game-based learning. Therefore, it is imperative to be cognizant of them to best implement them as an instructional tool in the classroom. To address this concern, educators or researchers must determine whether the content of the game is appropriate for specific age groups and whether the games are suitable for the standard-based accountability movement (Coffey, 2009). However, despite these limitations and challenges, they provide guidance for developing serious educational games that motivate and engage young learners toward digital game playing in positive ways (Owston, 2009).

Glossary

Twenty-first century skills a series of higher-order thinking skills which have been identified in many disciplines including schools and workplace to succeed in twenty-first century.

Constructivist theory of education it connects educational content with computer or mobile digital games which can be used in almost all subjects and skill levels.

Controller interface mouse, joysticks, or keyboards.

Cooperative gaming a game provides interaction with other learners to solve problems together.

Error–feedback reconstruction learners' knowledge is built through continuous error and correct feedback during the learning process.

Intrinsic motivation self-desire to seek out and gain new knowledge.

Mental quickness the cognitive speed of processing information.

Meta-reflection higher-level cognition or problem-solving skills.

Multi-sensory vision, audition, touch, smell, taste, etc., all work together.

Mobile digital games digital games such as video games implemented in a mobile interface.

Strategic reflective questions or scaffolding reflection The questions could facilitate learners to reflect their learning. For example, "what is the most important aspect about mathematics you learned from this game? What strategy did they use to help you to play this game? What was tricky about this game? Can you connect the math that you learned in this game to something you learned in class? How is this knowledge useful outside the classroom? What was the most fun thing about the game? How did you feel when you played the game? What were your strengths when playing the game? What advice would you give to someone to play the game in the future?"

Virtual world a computer-based simulated environment allows learners to learn and solve problem as in a real-world setting.

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Chapter 2
Mindfulness in Mobile and Ubiquitous Learning: Harnessing the Power of Attention

Agnieszka Palalas

Abstract Mobile and other digital technologies facilitate ubiquitous learning that offers unprecedented benefits. With mobile learners being able to "squeeze in" learning in-between other daily activities, they face contesting demands on their attention and their brain. Their learning experience might be hindered by multitasking, distraction, mind wandering, and even problematic dependence on digital devices. These influences are addressed in the chapter, and recommendations are presented on how to promote higher levels of attention and engagement in m-learning events. Based on the latest empirical evidence, mindfulness strategies can aid in attention regulation and cultivation of "healthier" learning habits, thus alleviating these problems amongst mobile learners. Recent discoveries in neuroscience and the renewed understanding of brain plasticity are bridging the science and practice of mindfulness. Combined with 35 years of scientific research in mindfulness, more recent exploration of the applications of mindfulness in education has demonstrated that learners can train their mind to respond to stimuli in a purposeful controlled manner leading to more successful learning. Incremental mindfulness practice tunes up our nervous system and strengthens the neuro-components that help us connect with our intentional attention capabilities. It is hence the purpose of this exploration and the resulting chapter to identify such learner-centered strategies to promote the development of mindfulness practice leading to enhanced intentional attention in mobile learning. Mobile technologies can be used to provide scaffolds for learners to engage and persist in mindful learning and practice of mindfulness. The author presents a variety of proven mindfulness practices and techniques that can be adapted in the m-learning design. She concludes with a call for more interdisciplinary studies and rigorous explorations of the intersection of mobile learning, education, instructional design, contemplative practices, cognitive science, and neuroscience to attain a better understanding of how to harness attention in mobile and ubiquitous learning.

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_2

Keywords Mobile learning · Attention · Focused practice · Distractions Problematic m-learning habits · Mindfulness strategies · Neuroscience Mindfulness research · Mindfulness in education · Self-regulation

2.1 Introduction

With m-learning expanding beyond the use of handheld devices, and the presence of digital information and communication becoming pervasive wherever we are (e.g., the "Internet of Things" where things and objects, such as tags, sensors, and mobile phones, are able to interact with one another and exchange information), it is vital to consider how the learner can actually benefit from this ubiquitous presence of information, and go beyond simply accessing content and successfully activate more persistent cognitive effects to attain deeper learning. As noted by Goleman (2013), "[w]e learn best with focused attention" (p. 16).

Mobile learning, particularly contextual m-learning, varies greatly in the context of use, extent and time of interaction with content, ergonomics of the experience (user posture, lighting, and background noise), social and physical context, and, consequently, demands on users' attention (Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009). Moreover, cognitive load, which has been identified as a key issue in successful instructional design (Ozcinar, 2009), is yet another aspect that is impacted by the content, delivery, and setting of mobile learning. In fact, environmental interferences can lead to a learner's cognitive system being overloaded when performing an m-learning task, thus hindering learning. Two extraneous load inducing factors that are highly relevant to the design of mobile learning environments are the need to *split* attention between multiple sources of information and "the need to *pay* attention to multiple sources of information that are self-contained and can be used without reference to each other (Liu, Lin, Tsai, & Paas, 2012; emphasis added). Other related influences that impact the quality of learning are multitasking, distraction, mind wandering, and problematic dependence on mobile devices leading to potential addiction to those devices. These concepts are explained in the chapter based on current research, and recommendations are offered on how to promote higher levels of engagement in m-learning and increase learner attention during m-learning events. The common theme for these behavioral issues triggered by digital devices is the contesting demands on attention and the brain. With mobile learners being able to "squeeze in" learning in-between other daily activities of their busy lives, the hindrance of distracted attention may be aggravated. Based on the latest empirical evidence, mindfulness strategies can aid in attention regulation and cultivation of "healthier" learning habits, thus alleviating these problems amongst mobile learners. It is hence the purpose of this exploration to identify learner-centered strategies to promote the development of mindfulness practice leading to enhanced intentional attention in mobile learning. Mindfulness is viewed hereby as a continuum of attention-based self-regulatory practices cultivated to develop a capacity to focus intentionally on what is happening *now*.

Latest discoveries in neuroscience and the renewed understanding of brain plasticity are bridging the science and practice of mindfulness. Combined with 35 years of scientific research in mindfulness, more recent exploration of the applications of mindfulness in education has demonstrated that learners can train their mind to respond to stimuli in a purposeful controlled manner leading to more successful learning. Incremental mindfulness practice tunes up our nervous system and strengthens the neuro-components that help us connect with our intentional attention capabilities (Siegel, 2016). It helps us cultivate our presence in the moment through intention, attention (focus and monitoring), and attitude promoting self-regulation and co-regulation in our mobile learning efforts. Mobile technologies can be used to provide scaffolds for learners to engage and persist in mindful learning and practice of mindfulness. In the world filled with distractions, learners should come off their autopilot and skillfully decide when, what, and how to learn.

Drawing on research and her own mindfulness practice,[1] the author suggests strategies to improve learners' attention, active awareness, engagement, and ensuing completion of learning tasks that require sustained and undivided attention. Improved task accuracy and being more "on-task" can be achieved through mindfulness practice that reduces mind wandering and helps to stabilize and focus attention on one's present moment experience in the service of effective learning. It can help a mobile learner to focus on a task at hand even if the task setting makes the learner performance susceptible to distractions. Moreover, these mindfulness strategies can be worked into the design of mobile learning to help learners notice when they are not focused (hence not engaged cognitively) and redirect selective attention back to the current learning task.

The author introduces some evidence-grounded m-learning design recommendations and mindfulness techniques, reflecting the state of mobile learner habits and the latest technology advancements, which can be applied in future m-learning practice and research. Mobile and other digital technologies facilitate ubiquitous learning that offers unprecedented benefits. It is of utmost importance that the m-learning community provides guidelines and strategies to use these powerful tools to the benefit of the mobile learner.

2.2 Mobile and Ubiquitous Learning: Harnessing the Power of Mobile Technologies

Mobile and ubiquitous learning has proven to be able to deliver education to learners of all ages, cultures, backgrounds, and geographical location. Mobile device users can tap into most of the information collected over centuries with new

[1]Acknowledgment: I would like to take this opportunity to express my gratitude to all my mindfulness teachers and guides, including the instructors of the Applied Mindfulness Meditation Certificate Program offered at University of Toronto, namely Dr. Michele Chaban, Professor Emeritus Dr. Robert J. MacFadden, and Michael Apollo Chabior.

resources being added every day, including free-access courses by world leading universities, such as Harvard and MIT, so anybody can learn from the best international experts. Mobile devices are the gateway to networks and information that a decade ago was accessible merely to the privileged and only a fraction of which was available digitally. Digital resources and tools have now reached learners in formal face-to-face and online classrooms across the world as well as in informal contexts in which people communicate with others, access information, and acquire knowledge as part of their daily life.

Informal learning, i.e., "intentional or tacit learning in which we engage either individually or collectively without direct reliance on a teacher or externally organized curriculum" (Livingstone, 2006, p. 204), is an integral part of our life and for millions of underprivileged people—the only available form of learning. For many, learning with mobile devices opens doors to equity and welfare through mobile access to resources, advice, aid, and supports that never used to be available prior to the mobile learning era (Palalas, 2017). Mobile and ubiquitous learning has reached the most remote corners of the globe to offer people "transformational change founded on personal, vocational, cultural, economic, social, and civic improvement of individuals and groups" (Palalas, 2017).

The relationships between formal and informal learning, face-to-face and distance learning, tethered and mobile-technology-enabled learning have been now more dynamic than ever. The pervasive digital technologies crossed many physical and cultural barriers that were impenetrable to other educational technologies. Not only did they democratize learning but they also gave a new meaning to situated learning contextualized in authentic meaningful settings and across a variety of contexts. This unprecedented ability to move learning out of the traditional static classroom into a real, virtual, or augmented reality conducive to the target learning outcomes has been recognized as one of the key drivers of the m-learning pedagogical shift.

Mobility and flexibility of mobile learning open new possibilities of choice and personalization of learning—the learner, especially adult learner, can decide how, when, and where to connect to digital resources and how long to stay "on." At the same time, this autonomy comes with requirements of self-regulation and enhanced agency. Personal mobile technologies offer tools to adjust when to engage in learning activities and when to disconnect and enjoy a moment of silence. How do we navigate that opportunity to personalize the time and place of learning? How do we optimize our time, brain, and mind capabilities to deal with all the challenges and information that we encounter? This often requires guidance from teachers, experts, instructional designers, or policies and regulations that facilitate learning and prevent unfavorable side effects of too much choice and "noise." Digital literacy skills are essential to an effective ubiquitous learning experience, so is "attention literacy."

The magnitude of the positive aspects of mobile and ubiquitous learning is sometimes underestimated, so are the possible detrimental effects on people and their well-being. Digital technologies, including mobile technologies, upset the balance between personal and public space, private time and "open" time when we make ourselves accessible. The lines between our work, family, and "me time" become blurred. Traxler (2016) observes that "digital conversation now intrudes into physical conversation, and cyberspace and phonespace now intrude into physical space, forcing new social practices and transformed etiquettes into our lives as we all attempt to manage our changed communities and the conversations within them" (pp. I–II). Our digital habits and behaviors have fundamentally changed how we interact with others and how and when we transition from our personal space to interactional space. Ironically, the very same devices that were invented to connect us can make us feel less connected and less present in the moment and with the people around us. Technological advancements, like many other inventions, can be double-edged swords that, on the one hand, solve problems and, on the other, create new ones. Fortunately, solid digital literacy and "attention literacy" skills can help the mobile learner steer away from most of the detrimental consequences of the overwhelming digital noise.

2.3 "Digitally Overwhelmed"

A study led by Nottingham Trent University (Andrews, Ellis, Shaw, & Piwek, 2015) estimated that the average person (age 18 to 33) checks their device 85 times a day with a total of five hours browsing the web and using apps, which equates to around a third of a person's waking time. Moreover, the actual mobile device usage is twice as much as the participants self-reported. Statista (2015) recorded even a higher number with users checking their phone on average more than 150 times a day. In 2015, the number of emails sent and received daily totaled over 205 billion; this figure is expected to increase to over 246 billion by the end of 2019 (The Radicati Group, Inc., 2015). People who check their email repetitively throughout the day tend to access their email via mobile devices. The constant inflow of emails, updates, and information can distract and overwhelm us. With mobile access to an endless choice of entertainment, communication, and information resources, the temptation to check in with the virtual space is unceasing. All that information at our fingertips can make it difficult for us to concentrate. For mobile learners, who can connect to their learning materials and networks at any time, it can lead to stressful and unproductive learning habits unless they employ strategic, purposeful, and meaningful learning practices.

Cultivating mindful digital habits would include being able to select when to turn the device off. If incessantly plugged-in, one might not be spending sufficient time in the physical company of other people and himself or herself. We are rarely alone with just our thoughts and when we are, thoughts rush through our head jumping from judgments about past actions to planning for future tasks. When we drive, walk, sit on the bus, wait in a lineup, or even "enjoy" a family dinner, hardly ever are we present and fully engaged in the moment. Instead, feeling overwhelmed by the pace and responsibilities of daily life, we plan next steps or reach for the mobile to send off yet another email in an attempt to shorten the to-do list. People now experience much higher levels of stress, which is yet another reason why mindfulness, the practice of being aware of one's thoughts, physical sensations, and surroundings, has been progressively becoming a very popular movement in the western world (Wallace, 2006).

Before considering these mindfulness strategies, the next four sections take a closer look at the need to leverage self-regulation skills to extract valid and useful information.

2.4 Information Overload

The sheer amount of information we are exposed to may hinder our ability to select and process any of those resources. This may cause stress and an inability to choose valid information and make decisions. This is not a new dilemma, though. According to Weinberger (2014), the concept of information overload was first introduced to the general public by Alvin Toffler in his 1970 book *Future Shock* citing research demonstrating that too much information can hurt the ability to think. When the brain is buffeted by information, appropriate filtering strategies should be applied to distill what is valid, useful, and relevant to us (Weinberger, 2014).

These sentiments can be traced back further. Ever since the introduction of Gutenberg's printing press in the mid-fifteenth century, people have been complaining about information overload. In the Renaissance, as a result of the growing popularity of technology of printing and an ever-increasing number of recovered texts of ancient authors as well as works of modern authors, "there was an over-abundance of works to be read and referred to in the cycle of textual commentary across all fields of study" (Blair, 2000, p. 69), causing objections to the consequential information overload. In 1685, French scholar Adrien Baillet lamented:

> We have reason to fear that the multitude of books which grows every day in a prodigious fashion will make the following centuries fall into a state as barbarous as that of the centuries that followed the fall of the Roman Empire. Unless we try to prevent this danger by separating those books that which we must throw or leave in oblivion from those that one should save and, within the latter, between the parts that are useful and those which are not. (Blair, 2000, p. 70)

Nowadays, due to the digital revolution, this problem is exponentially larger. Hence, the ability to distill what information is valid and worthwhile is more critical. In 2010, former Google CEO, Eric Schmidt, pointed out that we created as much information in two days in 2010 as we did from the dawn of man through 2003 (Siegler, 2010). Six years later, in 2016, according to IBM (2016), 2.5 quintillion bytes of data are generated every day with 90% of the data in the world today being created in the last two years alone. These data come from everywhere, including posts to social media sites, digital pictures and videos, purchase transaction records, cell phone GPS signals, and communication records just to name a few. Hilbert and López (2011) reported that we received five times as much information every day as we did in 1986. The capacity to process all this information with computers has doubled every 18 months and with telecommunication devices—every two years. While we are far from the saturation point and nowhere near the mind-boggling amount of information contained in the natural world, natural world remains fairly constant; “in contrast to natural information processing, the world’s technological information processing capacities are quickly growing at clearly exponential rates” (Hilbert & López, 2011, p. 64). We should be spending less time-consuming information, often irrelevant facts and fake news, and more time creating new understanding, new skills, and new knowledge. Devoid of “attention literacy” skills, learners are exposed to a range of distractions as highlighted in the next section.

2.5 Distraction

Distraction and chronic distractibility, splitting our focus between digital information and the real-life context we are in, and between the present moment and thoughts about the next one, have become the norm in the twenty-first century (Goleman, 2006). Distraction can be internal or external, habitual or unanticipated, frustrating or welcomed. Distraction might be appealing as it activates the brain and draws on the brain’s attraction to novelty (Bunzeck & Düzel, 2006; Willis, 2006). It also feeds into our misconception that, when we are involved in more than one action simultaneously, we “cover more ground” and get more done, or at least more checked off our to-do list. When we are switching between the article we are reading on our iPad, a Facebook page opened in the background to add a “Like,” and an email notification that popped up, we might be deceived by the erroneous perception of autonomy, freedom of choice, and control that the device offers. In fact, we might not be aware of the havoc that this behavior plays with our brain and our cognitive capabilities. The constant distraction an agitation of the mind leads to exhaustion and brain burnout (Willis, 2006). We cannot focus enough to produce any in-depth reflection, creative ideas, or engagement in learning. Lack of attention and mind wandering can interfere with learning and academic success (Morrison, Goolsarran, Rogers, & Jha, 2014). Mind wandering and off-task thinking are linked to diminished cognitive performance (McVay & Kane, 2012; Smallwood, Fishman, & Schooler, 2007). Mind wandering or “stimulus-independent thought,” albeit the brain’s default mode of operation (Killingsworth & Gilbert, 2010), can be particularly problematic in contexts where sustained attention to content and interaction are hindered by external information and distractors, as well as internal thoughts and emotions. We have to find solutions to the distractions, avoiding mindless and passive entertainment.

The mobile learner needs to engage in active learning activities with awareness and skills that have not previously been appreciated or associated with m-learning. Mindfulness and meaning are key to learning with focus, self-control, presence, engagement, intention, and patience so that one can harness the cognitive, processing, and creative powers of the brain. Learners should cultivate the qualities of self-awareness and self-regulation so that they can manage their mobile device usage leading to ubiquitous learning that is controlled by the learner and not by the compulsion to check in with the digital space.

The irony is that many companies creating the hardware and software that are gateways to the digital distraction are actively involved in practices of mindfulness that, amongst other benefits, aim at quieting the mind. Representatives from Google, Facebook, Apple, Twitter, eBay, and many Silicon Valley companies engage in individual and professional mindfulness practices (e.g., mindfulness training for approximately 5200 employees at Google) on a daily basis to introduce and maintain a healthy balance between the personal and digital space in our lives. One can meet them, for instance, at Wisdom 2.0, the international conference that aims to tackle the challenge of the twenty-first century to "not only live connected to one another through technology, but to do so in ways that are beneficial to our own well-being, effective in our work, and useful to the world" (Wisdom 2.0, 2016). Thanks to the ever-growing interest in the well-being of the digital technology user, more empirical studies are available to inform the mobile educational landscape. Some relevant studies on multitasking are presented below.

2.6 Multitasking and Continuous Partial Attention

Closely related to the issue of distraction and lack of focus on the task at hand is the tendency to multitask. It is the overcommitted schedules of learners that frequently drive much of their multitasking. Multitasking is also emotionally gratifying as is checking our Facebook status (Houlihan & Brewer, 2016; Wang & Tchernev, 2012). There is scientific evidence that multitasking, performing certain tasks simultaneously, is problematic (Bowman, Levine, Waite, & Gendron, 2010; Wallace, 2006). Accordingly, the brain is not capable of performing more than one task at a time and it switches back and forth between the tasks at hand. The more tasks we are trying to embrace, the faster the brain jumps between them (Jackson, 2012)—it is rapidly toggling between tasks rather than simultaneous processing them or multiprocessing. What might appear as multitasking is actually task switching with great rapidity which stresses our brain and makes it difficult to properly complete any single task. The brain requires time to switch back to the suspended task and refocus on it. In short, multitasking is ineffective as the quality of awareness allocated to each task is reduced. The consequential "experience of attending to multiple things at once is an illusion" (Wallace, 2006, p. 38).

Wallace (2006) in his exploration of how meditation can deepen the human capacity for sustained concentration aptly concludes that:

> The practice of focused attention is essentially "non-multi-tasking". It's learning how to channel the stream of awareness where we wish, for as long as we wish, without it compulsively becoming fragmented and thrown into disarray. (p. 38)

Likewise, related studies in the educational setting show that in order to achieve high performance, creative work, and effectiveness in learning, it is recommended to focus on a single task instead of feeding into our distractibility through multitasking. According to Fried (2008), frequent multitaskers reported paying less attention to lectures and their academic performance was inferior to other students in the class. Moreover, Bowman et al. (2010) cited multiple cognitive studies and research of attention (e.g., Broadbent, 1958; Deutsch & Deutsch, 1963; Kahneman, 1973; Pashler, Johnston, & Ruthruff, 2001; Treisman, 1960) and concluded that competing cognitive tasks affected performance and that "attentional capacities are limited and that dividing attention among one or more different tasks leads to decrements in performance" (p. 928). While the mechanism of multitasking, task switching, and the degree of distraction depend on the type of activities, researchers agree that paying attention to more than one learning task interferes with academic performance and "multitasking has been found to interfere with both length of time needed to complete a task and comprehension and memory for material learned" (p. 928). Students may think they accomplish more by multitasking; however, the findings by Bowman et al. (2010) suggest that the multitasking students, in fact, need more time to achieve the same level of performance on an academic task. Chen and Yan (2016), in their extensive review of literature on the influence of mobile phone multitasking on academic performance, conclude that further research is needed to fully understand the mobile phone multitasking phenomenon and to help learners develop skills necessary to prevent potential distractions.

This discussion would not be complete without reference to the notion of continuous partial attention (CPA), a phrase coined in 1998 by Linda Stone, a former manager of Apple and Microsoft. CPA refers to a behavioral approach to managing information when interacting with digital technologies and interfaces (Stone, 2006). Johnson (2004) posits that CPA "involves synthesizing superficially the data obtained, collecting the related information and going on with the following data flow" (p. 59). Similarly, Firat (2013a, 2013b) views CPA as constant fragmented attention motivated not by productivity but by the desire to be connected. He interprets CPA as "trying to follow and deal with everything while, in fact, failing to focus on anything." Stone (2006) further commented that our attention patterns shift in order to stay on top of everything and to superficially scan everything for opportunities to move our attention to some activity or person that could be potentially more important or make us feel more alive; but ironically, the selected object is not going to receive our full attention either. Stone posed fundamental questions of how people pay attention to things, to each other, and how the new technologies have affected our attention. She concluded that "In a world of interconnected communities and constant background noise, the overriding question is: what do we really need, and what do we need to pay attention to?"

There is a growing body of research examining what types of discrete tasks can be completed simultaneously and how to combine them to enhance learning, for instance, by not mixing attentional modes, i.e., reading an article while listening to a conversation. If we can drive a car and listen to the music at the same time and we can stroll in the park and listen to a podcast, why can we not switch between tasks in a skillful way in the m-learning context? Could learners be using their divided attention productively to look up information on their mobiles during a class lecture or to engage in a back-channel discussion about the lecture via Twitter? These and similar questions still need to be researched to inform our understanding of what comprises the "attention literacy" skills.

Concluding, our attentional capacities are not infinite. Although we may not have to always being narrowly focused on one task, we should not try to use attention concurrently for two incompatible tasks. More importantly, we should never let our digital devices control when and to what we dedicate our time, emotional, social, and cognitive resources. These learning strategy decisions should be mindful actions promoted by a trained attentive mind.

2.7 Addiction to Cell Phone

The results of a study with 2000 participants, sponsored by Microsoft Canada (2015), revealed the new adult attention span to be in 2013, on average, eight seconds compared to 12-second attention span in 2000. The more people reported reliance on their electronic devices, the less they were able to sustain their attention. Dependence on their smartphones negatively affected their cognitive load and their ability to concentrate.

The brain can be addicted to the cell phone the same way it becomes dependent on substances. The same reward pathways are observed in dependence on the mobile phone as in any other addiction (Houlihan & Brewer, 2016). According to the authors, neuroscience and the increasing understanding of brain function have "partially illuminated what common neurological features underlie seemingly disparate behaviors such as cocaine use, romantic infatuation, … posting selfies to Facebook," and checking one's cell phone when they become objects of addiction (p. 192). Dopamine can be released whenever new information or a "Like" on Facebook and Twitter is received, following the same addiction processes in our brain as when under the influence of drugs. The inherent drive of the human brain to be connected and receive new information (Siegel, 2016) fuels our tendencies to regularly check our phones in the fear that we are going to miss out on something important. That fear residing in the back of our mind can lead to anxiety and unnecessary preoccupation with the device in our pocket and with the information it can deliver (often trivial and invalid data). Much too frequently, such behavior may cause distraction, restlessness, and even compulsive habits.

Leung and Liang (2015) examined the literature pertaining to problematic use of mobile phones (including the often interchangeable concepts of mobile phone addiction, mobile phone dependency, and pathological or maladaptive mobile phone use) and possible behavioral health issues related to it. They observed that "adolescents and young users are becoming increasingly dependent, or "addicted," to this technology, not only for interpersonal communication but also as a way of "seeking gratification, searching for information, entertainment, relaxation, passing time, picture and video taking, and expressing status and identity…" (p. 640). The authors provided an overview of the existing models for assessing mobile phone addiction and observed that these were similar to other technological addiction scales derived from empirical studies. They listed common predictors of mobile phone addiction emphasizing the relationship between personality traits and problematic mobile phone use. Accordingly, the most prominent of those predictors are the following psychosocial factors: self-esteem, loneliness, shyness, leisure boredom (too much time, too little to do), and self-control. The authors offered a definition of mobile phone addiction: "addictive mobile phone use can be considered an impulse control disorder that does not involve intoxicants and is similar to pathological gambling" (p. 642) and cautioned the reader to distinguish between the addicted mobile phone user and habitual or heavy user. They continued that based on a study by Bianchi and Phillips (2005) the following are key signs of mobile phone addiction suffered by millions of mobile phone addicts:

- over-preoccupation with the phone (e.g., becoming worried when out of cellular range for a period of time);
- a need to use the phone for increasing amounts of time to achieve satisfaction;
- repeated and unsuccessful attempts to control, reduce, or stop using the phone;
- feeling lost, agitated, moody, irritable, or depressed, when attempting to decrease mobile phone use;
- staying on the mobile longer than initially intended;
- hiding from family, friends, and others to conceal the extent of the mobile device use;
- using the mobile phone as an escape from problems and dysphoric moods (e.g., feelings of isolation, anxiety, loneliness, and depression).

There is a debate about how increased mobile phone use may negatively impact student academic performance, mental health, and even well-being and happiness. Some studies suggest that excessive and inappropriate cell phone use may negatively influence users' health and behavior. For instance, Lepp, Barkley, and Karpinski (2014) observed that in a large sample of college students, cell phone use/texting was "negatively related to GPA and positively related to anxiety" (p. 343). These corroborate the findings discussed in the previous section and highlight the necessity to cultivate digital and attention skills which will help learners self-regulate how they distribute their attentional resources.

2.8 Attention Literacy Strategies

Wallace (2006) observes that the mind is prone to attention deficit and hyperactivity leading to imbalances in our mind and little control over attention. He continues that the ability to voluntarily sustain attention on a chosen topic, activity, or object is indispensable and that the faculty of attention can be trained. Drawing from the discussion of potential culprits challenging mobile learners and research on mindfulness in education, guidelines for the development of the essential "attention literacy" skills are proposed. This discussion is a mere prelude to a much broader conversation that is needed amongst mobile learning researchers and other related fields of science.

Mobile learners of the digital era have to be able to self-regulate their ubiquitous learning habits, and they have to pay attention to learning tasks consistently and mindfully, even when on-the-go, and often for stretched periods of time. While ubiquitous learning may rely on chunked-up information and learning tasks spread over multiple episodes and activities, occasionally the learner needs to concentrate on one task for a lengthier period of time. In many cases, that information that could be delivered in smaller chunks eventually has to be synthesized and critically reflected on for new knowledge to be effectively constructed. How long the learner needs to spend interacting with the mobile device depends on many factors, but it could be as brief as merely looking up a date in a performance support event or a two-hour location-based biology scavenger hunt activity in a grade 5 science field trip. In case of training new skills, sustained practice, persistence, and engagement are also indispensable elements; hence, dedicated temporal and location prerequisites need to be worked into the design of learning. It is a fallacy, then, that mobile learning equates to squeezing short episodes of information lookup whenever and wherever the learner happens to be. Mobile learning, particularly formal m-learning, like any other approach to learning, requires rigorous planning, strategy, and careful instructional design underpinned by sound pedagogy and methodology. The following section offers an example of how one aspect of ubiquitous learning, namely contextual learning can be enhanced with elements of attentional strategies.

2.8.1 Contextual Mobile and Ubiquitous Learning—Harnessing the Context

The untethered context in which learners find themselves—a key unique feature of ubiquitous learning, can serve as an enabler and supporter of learning or a distractor that contributes to the learner's feeling of being lost in the avalanche of stimuli and overwhelmed by the noise of information. The context of learning contributes to the learning process and outcomes on more than one level. Mobile technologies can be leveraged to situate learning in specific meaningful settings "at this time, in this place" (Parsons, 2014, p. 219) to offer contextualized or situated learning. In the resulting location-dependent m-learning tasks, for instance, a science scavenger hunt, it is the information embedded in the environment that is an indispensable learning resource with which students have to interact in order to create new understanding. In location-independent learning events, on the other hand, the time and place of learning may be entirely flexible (e.g., reading or posting comments in an online discussion). However, the time, place, and the circumstance of the context are never inconsequential to the learning activity at hand. Can the learner benefit from listening to a Chinese language pronunciation podcast while in a noisy marketplace? Can she fully engage with her classmates' posts and formulate an insightful reply when the iPad she is using bombards her every two minutes with notifications of Facebook posts and work emails? Can the learner dictate his notes through the mobile phone recorder in the midst of a face-to-face lecture as he would while reading an article at home? The answers to these questions are multifaceted and go beyond what is appropriate and conducive to learning.

The world around us is "knowledgeable" and, if we are paying attention and engaging with the selected valid information, each moment can bring new input for learning. When mobile learners interact with the environment around them in an attentive manner, they can more effectively notice and process information.

Hoven and Palalas (2016) posit, in their discussion of Ecological Constructivism, "that *humans learn from both* perceiving, interpreting, reacting to and acting upon affordances in the environment, *as well as* using these same processes in learning from and through interactions with others, in mutually inter-dependent and co-creative ways" (pp. 126–127). The authors continue that perception is the first step the learner must take to act upon an affordance in the environment. The learner then becomes aware of the presence of the affordance—notices it (step 2). He or she can respond to it initially through senses, then emotionally, cognitively, socially, or spiritually.[2] When the learner becomes aware of some usefulness of the element in the context to learning (step 3: awareness), she or he can react to it by taking action (step 4), such as acting upon it, integrating it into their schema of knowledge of the world, or even ignoring it.

For the first step of perceiving to occur, one has to pay full attention and be ready to engage with the information offered by the location, people, and other sources, not excluding digital technology. While in pre-planned location-dependent learning episodes, learners can be directed and pointed to the source using QR codes, reminders, and questions, in more ad hoc learnable moments, when learners spontaneously reach for the support of their m-learning device, their learning can be scaffolded by reminders to pause, take a breath and notice or reflect on their prior knowledge (discussed in more detail later).

Mobile learners often use their devices to connect to the source of information (e.g., communicate with peers, listen to podcasts, look up the meaning of a word), to capture data for future reference (e.g., record a video of a procedure, take notes, snap a photo of rare species), as well as to share information, artifacts, and ideas (e.g., share, through Twitter, resources related to a lecture in which they are participating or comment on a research article in an online class discussion). Regardless of whether they use their devices for immediate feedback or delayed spaced learning, ubiquitous learners should be reminded by external (facilitators or built-in supports) and internal (attention and awareness skills) guidelines to create

[2]"Spiritually" refers here to "human responses at a deep level, when elements of the environment resonate with a person's beliefs, values, or experience and their *sense of being* in the environment. This is not based on any religious worldview (though it may be), but rather on their perception of who they are and their capacities, capabilities, responsibilities, and potential within the world around them, and in which they move, live, and learn. " (Hoven & Palalas, 2016, p. 124).

m-learning contexts conducive to learning. Context is "continually created by people in interaction with other people, with their surroundings and with everyday tools" (Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sánchez, & Giasemi, 2011, p. 159). This interaction has to connect learners' internal and external worlds as they intentionally and knowingly transition from their own sensory, emotional, cognitive, and spiritual reflexive spaces to the external world of communication and interaction with others and with information. Being able to connect with oneself, with others, and the surroundings in a meaningful way is one of many benefits observed in research on mindfulness in education as discussed next.

2.8.2 Mindfulness in Education

According to Morrison et al. (2014), "Mindfulness is a mental mode characterized by attention to present moment experience without conceptual elaboration or reactivity." Definitions vary, but essentially, mindfulness is about awareness and giving full attention to the present moment, on purpose, non-judgmentally (Kabat-Zinn, 1994). It means approaching each moment with openness and presence in a way that allows one to pay attention to what is unfolding both internally and in the environment. Wallace (2006) defines mindfulness as "attending continuously to a familiar object, without forgetfulness or distraction" (p. 13). Rechtschaffen (2014), when discussing mindful education, observes that "Mindfulness invites us back to the preciousness of the present moment" (p. 7). David and Sheth (2009), in her book on mindful teaching, concludes that mindfulness promotes a learning community "in which students flourish academically, emotionally, and socially (p. 1)."

Mindfulness falls under the umbrella of contemplative science—the study of the mind–brain connection through techniques such as art, dance, meditation, prayer, yoga, and walking in nature. The unifying goal of these contemplative practices is to develop awareness of present moment experience—to have one's mind present with one's body rather than in a future or past state (Miller, 2013). Contemplative practices, such as meditation and yoga, "train skills by placing some constraint or imposing some discipline on a normally unregulated mental or physical habit" (Davidson et al., 2012, p. 147) and effect psychological functions, such as attention and emotion regulation, which overtime alter neuronal processes and result in structural and functional changes in the brain displayed by measurable behavioral outcomes. Such contemplative teaching and learning practices may include deep listening, storytelling, dialogue, establishing a personal space, quieting the mind, centering, visualization, and many other techniques presented, for instance, in books by Barbezat and Bush (2014) as well as David and Sheth (2009).

Mindfulness is an essential practice for education as it "opens the mind and gives space for new understanding" (Barbezat & Bush, 2014, p. 98). Mindfulness can be cultivated through meditation, the practice of paying attention to the present moment, in combination with other self-regulation techniques. Meditative inquiry traditions, which stem from classical Eastern contemplative heritage, have made unique advances in the area of attentional development (Wallace, 2006) and how to adopt them into the twenty-first-century life. Attention and awareness are dynamic; therefore, one can develop them overtime through systematic practice (David & Sheth, 2009). One can cultivate the ability to remain focused, notice when the mind wanders, and refocus at will after an interruption or distraction. Attentional training methods based on meditation, for instance, are accessible to anybody and can benefit those who engage in them through regular drills, repetition, and habituation (Wallace, 2006, p. 4). While mindfulness is an ancient practice with roots in different philosophies and traditions, it has now been adopted globally and is a widely used contemplative exercise. Importantly for educators, it has been extensively researched and is backed by over two decades of empirical evidence with more pertinent scientific research emerging every day.

While mindfulness might be readily criticized, the science supporting it is quite persuasive. Individuals who engage in mindfulness practice demonstrate reduced anxiety and depression (Hofmann, Sawyer, Witt, & Oh, 2010; Hölzel et al., 2013), lower stress (Baer, 2003; Creswell et al., 2016), richer and more positive personal relationships (Carson, Carson, Gil, & Baucom, 2004; Coatsworth, Duncan, Greenberg, & Nix, 2010), and increased self-regulation (Tang et al., 2007). Most importantly, benefits of cultivating mindfulness also include improved attention skills (Becerra, Dandrade, & Harms, 2016; Jha, Krompinger, & Baime, 2007; Sedlmeier et al., 2012), adults' ability to regulate attention and executive function (mental operations that involve attentional and cognitive control, planning, and working memory), including "orienting attention and monitoring conflict (Jha, Krompinger, & Baime, 2007) and inhibiting emotionally charged but irrelevant information (Ortner, Kilner, & Zelazo, 2007)" (Davidson et al., 2012, p. 148). Recently, there has been a growing body of evidence that students who engage in mindfulness practice perform better academically, even in mathematics (Schonert-Reichl et al., 2015). David and Sheth (2009) compiled a list of ten key benefits of mindfulness for students, including the following: mindfulness promotes (1) readiness to learn, (2) academic performance, (3) attentions and concentration, (4) self-reflection and self-calming, (5) social and emotional learning, (6) pro-social behaviors and healthy relationships, (7) holistic well-being; it also (8) reduces anxiety before testing, (9) provides tools to reduce stress, and (10) improves participation by promoting impulse control (p. 9).

Research has, indeed, demonstrated that mindfulness practice can be transformative not only to our health and well-being but also to our educational system. Mindfulness practice can alter the function of the brain of the learner and actually help train the mind to, amongst other skills, pay attention in a selective and purposeful way, not get distracted by the abundance of information, and not fall victim to the problematic mobile device habits. Just like we can train our bodies through daily exercise in the gym or regular Tai Chi practice, we can train our minds to be aware and focused. Cultivating mindfulness by learning and practicing brief simple mental training techniques enhances both teaching and learning process and outcomes (David & Sheth, 2009). It is essential for learners to train their brain so it does not stray or strain.

2.8.3 Mindfulness Strategies in Mobile Learning

Regular mindfulness practice and techniques, incorporated directly into the m-learning design, can create more conducive learning environments by giving students tools for paying attention, self-regulation, learning how to learn and eliminate distractions. This section presents some key mindfulness techniques that have been scientifically proven to enhance learning across various educational contexts. Recommendations are offered on how to adopt them through mindfulness micro-moments conjoined into a larger process of mobile learner evolving into a more mindful learner.

2.8.3.1 Focusing Attention on Intention

Mindfulness is a practice of intentionally paying attention. While our attention might be pulled away from us, through our intention, we have a choice to cast it a specific direction. Where attention goes, neural firing occurs, and new connections can be made overtime shaping our brain (Siegel, 2007). Siegel (2007) observers, that "Intentions create an integrated state of priming, a gearing up of our neural system to be in the mode of that specific intention: we can be readying to receive, to sense, to focus, to behave in a certain manner" (p. 177). Intentions are rooted internally and in the now, yet they have long-term effects. They promote clarity, motivation, and more purposeful engagement. To briefly define the concept, *intention* is a mental, emotional, or attitudinal model that positions one's mind to hold a particular orientation; intention focuses attention (David & Sheth, 2009). Intentions have no expectations or evaluation attached to them. An intention can be a purpose or attitude the learner chose to actualize—a statement of how learners want to be, think, feel, engage in their learning or with others, e.g., "I want to be fully present," "I'm here to enjoy this learning activity," or "I want to complete this activity without feeling stressed or rushed."

Intentions can be incorporated into the learning design so that learners know why they are doing what they are doing and thus commit to bringing focused mind to the activity. With help of intentions, learners can uncover what motivates them, which in turn aids them in strategizing attention and applying purpose to the learning in which they are engaged. This also furthers learners' feelings of agency and ownership.

It is essential to differentiate intentions from learning goals which focus on future outcomes and expectations. Setting intentions can be achieved through simple messages prompting learners to formulate and type in their intentions or select from a list of those that learners have previously personalized, and even share their intentions with others to create gentle accountability to them. Such messages and notifications also serve as basic reminders for students to reflect, engage, and self-regulate. Another technique would be to culminate a learning event with reflection questions, as simple as "How did your intention work for you?" or, if the intention was to stay focused on the task at hand, "Did you check any messages or emails when you were listening to the podcast?". It is through such self-reflection that students may gradually evolve into self-regulated autonomous learners. Metacognitive skills of attention and intention are the building blocks of one's mindfulness practice.

2.8.3.2 Self-regulation through Self-awareness and Reflection

The relational nature of our mind (Siegel, 2007, 2016) should be also considered in the design of learning. Related to the concept of self-regulation, which is dependent on integration in the brain (Siegel, 2016), is the need for learners to both self-regulate and co-regulate their "emotions, thoughts, attention, behavior, and relationships" (p. 82). According to Siegel (2016), studies on mindfulness provide evidence that mindfulness training integrates the brain resulting in enhanced self-regulation. Consequently, regular mindfulness practice should be combined with m-learning scaffolds that promote understanding of learners' own individual needs and preferences as well as those of others in the context of collective learning. In view of that, the increasingly popular social emotional learning (SEL) approach, which has been shown to promote emotional regulation, social competency, resiliency as well as academic performance (Rechtschaffen, 2014), should be considered in m-learning solutions. SEL supports students in developing the following five competencies: self-awareness, self-management, social awareness, relationship skills, and responsible decision making (David & Sheth, 2009; Rechtschaffen, 2014).

Drawing from the review of contemplative educational practices presented by Barbezat and Bush (2014), self-awareness, self-monitoring, and other metacognitive strategies complement holistic student development and emotional regulation leading to intellectual and experiential gains. Another significant dimension of mindfulness practice is that of meta-awareness which involves monitoring of experience including "an *introspective*, inward turn of attention and a *background* awareness of features of experience outside the current focus of attention (Lutz, Jha, Dunne, & Saron, 2015, p. 640; *emphasis added*). On a macro-level, attention to the present moment, to preferred ways of learning, coupled with the awareness of the bigger educational landscape (including larger personal and collective goals) is crucial for meaningful well-managed learning. Hence, alongside regular mindfulness-cultivating practices, learners should be encouraged to reflect on their learning through journaling; notes to themselves; opportunities to rank their preferred methods of learning, communication, and resources; or tools to block sources of distraction that they identified as their barriers to focused learning (examples of such tools are listed below). Chunking information in such a way that allows students to sort, organize, and reflect on concepts and smaller bits of information can also help them observe what elements work best for them. Another strategy would be reading reflections when learners are asked to not only extract meaning form the reading but also evaluate the reading for its relevance to their own interests and needs. Similarly, assignment reflective evaluations could facilitate self-regulation by asking learners to consider the strategies they used for an assignment, its results, and their experience, before they reflect on what works for them and what might need adjustments. These are only a few examples of self-regulation tactics, which combined into a holistic solution, would overtime lead to heightened attention and self-regulation skills that contribute to the "attention literacy" skill set.

2.8.3.3 Meditation

The systematic mindfulness practice, referred to in the previous section, would ideally include regular meditation—the process of getting to know oneself, ones' emotions, thought patterns, and how we experience the world. Meditation is also defined as practice of intentionally paying attention to the present moment without judgment and taking control of one's mind (Kabat-Zinn, 1994). Richard Davidson (2012), based on the numerous studies he conducted on meditation and its effects on the brain and attention, observed that meditation strengthens the ability to focus. The practice of meditation has been recurrently proven to promote changes in brain activity and improve attentive and focus capacities, owing to the state of mind cultivated through the practice (Barbezat & Bush, 2014; Miller, 2013; Rechtschaffen, 2014). It increases gray matter in brain regions that handle attention, compassion, and empathy. It also alleviates a variety of medical conditions, strengthens the immune system, and improves psychological functioning (Hanson, 2009). All in all, meditation supports the development of mental, cognitive, and emotional skills that can lead to improved learning.

Numerous educational programs incorporate brief meditation practice in their design and have observed its positive effect on learning (Miller, 2013). Mobile learning solutions can easily draw on the many meditation mobile apps and online guided meditation sources available to anybody at a click of a button. Examples of meditation mobile apps identified by the author as appropriate for m-learning include Headspace[3] and Mediation Studio.[4] They offer a range of meditations and mindfulness breaks, ranging from two minutes to an hour. Learners can choose from awareness, anxiety, stress, performance, confidence, and many more focuses. These brief practices and breaks can be built into any mobile learning design. Customized guided mediations can also be designed by mindfulness practitioners for specific m-learning content and contexts. Focusing on one's breath is a good starting point for such meditation practice.

[3]Headspace is available at https://www.headspace.com/.

[4]Meditation Studio is available at http://www.meditationstudioapp.com/.

2.8.3.4 Breath Awareness

Awareness of the breath helps to focus attention on intention. Taking pause to be aware of one's breath and reflect inward prepares learners for intentional learning. Regular practice, for only 10 min a day, can promote the development of a self-observational ability (Siegel, 2007) that results in improved self-regulation. Breath can serve as the anchor whenever one gets distracted (Rechtschaffen, 2014; Siegel, 2007) and "returning awareness gently to the breath when attention has wandered strengthens the hub and initiates the reflexive capacity to become aware of awareness" (Siegel, 2007, p. 295). The awareness of breathing can bring us into the here-and-now and ground our experience (Miller, 2013).

In an m-learning context, mindful breathing can be used to stay centered and calm amid the distracting thoughts and feelings (Rechtschaffen, 2014). Pausing to take a breath or a short Take 5: Mindful Breathing exercise[5] can help to slow down, notice, and redirect the energy of the learner (David & Sheth, 2009). Breath awareness pauses can be incorporated into podcasts, readings, m-learning activities, and even assessments by means of audio or written reminders and guided mindfulness moments.

2.8.3.5 Mindful Language and Emotional Climate

It is imperative to create a safe learning environment, based on trust and stress-free emotional climate. Stress, threat, and fear can activate affective filters in the brain that hinder information processing, patterning, and memory circuits (Willis, 2006). This requires a combination of elements and strategies and can be fostered by attitudes and messages of support, gratitude, and compassion, constructive rather than destructive feedback, as well as mindful, respectful, and relational language. Such encouraging m-learning messages may be conveyed, for instance, through communications from facilitator containing words of encouragement and guidance on mindful strategies. When discussing attention, it is beneficial to use language that inspires students and points them toward self-discovery and the subsequent development of attention skills (Rechtschaffen, 2014). With many contemplative exercises being introduced through verbal instruction, clear guidance should be offered by using language that is familiar and transparent (Barbezat & Bush, 2014). It is recommended to keep it kind, simple and concise.

[5]Described in detail in Appendix 2 of David and Sheth's (2009) book amongst many other mindfulness activities for students and teachers.

2.8.3.6 Other Mindfulness Techniques

There are many other mindful learning strategies, discussion of which deserves a separate volume. For the sake of brevity, only some of them are summarized below.

- Incorporate a step to activate prior knowledge (Willis, 2006), connect to what has been done before, for instance, by way of mindful memory games, such as a two-minute concentration (word-matching) game at the start of a podcast to activate learners' prior knowledge of terms and concepts, and to promote attention practice.
- Promote students' readiness to learn and transition into a learning event by means of riddles and brief quizzes before embarking onto an activity (David & Sheth, 2009, p. 51).
- Remind the learner where they are in context-dependent activities and encouraged them to connect with the setting around them by using mindful seeing techniques, such as an observation technique described by David and Sheth (2009, p. 63), which also contributes to the improvement of short-term memory. Directions, guiding questions, and pointers can also be employed to support noticing and connecting to contextual affordances.
- Use "mindful moment" techniques to help learners shift their attention away from learning and toward other aspects of their present experience to calm and re-center their minds; for instance, introduce thirty seconds of silence in the middle of an activity; ask students to listen to ambient sound around them for 30 S, build in a one-minute clip of calming and inspiring music (David & Sheth, 2009).
- Prompt the learner to ensure that the conditions are conducive to learning. Reminders and directions to apply mindful listening, speaking, reading, and writing techniques[6] should be incorporated.
- Integrate music as it supports contemplative practice (Miller, 2013); well-selected music (e.g., soothing sounds and classical music) offers a calming effect as well as an opportunity to practice focus through the awareness of the sound (Barbezat & Bush, 2014). Music can also be used to inject an element of novelty and surprise (Willis, 2006).
- Incorporate tools that help block distracting sites and apps for a customized period of time and those that track and measure when the learner is doing meaningful work.

This is by no means a complete list but rather ideas to guide m-learning designers in the creation of solutions appropriate for their educational contexts. Examples of specific software and tools mentioned above are listed in the following section.

[6]Examples and explanations of these techniques are widely available on the Internet and can also be obtained by contacting the author.

2.8.4 Harnessing Learner's Attention—Tools

As already discussed in this chapter, attention is a skill that must be learned and practiced and it will evolve overtime. There is an array of tools that can be employed to help control the digital space and promote more on-task focus. The following are examples of such applications.

- http://www.teamviz.com/pricing-plan/ (TeamViz) and https://www.focusboosterapp.com/ (focus booster)—Focus on the task and divide it into manageable working intervals with short breaks in-between.
- https://freedom.to/ (Freedom)—Block distracting sites on the Internet, social media, and apps blocker.
- https://selfcontrolapp.com/ (SelfControl)—Block your own access to distracting websites, your mail servers, or anything else on the Internet; identify what your distraction triggers are.
- https://gottcode.org/focuswriter/ (FocusWriter)—Enjoy a distraction-free writing environment by utilizing a hide-away interface.
- http://antisocial.80pct.com/ (Anti-Social)—Target and block any distracting website to be more productive.
- http://www.one-tab.com/ (*One*Tab)—Use only one tab at a time when browsing, convert your tabs to a list for future reference.
- https://www.rescuetime.com/ (RescueTime)—Understand your daily habits so you can focus and be more productive. Obtain detailed reports and data based on your activity.
- Use apps like Twitter, Flipboard, Pulse, and Zite to save artifacts directly from the browser for future read or reference offline and to minimize destruction.
- Set the buzzer on your phone to remind you to take breaks.
- Track your own phone habits with apps like Checky (http://www.checkyapp.com/) and Momentum (https://inthemoment.io/).

These and similar applications promote the development of self-regulation and self-control skills. They may be used to support the practice of "attention literacy" on the way to becoming a mindful mobile learner.

2.9 Conclusion

Smartphones and other digital devices might be viewed as technologies used to control the flow of information and our social networks or technologies of escape that tap into our need for withdrawal into a personal space. Inherently, they are neither good nor bad; they are merely tools which, if used properly, can empower and help learn and, when misused, can lead to cognitive and emotional exhaustion and even addiction. They can be a gateway to the abundance of information that functions either as noise or as invaluable input for learning. They can be a source of distraction or, on the contrary, tools used to tame unhealthy habits of absent-mindedness and partial attention. Digital tools and online resources can be also utilized to train attention and teach mindfulness albeit without personal presence (Barbezat & Bush, 2014). As learners, we have the autonomy and choice to do the right thing. As m-learning designers, it is our responsibility to consider what attention promoting strategies to incorporate into the ubiquitous learning designs.

As demonstrated in this chapter, m-learning design can adopt simple attentional practices and mindfulness strategies that have been proven through scientific studies to support the metacognitive process of self-monitoring and self-regulation (Rechtschaffen, 2014). Mindfulness strategies, which bring about numerous other benefits for both teachers and students, can also help cultivate self-awareness and confidence, emotional intelligence and resilience in the face of stress rooted in a wide range of pressures to perform and produce in a fast-paced environment.

In conclusion, there might be nothing wrong with our minds wandering or our attention being diverted occasionally, provided that this does not turn into a habit of constant partial attention and digital interface hopping. Given the demonstrated influence of multitasking, hindered attention, and problematic dependence on digital devices, juxtaposed with the benefits of undistracted attention and mental training in learning, more interdisciplinary research should be conducted to discern what m-learning design practices can have impact on the development of "attention literacy" in ubiquitous learning. Methodologically rigorous explorations and evaluations of the intersection of mobile learning, education, instructional design, contemplative practices, cognitive science, and neuroscience may offer a clearer picture of how to harness attention in mobile and ubiquitous learning.

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Author Biography

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Chapter 3
An Analysis of Adult Language Learning in Informal Settings and the Role of Mobile Learning

Gráinne Conole and Pascual Pérez Paredes

Abstract Despite the emergence of Open Educational Resources (OER), the role of mobile learning, in general, and that of language processing technologies, in particular, has remained largely under-explored in the context of adult foreign language learning. This chapter sets out to bridge the gap between the possibilities offered by Information and Communication Technologies (ICTs) and the huge demand for ubiquitous personalised language learning opportunities. This chapter provides a state-of-the-art review of the use of mobile devices for non-formal learning and in particular adult language learning. It will consider the challenges and opportunities of recognition of learning achievements through open learning. The aim is to inform the debate concerning recognition of open learning and indicate the types of recognition practices in existence and the factors that influence them. Practices, attitudes and rationales for the types of recognition awarded are discussed, along with the factors that influence decisions and the contexts in which non-formal, open learning are recognised.

3.1 Introduction

This introduction sets the scene for the report in terms of key definitions. Learning can be classified into three main categories: formal learning, informal learning and non-formal learning. Formal learning is learning that occurs in an organised and structured context (e.g. in an education or training institution or on the job) and is explicitly designated as learning (in terms of objectives, time or resources). Formal learning is intentional from the learner's point of view. It typically leads to validation and certification. In contrast, informal learning is learning resulting from daily activities related to work, family or leisure. It is not organised or structured in

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_3

terms of objectives, time or learning support. Formal learning is the most socially recognised form entrusted to official institutions with structure learning objectives, a prescribed timeframe and associated support. It is intentional on the learner's part and leads to certification. Informal learning is mostly unintentional from the learner's perspective. Informal learning corresponds to everyday life, i.e. activities whose main objective is not educational. It is not structured, and it is non-intentional and does not lead to certification. Finally, non-formal learning is learning which is embedded in planned activities not always explicitly designated as learning (in terms of learning objectives, learning time or learning support), but which contain an important learning element. Non-formal learning is intentional from the learner's point of view. In particular, adult non-formal learning refers to the self-directed intentional learning that takes place in people's leisure time outside of both the workplace and the curriculum of formal learning activities. Non-formal learning is offered by many types of organisations not officially recognised as learning institutions and does not lead to certification. Self-directed informal learning is not completely divorced from the non-formal learning that takes place in adult education provision. Any formal or non-formal learning episode may have informal attributes or qualities because it will help to advance the self-directed informal learning goals of the individual learner.

Accreditation is a process by which an officially approved body, on the basis of assessment of learning outcomes and/or competences according to different purposes and methods, awards qualifications (certificates, diplomas or titles) or grants equivalences, credit units or exemptions, or issues documents such as portfolios of competences. In some cases, the term accreditation applies to the evaluation of the quality of an institution or a programme as a whole. (UNESCO 2012). In contrast, credentialisation is the award of academic credentials of any sort, by an academic institution, usually on the basis of completed assessment.

Related to these terms is the term competences, which indicate a satisfactory state of knowledge, skills and attitudes and the ability to apply them in a variety of situations. (UNESCO 2012). A qualification is an official record (certificate, diploma and degree) of learning achievement, which recognises the results of all forms of learning, including the satisfactory performance of a set of related tasks. It can also be a condition that must be met or complied with for an individual to enter or progress in an occupation and/or for further learning. (UNESCO 2012). Validation is the confirmation by an officially approved body that learning outcomes or competences acquired by an individual have been assessed against reference points or standards through pre-defined assessment methodologies (UNESCO 2012)

Finally, recognition of learning is a process of granting official status to learning outcomes and/or competences, which can lead to the acknowledgement of their value in society (UNESCO 2012).

Learning outcomes are the set of knowledge, skills and/or competences an individual has acquired and/or is able to demonstrate after completion of a learning process. (CEDEFOP, 2009, from the definition of learning outcomes) Learning achievements are similar to learning outcomes, but normally self-initiated by the learner, not pre-defined by a set curriculum.

The term ‘open learning’ is used in a slightly different sense from ‘open education’ in this report. Where ‘open learning’ is used, there is an implication that the learner has agency (or is the implied subject of the sentence), whereas ‘open education’ is used when providers are the stated or implied agents. The rationale here is that it sounds awkward to talk about ‘providers of open *learning*’, just as it sounds awkward to refer to the ‘recognition of open *education* achievements’ on the part of learners.

Open educational resources and open educational practices have their antecedents in many areas: the drive towards open sharing of creative works and software through Creative Commons and free- and shareware, the growth of digital repositories for teachers to share their materials under open licences, and the policies of research funding bodies, such as the Research Councils in the UK, for open access to data outputs and the subsequent provision of data services to enable these. Similarly many institutions have found popular success through making lectures available via social media channels such as YouTube and iTunes.

In particular, the growth and popularity of Massive Open Online Courses (MOOCs) has generated a great deal of publicity in recent years. Because of the proliferation and high profile of MOOCs, this form of open education is mentioned extensively in the report.

A recent report by the UK Department for Business Innovation and Skills (2013) observed that the development of massive open online courses (MOOCs) in the Higher Education (HE) sector is reaching a point of maturity, where ‘after a phase of broad experimentation … MOOCs are heading to become a significant and possibly a standard element of credentialed University education’ (Ibid., p. 5). According to the report, although credit for completion has not been a major motivation for learners up to this point, ‘there are clear signs that this will change’ (Ibid., 5), and there is an increasing demand for the HE sector to provide ‘flexible pathways to learning and accessible affordable learning’ (Ibid., p. 6).

In order for MOOCs, and more broadly, learning through open educational approaches, to have a meaningful impact on learners and society in general, mechanisms therefore need to be developed for learners to obtain formal recognition for their learning achievements. The option to gain this recognition will allow those learners for whom open online is not just a hobby or leisure activity to reap the benefits of their efforts. Formal recognition of non-formal, open learning can fast-track learners through traditional education programmes and enables them to demonstrate their skills and knowledge to employers. The same UK report quotes from Nathan Harden, a US-based journalist specialising in higher education, who predicts that open education will supplant traditional universities by offering education at lower costs, and that devices such as ‘certificates of mastery’ will enable greater flexibility in HE, with employers recruiting based on these certificates (Department for Business Innovation and Skills 2013, p. 61).

There are three main routes for recognition of non-formal, open learning:

1. Universities may provide exemption from a course/module upon receiving evidence of successful completion of a MOOC. Following the traditional model

for transfer of credits, this route would only be possible if the MOOC provider was itself accredited (by the relevant national body), the content and bibliography were made available, there was an examination in a physical examination centre, and the learner's identity was validated. Many subject domains also do not recognise awards of fewer than 5 ECTS credits.
2. If the above conditions are not met, a university may agree to exempt a student from attendance on a course, but require the student to take an examination. (In this case, it is the exempting university providing the examination, not the MOOC provider.)
3. There is a form of Continuing Professional Development (CPD) available to members of occupational groups in the Netherlands in which learners can be awarded 'Permanent Credits' on the basis of a certain number of hours' or days' attendance at job-related training courses.[i] In these instances, MOOC providers would only need to estimate the notional training hours the MOOC is equivalent to.

The OpenCred project developed a framework for analysing the recognition of open learning was developed comprising the following four domains:

1. Formality of recognition.
2. Robustness of assessment.
3. Affordability for learner.
4. Eligibility for assessment/recognition.

The framework can be used to make comparisons between open recognition initiatives by ascribing a numerical value for each domain. Once the values for any given initiative have been determined, a diamond-shaped graph can be produced providing a visual overview of the recognition model for that initiative, with formality of recognition, robustness of assessment, affordability of assessment for learners and eligibility for assessment at each of the four points.

The potential of MOOCs as a means to promote accessibility and affordability for all is constrained by the problem of providing high value for low cost. Formal qualifications require robust assessment; otherwise, the value of the qualifications is undermined. In the majority of cases observed, the two are intrinsically linked. Robust assessment requires tutor intervention to assess in-depth learning, as (to date anyway) automated assessment can only judge superficial learning. Tutors cost money, but the ideal of open education is that it is free, and therefore robust assessment does not appear to fit neatly within current business models for MOOCs or open education in general. As a consequence, institutions choose to either (a) pass on the cost to learners, or (b) offer assessment and recognition for free only to students enrolled on their own programmes.

There is a cap on the formality of recognition that is awarded for open learning. Even the highest forms of recognition from amongst our examples were limited to a small number of ECTS credits, or only partial contribution to a formal qualification, in the form of exemption from modules or exams. No-one can yet acquire a diploma or generally accepted certificate from open learning alone. Organisations such as the OERu[1] are aiming to change that; however, these are both in the early stages and so there are no examples yet of learners having achieved an entire qualification via open learning.

Through a series of interviews with key stakeholders, the OpenCred project found that there are a number of perceptions held by different stakeholders in open education that have a direct impact on the sector's ability to provide recognition for open learning.

One commonly voiced perception is that online education is still seen as a second-rate form of education, with learners and teachers reporting that online courses will be taken less seriously by employers and other educational institutions. A recent Pearson report[ii] on faculty attitude to IT echoes this. The aspect of online learning that generates the greatest concern when it comes to recognition is assessment. Concerns over validation of the identity of the authors of submitted work are stronger if the student is on an online course than on a face-to-face course, and online proctoring is seen by some as a lesser form of validation than an examination in a physical location.

A second perception is that the value of ECTS credits as a currency is sometimes questioned. In some cases, particularly in the UK, highly robust assessment is provided for open learning, but this does not lead to ECTS credits as would be expected. Some anecdotal evidence was also gathered to indicate that even in countries where ECTS credits are widely accepted, their value might be questioned in the context of open, online learning.

A further perception regards the value of badges. From the evidence gathered in this research, it appears that badges do increase learners' motivation in many instances

For open education to lead to social and economic mobility, it needs to be free and allow anyone to access it, while also leading to generally recognised qualifications. That is, it needs to score highly on all four of the framework categories. However, it may be that there is no single model that fits all and that each type discovered here (and new ones that may arise) will enable educational institutions to more effectively identify what shape of open education they are aiming to develop, and from whose experience they can most usefully draw. One option for institutions to consider would be to offer learners the choice between bearing the cost of assessment themselves and enrolling in a mainstream programme. That would potentially widen the audience of open learners applying for recognition.

Greater clarity of information is needed regarding exactly what the MOOC or open learning initiative is offering learners, and what will be required in terms of fees and assessment commitments, should they wish to obtain recognition. Sample certificates are also very helpful in illustrating exactly what credential learners will receive. To be easily recognised by other institutions or employers, the certificates themselves also need to contain detailed information on the nature of the course and the nature of the assessment process.

[1]http://oeru.org/.

3.2 Mobile Learning

Smart phones and tablets are now practically ubiquitous, and we have practically near ubiquitous Wi-fi connectivity. They are now much more affordable, robust, light and with a good battery life. There is a range of excellent Apps available to support communication, productivity, curation and learning. The positive aspects of these mobile devices are that they mean learning anywhere, anytime is now a reality, more and more websites are mobile ready, learning is possible across contexts and devices. The negative aspects are that being online all the time means that there is no ‘down time’; people are expected to be online 24/7. We are increasingly dependent on these devices and more and more of our data is stored in the cloud.[2] Finally, many learners and teachers lack the necessary digital literacy skills to make effective use of these devices for learning purposes.

The field of mobile learning research has matured since its nascent beginnings, and now there are numerous sub-fields: seamless learning, cross-contextual learning,[3] BYOD in the classroom, field-trip learning, ubiquitous learning, wearable learning, evaluation of learning on the move, and mobile devices for data capture to name just a few.

The first generation of mobile devices emerged in the mid-nineties, with the promise of enabling learning anywhere, anytime (Sharples, Corlett, & Westmancott, 2002). Mobile devices have advanced significantly since this time, nonetheless it is worth referring back to Kukulska-Hulme and Traxler’s (2005) statement of the nature of the initial generation of mobile devices:

> What is new in ‘mobile learning’ comes from the possibilities opened up by portable, lightweight devices that are sometimes small enough to fit in a pocket or in the palm of one’s hand. Typical examples are mobile phones (also called cellphones or handphones), smartphones, palmtops and handheld computers (Personal Digital Assistant or PDAs), Tablet PCs, laptop computers and personal media players can also fall within its scope.

Sharples and Pea (2014) provide a useful summary of the key developments in mobile learning; starting with the vision for the creation of *Dynabooks* in the early seventies. They described a number of key mobile learning projects, which explored learning across different learning contexts (informal and formal), different devices, and different locations. They list Wong and Looi’s (2011) ten characteristics of mobile-assisted seamless learning:

- Encompassing formal and informal learning.
- Encompassing personalised and social learning.
- Across time.
- Across locations.
- Ubiquitous access to learning resources.
- Encompassing physical and digital objects.

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[2]See http://e4innovation.com/?p=893.

[3]See http://e4innovation.com/?p=879.

- Combined use of multiple device types.
- Seamless switching between multiple learning tasks.
- Knowledge synthesis.
- Encompassing multiple pedagogical or learning activity models.

Sharples and Pea argue that the teacher's role is still crucial, but that they are more of a learning facilitator, rather than content provider. The projects they describe indicate that with mobile devices it is possible:

> To connect learning in and out of the classroom using mobile devices to orchestrate the learning, deliver contextually relevant resources and exploit mobile devices as inquiry toolkits.

They conclude by stating:

> Mobile learning takes for granted that learners are continually on the move. We learn across space, taking ideas and learning resources gained in one location and applying them in another, with multiple purposes, multiple facets of identity. We learn across time, by revisiting knowledge that was gained from earlier in a different learning context. We move from topic to topic, managing a range of personal learning projects, rather than following a single curriculum. We also move in and out of engagement with technology, for example as we enter and leave phone coverage.

Bird[4] undertook an evaluation of the use of iPads by Medical students at Leicester University. Overall the students were very positive about the use of their iPads, stating they were convenient, efficient, useful and easy to use. Bird lists the follow as examples of how the students were using the mobile devices for learning:

- To annotate and organised notes.
- For group work and development.
- Memorising key concepts, through student generated flashcards and quizzes.
- For handwriting and drawing.

With the increase in access to information and production of knowledge, mobile learning is challenging traditional educational institutions and associated authorities. It provides the opportunity to shift away from teacher-centred pedagogies to an increased focus on learning and the learner, through concepts like the flipped classroom. Because mobile devices enable learning anywhere, anytime and because they can be personalised they are ideally suited to informal and contextual learning. Learning across formal and informal contexts means that there is a blurring of the boundaries between learning and work.

[4] http://www.slideshare.net/tbirdcymru/building-a-digital-platform-ipads-in-undergraduate-medicine.

An EDUCAUSE report argues that microlearning encourages learners to focus on discrete chunks of content and learning activities.[5] Fastcodesign[6] argues that there are ten ways in which mobile learning will revolutionise education:

- Continuous learning: learning is increasingly getting interspersed with our daily lives through the use of mobile devices and near ubiquitous access to the Internet.
- Educational leapfrogging: low-cost mobile devices are particularly important in developing countries.
- A new crop of older, lifelong learners: often referred to as the silver surfers, are increasingly getting into using mobile devices, often motivated by a desire to keep in touch with their children and grandchildren via social media.
- Breaking gender barriers: in parts of the world where woman are not allowed access to formal education, mobile devices provide them with a means to access high-quality resources and to communicate with peers.
- A new literacy is emerging: there are now numerous companies (such as Codeacademy) that teach people via interactive lessons to write software programmes.
- Education's long tail: The vast array of resources to support many different subjects means that mobile devices enable learners to study niche subjects.
- Teachers and pupils trade roles: Learning and teaching become a two-way process, where teachers can learn from the learners and vice versa.
- Synergies with mobile banking and mobile health: A lot can be learnt from the way in which mobile banking and health have developed, such as using text messaging to deliver short lessons, and give teacher feedback and grades.
- New opportunities for traditional educational institutions: Mobile learning can potentially complement and extend traditional educational offerings. We are seeing a disaggregation of formal education. Increasingly rather than signing up for a full course, learners may instead choose to pay for components, such as access to high-quality resources, pedagogically informed learning pathways, support from tutors or peers, and accreditation.
- A revolution leading to customised education: Mobile learning is not just about digitising existing content, it is about harnessing the power of social media and embracing open practices.

Te@chthought[7] lists the following 12 principles of mobile learning:

- Access: in terms of access to content, peers, experts, and resources.
- Metrics: increasing there are metrics associated with how we are using mobile devices, which can be used to inform and improve the way we learn.

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[5]http://www.educause.edu/library/resources/7-things-you-should-read-about-microlearning-mobile-and-flipped-contexts.

[6]http://www.fastcodesign.com/1669896/10-ways-that-mobile-learning-will-revolutionize-education.

[7]http://www.teachthought.com/technology/12-principles-of-mobile-learning/.

- Cloud computing: means that we can access information anywhere, via any device.
- Transparent: transparency is a by-product of connectivity, mobility and collaboration.
- Play is a key characteristic of authentic, progressive learning. In a mobile learning environment, learners encounter a dynamic and often unplanned set of data, domains and collaborations.
- Asynchronous: enabling a learning experience that is personalised, just in time and reflective.
- Self-actuated: where learners plan how and what they learn, facilitated by teachers, who are the experts in terms of the resources and assessment.
- Diverse: learning environments are constantly changing, enabling learners to encounter a stream of new ideas, unexpected challenges, and constant opportunities for revision and application of thinking.
- Curation: there are now a wealth of Apps to support curation so that individual learners can group and share useful resources.
- Blending: Across the physical and digital space and across different devices, supporting both formal and informal learning.
- Always-on: Always-on learning is self-actuated, spontaneous, iterative and recursive.
- Authentic: enabling situative and personalised learning.

So it would appear that mobile learning has finally come of age, it will be interesting to see how the use of mobile devices learning and teaching develops in the coming years.

3.3 The Role of Mobile Learning in Adult Language Learning

This section considers the role of mobile learning in adult language learning. It examines the current landscape of adult non-formal learning using digital technologies. It describes how adult is using technologies for non-formal learning and reviews the associated tools, resources and services used to support this. The intention is to develop a shared understanding of the ways in which digital technologies are used for adult non-formal learning and how this could be enhanced to transform adult non-formal learning in the future.

Mobile learning as a research field has expanded in the last ten years or so, particularly in light of the emergence of smart phones, mobile devices and e-books. Work in the field has shown how mobile technology can offer new opportunities for learning that extends beyond the traditional teacher-led classroom. Mobile learning is not just about learning using portable devices, but also about learning across contexts.

The meaning of the term mobility (See Traxler in Bachmair 2010, pp. 103–113) in as in mobile learning or more specifically mobile-assisted language learning has evolved over time. Mobility often refers to the mobile device, technology, system or access via a portable, handheld, personal electronic device often connected to the network, enabling anywhere, anytime access to data, ICT tools and web 2.0 applications. Mobility also refers to time and place. Sharples (2006) defines m-learning as:

> The processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies.

The key characteristics of mobile learning include:

- Enables knowledge building by learners in different contexts.
- Enables learners to construct understandings.
- Mobile technology often changes the pattern of learning/work activity.
- The context of mobile learning is about more than time and space.

Mobile learning can be motivational in a number of respects: it can facilitate personal control, it invites ownership it can be fun, it can promote communication, it can enable learning in context, and it can provide continuity between contexts.

Adult non-formal learning is important in a number of respects. Firstly, it is an important and valuable part of an individual's learning journey. Secondly, it can help us respond to the challenges of a changing society. Thirdly, it can support both individual happiness and motivation and well-being and social cohesion and inclusion. For these reasons, it deserves substantial attention from adult educational practitioners, researchers, policy makers, those involved in the technology industry and the adult learners themselves. Indeed there is growing policy interest in adult non-formal learning.

A recent report (Hague & Logan, 2009) identified the following from a survey on adult non-formal learning:

- Adult non-formal learning is extensive, with 94% of adults having engaged in some form of non-formal learning activities over the previous three months.
- 79% of adults say they use technology for learning in their leisure time and adults use technology for this purpose for an average of eight and a half hours a week.
- 96% of those who use technologies to learn in their leisure time do so at home.
- Adults use a wide variety of technologies to learn, with the Internet, TV, DVDs and videos being the most common.
- 75% of adults were able to cite at least one benefit of using technologies for non-formal learning, whilst 23% were unable to cite any benefits.
- 47% of respondents did not think that there were any factors preventing them from using technologies to learn informally, whilst 44% cited at least one barrier.

Promoting adult informal and non-formal learning is important as a means to respond to the many changes and challenges facing society today. These include:

operating in an uncertain economic climate, adapting to globalisation and climate change, working in a context of rapid technological change, moving from an industrial to an information or knowledge-based economy, and dealing with increasingly complex career patterns. These factors will mean that there is an increase in the number of learners in the future and these learners have changing learning priorities. Adult learning can enable people to find meaning and purpose in periods of unemployment and in post-employment. It can give them transferable skills to help them make career changes. Finally, it can provide a way to share knowledge and experience between generations. Adult informal and non-formal learning enable learners to set their own learning goals, in a way that is personally meaningful within their own lives and contexts.

Digital technology can facilitate adult learning in a number of ways:

- It can provide access to information about a wide range of learning opportunities.
- It can inspire interest in a particular subject.
- It can provide opportunities and resources for adult learner to continue learning after they have finished a particular formal course, leading to lifelong learning.
- It can widen accessibility to learning by offering alternative pedagogical approaches.
- It can open up interaction and collaboration between adult learners in dispersed geographical locations.
- It can transform the way people learn by allowing innovative and collaborative learning practices.
- It can provide opportunities for adults to reflect on their learning.
- It can increase the options and resources available to adult education providers.
- It can help to engage the adult learners of the future.
- It can allow adults to engage in learning which suits their learning needs and takes place at their own pace.
- It can offer a convenient, flexible and engaging learning medium.

Technologies can be used to make connections more visible between non-formal learning and the informal self-directed learning that takes place at home or in locations outside adult educational settings. They can also be used to support learners in their learning journey and make them more away of it. Finally, they can be used as a learning medium and deliver mechanism for adult education provision.

However, it is important to note that the benefits of using technology for learning are not determiner by the technology itself, but derive from the manner in which the technology is used, the opportunities the technology offers for the development of new learning practice, and the context within which learning takes place. One of the challenges with using technology for learning is to consider how they can be used to facilitate a deeper sense of learning, which does not rely simply on the transmission of information. The focus needs to be on using them in new and transformative ways to construct not only digital tools and texts, but also to facilitate the collaborative constitution of meaning and the acquisition of new and changed knowledge and attitudes.

Mobile-assisted language learning is the learning of a foreign language with the assistance of mobile devices and is a relatively new research area (Vavoula & Sharples, 2008).

In a study on the use of mobile devices for language learning, Chen observed the following findings (Chen, 2013). Simply providing the students with a mobile device did not result in its effect use in language learning. He concluded that learners need to be properly guided both technically and methodologically. Some students may lack the necessary knowledge and experience to enable them to solve problems in the process of adopting new technologies. Instructional guidance on how the mobile technology can be better use for language learning in terms of activity design and collaboration is important. He did however find that students' attitudes towards the usability, effectiveness and satisfaction of mobile devices as tools for Mobile-assisted language learning were quite positive. He concluded that mobile devices are ideal tools to foster learner autonomy and ubiquitous learning in informal settings, provided that their technological affordances are clearly articulated to the students.

3.4 Conclusion

The report has provided an up to date state-of-the-art review of the use of mobile devices for adult non-formal learning for language acquisition. Key terms were defined, and the broad literature on mobile learning and in particular language acquisition was described. It is clear that adult non-formal learning is increasingly important in today's complex society. New mobile devices, along with near ubiquitous connectivity, means the learning anywhere, anytime is now a reality.

Notes

i. Similar CPD requirements were found in cases in other EU Member States (for example in Italy, where the government established a framework for validation of vocational competences in 2001 (Cedefop 2007). Within this framework, teacher trainers who have five years of experience can apply for University of Rome training credits by making a personal statement based on their work experience as trainers. Examples from the UK (Scottish Borders College and ACCA) are discussed as case studies in Section 4).

ii. https://commission.fiu.edu/helpful-documents/online-education/12-ihe-survey-faculty-attitudes-on-technology-2013.pdf.

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Chapter 4
Opening Real Doors: Strategies for Using Mobile Augmented Reality to Create Inclusive Distance Education for Learners with Different-Abilities

Amy Tesolin and Avgoustos Tsinakos

Abstract Technological developments of recent years can provide the ability to use innovative techniques and tools in education. One of these useful tools is mobile augmented reality, a technology that enables users to enrich the real world with virtual content using mobile computing. Learners with different-abilities (or learner with disabilities) are a growing and significant demographic globally, yet distance education has failed to address their specific needs to create a fully inclusive experience in education. Mobile augmented reality (MAR) and its distinct characteristics provide an opportunity to remedy this situation. This chapter will present three strategies for eliminating systemic barriers in distance education through the added value of MAR. The chapter concludes by summarizing and contextualizing the research, describing the current limitations, gaps in research and exploring key areas for future studies so that MAR technology can reach its full potential for inclusiveness in distance education.

Keywords Mobile augmented reality (MAR) · Disability · Distance education
Attention deficit hyperactive disorder (ADHD) · Augmented reality (AR)
Autism spectrum disorder · Inclusion · Intellectual disability (ID)
Learning disability (LD) · Mobile augmented reality (MAR)
People with different-abilities

4.1 Introduction

People with different-abilities are 15% of the global population (World Health Organization, 2014). Also labeled "people with disabilities," they represent the world's largest marginalized group, necessitating that distance education addresses

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_4

their needs. Students with different-abilities are more likely to drop out of school than any other vulnerable group (Global Partnership for Education, 2012). Can mobile augmented reality (MAR) used in distance education help this global problem?

Unfortunately, people with different-abilities are the least considered in the context of distance education (Kinash, Crichton, & Kim-Rupnov, 2004). This is despite the fact that some of the first beneficiaries of distance education were people with different-abilities because it gave them options in terms of when and where to learn (Valore & Diehl, 1987). In addition to the flexibility that distance education offers for location and time, students with different-abilities have the potential to benefit from increased accessibility through technology, increased interaction and structured learning around preferences to build independence and self-confidence (Erickson & Larwin, 2016).

As new technologies emerge and are used in distance education, many barriers can also emerge for learners. For example, online courses that rely on Web sites that do not conform to the Website Content Accessibility Guidelines (WCAG) 2.0 severely reduce options for students with different-abilities (Seale, 2013). Many technologies can do the opposite, to remove barriers and act as a bridge to enhance the learning experiences for all students and specifically students with different-abilities.

Augmented reality (AR) technology is potentially transformational for students with disabilities in distance education by aligning virtual and real objects in a real setting and creating opportunities for people to work interactively in real time. The global rise in use of mobile devices has led to mobile augmented reality (MAR) learning—a subset of mobile and ubiquitous learning that is the focus of this chapter (Nincarean, Ali, Halim, & Rahman, 2013). MAR learning, with its increased accessibility and affordability, is well positioned to address some of the systemic barriers for students with different-abilities all over the world, especially those for whom poverty is also a barrier.

After analyzing the existing literature to identify systemic barriers in distance education and the uses of MAR in education, this chapter presents three strategies for how MAR can be used specifically to remove these barriers and create an inclusive distance education.

4.2 The Approach

In constructing this chapter, a number of papers were reviewed to determine the existing systemic barriers in distance education for learners with different-abilities and then another set of papers were reviewed to identify the best uses of MAR in education. The purpose of this approach was to ascertain whether the successful educational MAR uses could address these identified barriers. All publications older than 29 were excluded to ensure the relevancy with respect to MAR learning.

The results and references to papers appear in Tables 4.1 and 4.2. The researchers inductively identified eight barrier categories in distance education

Table 4.1 Barriers in distance education

Inductive themes for barriers in DE	Identified barriers in DE	Authors	Research methodology
Stereotypes: internal and external	– Invisibility of disability	Tandy and Meacham (2009)	Literature review
	– Non-visibly impaired learners have negative attitude about requesting accommodations	Barnard-Brak and Sulak (2010)	Online survey
	– Learners with disabilities have negative perception on ability to succeed	Roberts, Crittendon and Crittendon (2011)	Survey
	– Reluctance to disclose	Moorefield-Lang, Copeland and Haynes (2016)	Literature review
Lack of infrastructure	– Lack of infrastructure – Politics	Mikolajewska and Mikolajewski (2011)	Literature review
	– Lack of infrastructure; access to Internet (digital divide)	Fatma (2013)	Literature review
	– Infrastructure	Nti (2015)	Literature review
Inaccessible education platforms, Web sites and resources	– Inaccessibility of course management system (CMS) and Web sites	Fichten et al. (2009)	Online survey
	– Text-based material inaccessible	Tandy and Meacham (2009)	Literature review
	– Education relies heavily on text presentation	Jelfs and Richardson (2010)	Online and postal surveys of post-secondary students
	– Different accessibility issues based on different impairments – Resources inaccessible – Inaccessible Web sites	Lazar and Jaegar (2011)	Literature review
	– Inaccessible courses – Lack of structure	Mikolajewska and Mikolajewski (2011)	Literature review
	– Inaccessibility of platforms and resources (especially with AT—screen readers)	Massengale and Vasquez III (2016)	Course evaluation by WAVE accessibility analysis

(continued)

Table 4.1 (continued)

Inductive themes for barriers in DE	Identified barriers in DE	Authors	Research methodology
Lack of qualified educators/training	– Educators unaware of accessibility issues – Lack of training in educators	Tandy and Meacham (2009)	Literature review
	– Accessibility issues aren't considered by educators	Lazar and Jaegar (2011)	Literature review
	– Lack of qualified educators in accessibility	Mikolajewska and Mikolajewski (2011)	Literature review
	– Educators lack knowledge of accessibility	Rice and Carter (2015)	Semi-structured interviews
	– Lack of knowledge of accessibility in educators; design of courses	Moorefield-Lang et al. (2016)	Literature review
Lack of interaction	– Communication cognitively demanding	Tandy and Meacham (2009)	Literature review
	– Lack of interaction; disconnection with peers and instructors	Moorefield-Lang et al. (2016)	Literature review
ESL barrier	– ESL barriers in India	Fatma (2013)	Literature review
	– ESL barriers in developing countries	Nti (2015)	Literature review
Technology-challenged learners	– Technology challenges	Fatma (2013)	Literature review
	– Technology challenges	Nti (2015)	Literature review

(stereotypes: internal and external, lack of infrastructure, inaccessible platforms, Web sites and resources, lack of qualified educators (accessibility), lack of interaction, ESL and technological challenges (Table 4.1). Seven successful approaches were also inductively categorized for MAR in education (multimodal, motivation, authentic learning, conceptualization, collaboration, interaction and autonomy) (Table 4.2).

4.3 Discussion

Barriers are described by the IMS Global Learning Consortium (24) as the "product of mismatch between the needs of the learner and the education offered" (Sect. 2) as cited by Jane Seale (2013). Taking a critical approach and working within the social model of disability, this chapter looks to remove or reduce these identified barriers (Table 4.1) to match the needs of learners with different-abilities.

Table 4.2 MAR uses in distance education

Inductive themes for MAR uses in DE	MAR uses in DE	Authors
Multimodal	– Multimodal possibilities	Bacca, Baldiris, Fabregat, Graf and Kinshuk (2014)
	– Multiple representations of information	Radu (2014)
Motivation	– Student engagement	Dunleavy, Dede and Mitchell (2009)
	– Motivate learners	Yuen, Yaoyuneyong and Johnson (2011)
	– Engaging students	Antonioli, Blake and Sparks (2014)
	– Motivation	Bacca et al. (2014)
Authentic learning	– Authentic learning	Yuen et al. (2011)
	– Portability, ubiquity, flexibility – Real-life settings	Wu, Lee, Chang and Liang (2013)
	– Hands-on laboratory skills	Akçayir, Akçayir, Pektas and Ocak (2016)
Conceptualize	– Conceptualize	Yuen et al. (2011)
	– Conceptualize	Aziz et al. (2012)
	– Conceptualize	Wu et al. (2013)
	– Deeper understanding of concepts	Antonioli et al. (2014)
	– Learning gains	Bacca et al. (2014)
	– Conceptualization	Radu (2014)
Collaborations	– Collaboration	Dunleavy et al. (2009)
	– Enhance collaboration	Yuen et al. (2011)
	– Collaborations	Antonioli et al. (2014)
	– Collaboration	Bacca et al. (2014)
	– Collaboration	Radu (2014)
Interactions	– Interactive	Aziz et al. (2012)
	– Interaction	Bacca et al. (2014)
	– Increase interactions for constructions of knowledge	Chang et al. (2014)
	– Interaction	Radu (2014)
Autonomy	– Autonomy	Yuen et al. (2011)
	– Autonomy	Aziz et al. (2012)

Figure 4.1 illustrates the ways that the educational advantages of mobile augmented reality (Table 4.2) align to reduce the systemic barriers in distance education.

The educational advantages of multimodal presentations hope to reduce the inaccessibility of educational platforms, Web sites and resources in distance education by increasing multimodal learning opportunities. Similarly, lack of

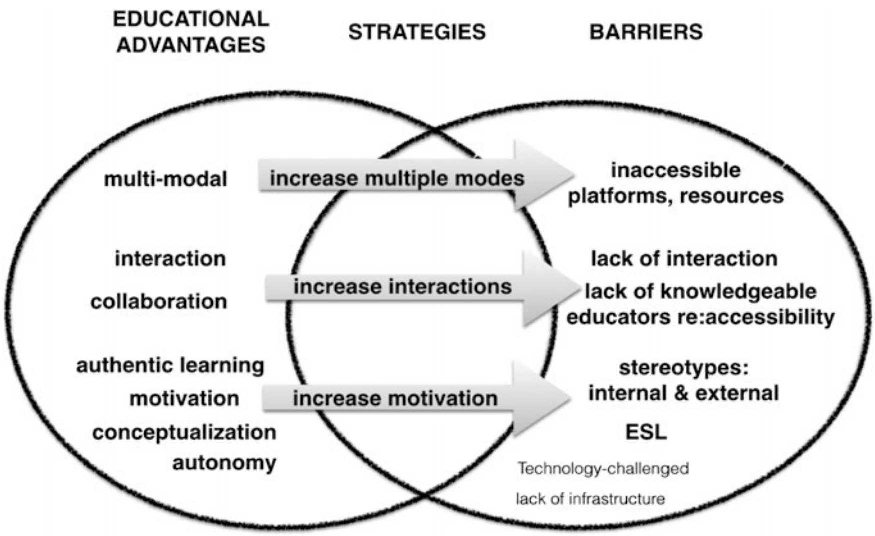

Fig. 4.1 Strategies for reducing barriers using MAR

interaction, lack of knowledgeable educators regarding accessibility and stereotypes and stigmas by both peers and instructors might be eliminated by increased collaboration, and more generally by increased interactions. Finally, internalized stereotypes of learners with different-abilities and ESL barriers found in the majority of the world are reduced by increasing motivation through authentic learning experiences, engaging learners and by deepening a student's understanding of concepts.

Two of the barriers found in many parts of the world and listed in Fig. 4.1 are lack of infrastructure and learners challenged by technology. These two can be addressed by the inherent ubiquity and flexibility of MAR where AR is accessed through mobile devices such as smart phones and tablets. Youth in the majority of the world are acquiring mobile devices at an ever-increasing rate (Moreira, Ferreira, Santos & Durão, 2016), and there are now more connected mobile devices than people (UNESCO, 2013). While mobile devices and MAR can reduce certain expenses and help with technologically challenged people through their intuitive operating systems, these two barriers will not be specifically examined in the strategies developed for this chapter. Simply giving learners around the world access to mobile devices and educational resources does not bridge the learning divide. These strategies presented herein are guidelines for how to use MAR to create an inclusive distance education for all learners by increasing multiple modes, interaction and motivation.

4.3.1 Increasing Multiple Modes

An inclusive distance education experience should remove limits that have traditionally prevented learners with different-abilities from fully realizing their potential. Many studies have shown that a prominent challenge for learners with different-abilities is the physical and structural barriers that exist within education and specifically distance education (Bacca et al., 2015; Banks, 2014; Betts, 2013; FitzGerald et al., 2013; Denhart, 2008; Dryer et al., 2014; Dunleavy & Dede, 2014; Moisey, 2004; Pivik, McComas, & Laflamme, 2002; Oralbekova et al. 2016; Wang, 2014). Students with different-abilities are often deeply affected by the limited educational activities and must request alternative activities, suffer in silence or dropout of the distance education course entirely (Moisey, 2004; Seale, 2013). Distance education courses that only provide text to acquire information and only a writing option on a discussion thread to demonstrate understanding would limit students with certain impairments. By providing multimodal learning opportunities, "when material is presented in multiple forms" (Wideman & Odrowski, 2012, para. 2), alternatives and assistance to activities that contain physical and structural barriers, these students are no longer limited.

4.3.1.1 Multiple Learning Opportunities

A striking characteristic of MAR technology is its flexibility and the variety of modes that it provides for encountering the real world; many of which can be simultaneously experienced. This flexibility allows mobile augmented reality applications to be designed specifically to provide a variety of learning activities and offers options in learning activities to students who might otherwise be denied. McMahon's Ph.D. dissertation proposes that Universal Design for Learning (UDL) be used as framework for using mobile augmented reality for students with different-abilities (2014). The first guiding principle of UDL is to provide multiple means of representation (CAST, 2014) or a variety of ways that learners can gain understanding. The first study in his doctoral thesis exemplifies this guiding principle. It provides an opportunity for learners with intellectual disabilities and learners on the autism spectrum to learn scientific vocabulary words through marker-based MAR. Students use their mobile devices to access two learning modes of audio and video content that relate to unknown scientific terms. The conclusion was that participants learned new terms using MAR instruction based on UDL design (McMahon, 2014).

In another study, one hundred and fifty-eight students in Singapore, aged 12–13, demonstrated their understanding of a topic by designing a virtual gallery with *MUSE* (an augmented reality program) that used multiple means of expression (sight, sounds, text, etc.) (Ho, Nelson, & Müeller-Wittig, 2011). Participants were interviewed pre-, mid- and post-intervention, and open coding was used to determine a variety of themes including participants' awareness of multimodal impact and their appreciation for its role in learning (Ho et al., 2011). This demonstrates the role that MAR can have in not only expressing but presenting or evaluating learning.

4.3.1.2 Assistive Technology

While MAR can be used to create new learning opportunities, a complementary feature is its ability to act as an assistive tool (AT) for any learning opportunity. AT is described by the US Congress (2004) as an anything that can be used to increase, maintain or improve the function of an individual with disabilities (as cited in Seale, 2013). These tools address specific impairments to allow students with disabilities to experience existing educational activities. In fact, these tools can include many ways that humans perceive their environment through sight (e.g., animation, graphic, text, images), sound (e.g., music, voice, animal calls) and touch (e.g., braille) (Azuma et al., 2001). MAR apps are being created for people with various physical disabilities and are becoming an affordable and more accessible assistive tool along with being a component of augmented reality (Ismaili, 2016). One study conducted by Dr, Moisey (2004) analyzed, through descriptive and Chi-square statistics, the relationship between course completion as a measure of success and type of disability and type of services received. A standout of this study was the measurable success achieved by students with learning impairments who used assistive tools compared to other types of services.

Mobility

There are many examples of people with different-abilities using MAR apps as assistive tools. Much of the research looks at specific issues of impairment with respect to MAR. AT for mobility is one of those well-covered areas, as demonstrated by the study by Oliveira, Soares, Cardoso, Andrade and Lamounier Júnior (2016) that allows students to interact in their environment through the use of an enhanced indoor navigation system. Or, the research focused on *REVEL,* another mobile augmented reality technology that allows students with limited mobility to perceive virtual tactile texture in real objects (Bau & Poupyrev, 2012).

ADHD

Attention Deficit Hyperactive Disorder (ADHD) is included in this select body of research with respect to AT and MAR. Studies have shown that physical activity can be used as an intervention to reduce severity of symptoms for students with ADHD and improve memory retention (Smith et al., 2013). Students with ADHD have also had success in a study where the interactive component of MAR allowed them to explore a controlled environment (Aziz et al., 2012).

Autism Spectrum

Perhaps most prominently, mobile augmented reality applications are studied as an assistive tool for students on the autism spectrum (Ayres, Mechling, & Sansosti, 2013; Escobedo, et al., 2012; Escobedo, Tentori, Quintana, Favela & Garcia-Rosas, 2014; Vullamparthi, Nelaturu, Mallaya, & Chandrasekhar, 2013), whether it is to assist them with social cues through training (Tentori & Hayes, 2010), or by focusing their attention such as in a study that looked at how *Mobis*, a MAR app, overlays digital content on physical objects and increases sustained attention in students on the autism spectrum (Escobedo et al., 2014). Students on the autism spectrum are using mobile technologies with increasing frequency and developing a familiarity with mobile devices which makes MAR even more effective as an assistive tool as it reduces cognitive overload.

4.3.1.3 Example of How MAR Used in DE Could Increase Multiple Modes

With the increasing number of apps created for people with different-abilities, students with physical disabilities including mobility, hearing and visual impairments, could use MAR as an assistive tool for educational resources in a distance education course. An instructor or instructional designer could provide a list of resources and formats (video, research paper, book, etc.) along with suggested MAR apps that could address potential limitations.

Increasing multiple modes of learning both as varied learning activities and as an assistive tool to experience existing learning activities provides alternatives for learners structurally and physically limited by one or more learning experiences. The opportunities to learn presented in a typical distance education experiences are increased and are what help create an inclusive environment.

4.3.2 Increasing Interactions

Systemic restrictions to education for people with different-abilities can be attitudinal barriers, such as stigmas, stereotypes or neglect due to lack of understanding of accessibility issues (Jaeger, 2014; Moisey, 2004). The attitudes of peers and instructors are often caused and/or cause the limited interactions with peers, and instructors (Edmonds, 2004). The features of mobile augmented reality that promote interactions with peers and instructors relate primarily to portability and ubiquity, but also to the ability to create shared learning activities between peers and to assistive qualities that remove barriers for interactions.

4.3.2.1 Group Discussions

Group discussions specifically benefit students with different-abilities by providing a chance for students to synthesize and evaluate ideas and concepts. Martín-Gutiérrez, Fabiani, Benesova, Meneses, and Mora (2015) studied a MAR educational application randomly assigned to one of the 6 groups of 25 students taking an electrical engineering course. The mobile augmented reality allowed the students to collaborate with each other in their laboratory practices which resulted in a high satisfaction rate in their usability survey and feedback form (Martin-Guitérrez et al., 2015). Morrison et al. (2009) demonstrated that augmented reality features from a MAR map created a common ground for participants and elicited group discussion that allowed them to problem-solve more effectively compared to those participants who only used a paper map.

4.3.2.2 Communication

An increase in interactions between peers and also between learners and educators allow for more meaningful communication in distance education. In our society, certain impairments play a greater role in limiting that communication than others. For example, people who are hearing impaired are often limited in social interactions with others. Additionally, speech impairments, autism and even mobility limit interaction and socialization with other people. Mobile augmented reality can increase socialization as a ubiquitous assistive tool that enhances communication with not only peers but also instructors. Learners with certain disabilities would communicate more frequently and effectively with their educators thereby allowing their educators an opportunity to understand these learners more completely. Stigma, neglect and other attitudinal barriers could be addressed directly through these increased interactions.

One exploratory study with students in grades 7–12 that focused on the mobile app, *MyVoice*, allowed students with speech disabilities to customize programs to help with vocabulary and speak for them (Campigotto, McEwen & Epp, 2013). Consequently, researchers Campigotto et al. (2013) found it positively affected the self-confidence of students with speech disabilities, including their ability to pay attention and their sense of community. An audio-visual-speech augmented reality app can alternatively provide tone and nuance for students who are hearing impaired (Mirzaei, Ghorshi, & Mortazavi, 2014).

4.3.2.3 Example of How MAR Could Be Used in DE to Increase Interactions

K-12 students with communication disabilities could participate in a distance education mapping activity. Mixed groups of students with and without impairments could be created in the distance education course, and individual students could use a MAR app to map out familiar areas. This would create a common experience, and then, discussions could develop either through asynchronous postings or in real time through the assistive technology found on the mobile device.

Increasing interactions would have a dramatic impact on all students in a distance education program and especially impact those students for whom interactions and collaborations have been limited due to systemic and disabling barriers.

4.3.3 Increasing Motivation

More than traditional education, distance education encourages learners to be independent and self-motivated (Moore, 1989). However, the lowered educational expectations placed on many learners with different-abilities both by themselves and by others can reduce their self-confidence and consequently their autonomous learning and motivation to succeed. Key MAR traits that reduce these expectation barriers by increasing motivation are found in applications that address self-confidence, autonomy, conceptual learning and real-world applications.

4.3.3.1 Self-confidence

Research has shown that motivated students with different-abilities achieve greater learning success (Dryer et al., 2014). In particular, many studies show correlations between self-confidence and autonomous learning and mobile augmented reality (MAR) instruction. Bacca et al. (2014) developed a MAR application for 13 students with cognitive impairments in a Vocational Education and Training program that evaluated student's motivation based on Keller's Design for Learning and Performance (2010). An Instructional Materials Motivation Survey was used to determine student's attention, relevance, confidence and satisfaction dimensions. While all dimensions rated positively in the statistical analysis, confidence and satisfaction rated the highest. The sample size was small, but this study shows promise in the use of MAR applications to increase self-confidence, satisfaction and consequently motivation for students with cognitive impairments (Bacca et al., 2014).

Another recent study tested a MAR-game developed to increase math skills for 20 elementary students with diverse learning needs through a focus on learner control to boost confidence (Tobar-Muñoz, Fabregat & Baldiris, 2015). ADHD characteristics and learner's attention played prominently in the design of this MAR learning activity. This resulted in both positive quantitative measurement of tasks achieved versus time-to-complete tasks in a performance graph and qualitative assessment of learner's motivation through an interview of the headmaster of the school (Tobar-Muñoz et al., 2015). While only a preliminary study to help in the development of future MAR games for teaching mathematics for students with special needs, this study also shows that MAR can be designed to increase a student's self-confidence and increase motivation.

Finally, in a study of 21 elementary students with special needs, mobile augmented reality was used to help them complete a puzzle independently with a goal to increase self-confidence (Lin et al., 2016). The educational application demonstrated a step-by-step process, a technique beneficial to students with ADHD and memory impairments. A Wilcox test measured the performance assessment, and a qualitative survey was analyzed to show that independent learning increased the students self-confidence and consequently learning motivation (Lin et al., 2016).

4.3.3.2 Contextual Learning

The real environment that makes the content and concepts authentic and relevant and the virtual information that can grab the learner's attention are MAR features that increase learning motivation. MAR increases interaction with the subject as it contextualizes concepts. Most research that examines mobile augmented reality with respect to creating authentic learning activities usually fall into three categories: language and vocabulary, science and mathematics and navigation.

Language

An example of students learning a language is the study of 130 undergraduate students who were learning English from a state-run university in Turkey (Solak & Cakir, 2015). The Turkish version of Material Motivational Survey was used to determine the undergraduate students' motivational level about the learning activities and content which was designed with AR technology to teach English words at the elementary level. The results of this study suggested that AR technology materials had a positive impact on increasing undergraduate students' motivation for learning vocabulary in a language classroom (Solak & Cakir, 2015). Success in this area could be an avenue for reducing the English as a second language (ESL) barrier that exists for learners in countries all over the world. ESL barriers have been identified as limiting in many countries because many distance education videos and course information can only be found in English.

Scientific and Mathematical Concepts

Similarly, an example referencing scientific concepts in real situations is the study that looked at 76 first-year physics students and the effectiveness of using MAR to teach laboratory skills (Akçayir et al., 2016). Results showed that the contextualized learning through MAR had a positive impact on both the learning of the laboratory skills but also on the attitude of the students toward physics laboratories (Akçayir et al., 2016).

Navigation

In the second study in McMahon's dissertation (2014), there is a focus on navigation in a real-world context. The study looked at how undergraduate students with disabilities were able to use location-based MAR to find potential employment opportunities. Through visual analysis, the MAR navigation application was shown to be a more effective way for students to locate their destination compared to paper maps and Google maps (McMahon, 2014). Students with disabilities often suffer from lowered expectations, but MAR applications that offer students real-world experiences and skills will ultimately motivate them to succeed and build their confidence.

4.3.3.3 Example of How MAR Can Be Used in DE to Increase Motivation

Students with different-abilities from all over the world could use a marker-based MAR app in a distance education ESL course. The app would recognize real objects in the students' lives through the mobile device's camera. This contextualized learning gives autonomy to the student and should increase their learning motivation.

Lowered expectations for learners with disabilities by their instructors, peers and especially by themselves are a debilitating barrier (Roberts et al., 2011). Increasing learner motivation is a goal for inclusive distance education as it leads to the persistence and independence necessary for success in learning and in life.

4.4 Conclusion

Authentic inclusion of learners with different-abilities must be a principal aim for the field of distance education to remain relevant now and in the future. Mobile augmented reality (MAR) technology has the potential to help global distance education (DE) achieve this goal. This chapter organizes the mobile augmented reality research as it relates to inclusive DE around three strategies inductively found from the available literature: (1) increasing multiple modes, (2) interactions and (3) learning motivation. Ultimately, these focal points could form the basis for guiding educators and learners interested in creating inclusive distance education experiences.

By reviewing, analyzing and evaluating the relevant literature with respect to MAR and students with different-abilities, this chapter also provides a foundation for advancing knowledge in the field of distance education and suggests areas for important future research.

4.4.1 Limitations and Challenges

Not all of the barriers are easily remedied by the characteristic advantages of MAR identified and the alignment is not as precise as it could be. The strategies themselves are simple and may not contain enough detail for practical applications. Further research could test these strategies in a variety of distance education settings such as in K-12 online education, global post-secondary institutions and/or online employment training sessions to help focus and substantiate them.

4.4.2 Existing Research

Distance education struggles to be fully accessible partially due to lack of practical research specific to learners with different-abilities. Additionally, the lack of extensive research with MAR in distance education limits the promotion of this emergent technology to distance education designers, instructors and administrators. Lack of training, systemic technical problems, and lack of planning can also be perceived as barriers to the adoption of MAR (Berge & Muilenburg, 2000). Technology is neither inherently limiting nor inclusive and is always subject to how it is used in education.

4.4.3 Pedagogical Framework

MAR applications should be used within a pedagogical framework based on accepted learning theories and research. While Universal Design for Learning (UDL) has been proposed as an educational framework (McMahon, 2014) for inclusive learning using mobile augmented reality, there are issues with this framework that need to be addressed. Edyburn (2010) notes that many working in the education field cannot accurately define UDL and there is a lack of clarity in the research. UDL was referred to in numerous studies that examined MAR as it related to students with different-abilities. Although it was stated that UDL was used to design the learning activities in the studies, exactly what was being studied was unclear (Bacca et al., 2015; Martin-Guitérrez et al., 2015; McMahon, 2014). Seale (2013) accurately states "it is imperative that we examine the evidence that universal design is effective in improving the accessibility of e-learning resources or that accessibility training improves accessibility practices" (p. 17). For UDL to become this educational framework, further study is needed to better define the UDL characteristics for MAR and look critically at UDL's effectiveness.

Without this recognized educational framework, MAR instructional activities could become as limiting as the systemic barriers that currently exist in DE. A recognized framework is needed to serve as a guideline for those in the field of distance education to understand the educational concepts of mobile augmented reality and determine the value of each new MAR application that is developed.

4.4.4 Possibilities and Future Research

Any study that specifically examines MAR in the context of distance education for people with different-abilities is a possibility for future research because none currently exist. Within this topic, there are many interesting research areas to pursue.

4.4.5 Assistive Technology

Several studies look at MAR as an assistive tool but they are mainly focused on features that assist mobility, ADHD and autism. Certain prominent disabilities found in high school students include learning disabilities such as dyslexia and the psychological disabilities of anxiety and/or depression that could be studied in the context of MAR in DE. Outdoor activity has the potential to alleviate symptoms for learners with the psychological disability of anxiety/depression (Robertson, Robertson, Jepson, & Maxwell, 2012). Distinctly natural surroundings in outdoor settings have a restorative effect on depressed individuals (Gullone, 2000; Hartig, Mang, & Evans, 1991). Another area of study for MAR as an assistive technology could be for students who have learning disabilities such as dyslexia (Karamanoli & Tsinakos, 2016). The characteristics of MAR that allow information to be overlaid on real objects could assist students with learning disabilities for whom graphic organizers and animated concepts are useful.

4.4.6 Communication

While research papers have focused on the ability for MAR to enhance communication, one area not studied is the potential for MAR to increase interaction between instructors and learners. Studies have shown that there are definite barriers for post-secondary distance education students, as instructors can distance themselves from learners with disabilities and refer them to school support systems instead of creating an inclusive learning environment (van Jaarsveldt & Ndeya-Ndereya, 2015).

4.4.7 Contextualize Learning

More research could examine how MAR can be used to motivate and increase confidence for learners with disabilities in authentic or real-world situations. Contextualized MAR studies have focused on navigation skills and scientific skills, but there are many other real-world skills to explore. Applications for this research could be used to increase self-reliance and autonomy in learners.

MAR-assisted education provides a platform for ongoing, life-long and empowering learning to serve people with different-abilities in employment and society at large. The unique attributes of mobile augmented reality are enhanced using the three strategies of increasing multiple modes, interaction and motivation. MAR provides "real world" learning that opens doors for learners of all abilities.

Glossary

Attention Deficit Hyperactive Disorder (ADHD) Attention Deficit Hyperactive Disorder is a mental disorder of the neurodevelopmental type. It is characterized by problems with paying attention, excessive activity and/or difficulty controlling behavior.

Augmented Reality (AR) For the purposes of this chapter, AR will be defined as experiencing the physical world while using a device that provides an informational or graphical overlay to enhance the person's perception of reality. Users interact with the real world in real time through a tool that can display additional information in the form of videos, graphics, sound and/or GPS data. Augmented reality can also be classified as either marker-based or location-based. Marker-based AR uses recognizable images or symbols in the real world such as Quick Response Codes (QR Codes), whereas location-based AR uses the location of the user through systems such as the Global Positioning System (GPS) to augment the physical world.

Autism Spectrum Disorder (ASD) Autism Spectrum Disorder describes a range of conditions classified as neurodevelopmental disorders. Individuals diagnosed with autism spectrum disorder must present two types of symptoms: deficits in social communication and interactions along with restricted, repetitive patterns of behavior, interests or activities. Features of these disorders include social deficits and communication difficulties, repetitive behaviors and interests, sensory issues, and in some cases, cognitive delays.

Inclusion Inclusion in an educational context describes a learning situation that considers and values all learners. All learners are full participants in the learning environment and not restricted in any way.

Intellectual Disability (ID) An intellectual disability is a disability characterized by significant limitations in both intellectual functioning and adaptive behavior.

Learning Disabilities (LD) Learning Disabilities are neurologically based processing problems. These processing problems can interfere with learning basic skills such as reading, writing and/or math. They can also interfere with higher level skills such as organization, time planning, abstract reasoning, long- or short-term memory and attention.

Mobile Augmented Reality (MAR) Mobile augmented reality is the intersection of two interface technologies: augmented reality and mobile computing. Small and portable computing devices (i.e., smartphones and tablet computers), linked by wireless networks, contain elements such as a camera and MEMS sensors such as accelerometer, GPS and solid-state compass that make them suitable for AR platforms

People with Different-Abilities For the purposes of this paper, the term "people with different-abilities," "learners with different-abilities" or "students with different-abilities" will be used to describe people who have been limited in society physically, sensorial, cognitively and/or psychologically. These include but are not limited to people who are visually, hearing, motility or otherwise physically impaired, people who are on the autism spectrum, have Attention Deficit Hyperactive Disorder (ADHD) or have one or more learning disabilities, people who are developmentally disabled and also people who have mental health issues.

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Chapter 5
Ethical Considerations in the Incorporation of Mobile and Ubiquitous Technologies into Teaching and Learning in Educational Contexts

Jocelyn Wishart

Abstract This chapter will review the range of ethical considerations that have arisen over the past fifteen years alongside research into the increasing use of personal, mobile devices as learning tools in formal educational contexts. Issues that range from an irresponsible use of images to active cyberbullying, from jealousy driven by a classmate's upgraded device to fear of an invasion of privacy plague educators' approaches to teaching through mobile learning. In addition to the challenge of incorporating these potentially disruptive (Sharples in International Journal of Continuing Engineering Education and Life Long Learning: 12: 504–520, 2002) tools and maintaining their classes' focus on the task at hand, there are also concerns for teachers over the devices' accessibility and affordability for students. One common approach found in countries across the globe is to resolve potential issues by simply banning mobile devices from the educational institution itself. For schools are likely to ban things they believe (a) encourage students to adopt improper moral values or (b) enable students to waste time that should be spent pursuing the school's learning goals (Thomas in What schools ban and why. Praeger, Westport, Connecticut, 2008) and both of these can be applied to the case of mobile phones. However, that does no-one a service, it prevents students from benefiting from mobile learning opportunities which Dyson, Andrews, Smyth, and Wallace (The Routledge handbook of mobile learning. Routledge, New York and London, pp. 405–416, 2013) go so far as to describe in itself as unethical and does not enable teachers and lecturers to demonstrate responsible use. In order to support teachers and lecturers in designing and successfully implementing mobile technologies in their current teaching practice, the chapter will also present an overview of guidelines drawn from different educational contexts in the UK that encourage their students to 'bring their own device'.

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_5

Keywords Ethics · Ethics frameworks · BYOD · BYOD policy
Acceptable use policy · Scenario-based learning

5.1 Introduction

The chapter starts with an introduction to the context of mobile and ubiquitous learning in schools, colleges and universities. It may seem contradictory to discuss learning opportunities that capitalise on the affordances of mobile devices, that is to say learning any place, anytime, anywhere, when referring to fixed classroom contexts. However, such devices enable both students and teachers to bring the outside world inside in the form of captured images, notes, video and audio recordings or to access it via the Internet. They provide a wealth of engaging and readily accessible material that enables teachers to contextualise their subject content and so increase the level of authenticity in their students' learning. However, not all of the students have the mobile technology, a Smartphone or a tablet computer, necessary to capture or access material to support their learning and those that do, don't necessarily understand the full implications of all the different opportunities their device offers. The next section therefore presents an overview of ethical considerations and concerns that have arisen over the past fifteen years alongside the increasing use of personal, mobile devices in educational contexts. This is followed by a section, triggered by an overview of guidelines drawn from different educational contexts in the UK that draws out the implications of these different ethical considerations for teachers and lecturers. The chapter then concludes with a short summary of the key issues of concern and recommends raising educationalists' ethical awareness, whether teachers, lecturers, stakeholders or students, through collaborative creation of ethics frameworks and consequent scenario-based learning.

5.2 Mobile and Ubiquitous Learning in Schools, Colleges and Universities

Increasing levels of mobile device ownership are being reported with penetration rates for mobile phones in several countries now greater than 100% (people own more than one device). As for mobile broadband ITU (2016) reports that, in developed countries, just over 90 (90.3) in every 100 inhabitants have access to mobile broadband falling to a not insignificant 40.9 per 100 inhabitants in the developing world. However, younger children everywhere are less likely to have access to their own mobile phones. For example, the British national body that oversees electronic communications services, Ofcom, which collects data annually on children and young people's media literacy and online access, reports that the likelihood of owning a Smartphone increases with the age of the child (Ofcom, 2015a). Just 4% of 5–7-year-olds reported owning a Smartphone, rising to one in four of 8–11 year olds (24%) and to seven in ten 12–15 year olds (69%). Smartphone ownership is more likely amongst girls than boys aged 8–11 (29% compared to 19%) although there are no observable differences between genders amongst 12–15 year olds. The numbers of school children owning mobile phones in the UK have actually fallen slightly since 2010 when the proportion of those owning basic, not internet enabled, phones was higher; however, portable tablet computers are now owned by two in five (40%) 5–15 year olds. Ownership of these is also higher amongst 8–11 year olds (43%) and 12–15 year olds (45%) than 5–7 year olds (29%). As for young adults attending university in the UK, Ofcom (2015b) reports that the vast majority (90%) of 16–24 year olds now own a Smartphone and Davies (2014) reported that, even in 2013, Smartphone ownership at some UK higher education institutions (HEIs) had reached over 90%.

The way these devices are used in schools, colleges and universities to support mobile or ubiquitous learning opportunities varies similarly with older students being much more likely to be allowed to bring them into school or college than younger ones. Primary schools considering the potential of mobile devices to enhance learning have often chosen instead to invest in lightweight tablet computers as a classroom resource. In England the British Educational Suppliers Agency (BESA) annual report on tablets and connectivity in schools for 2015 records that 71% of the 335 primary schools surveyed are making at least some use of tablets to support learning (Connor, 2015). Examples of innovative use in primary schools include: using gaming on iPads to stimulate collaborative group work (Williams, 2012) and using school-supplied Smartphones to scaffold personalised enquiry learning on school trips such as the zoo or a soft drinks factory (Looi et al., 2011) or to support mobile digital storytelling stimulated by a school visit to a cultural landmark (Nordmark & Milrad, 2015).

At secondary school Bring Your Own Device (BYOD) or Bring Your Own Technology (BYOT) policies start appearing, the key difference being that with BYOD the device make and model to be provided is specified by the school. At secondary level use of these devices to support learning in the UK varies, Twining (2014) presents 14 case studies of schools implementing BYOD policies on his EdFutures wiki but only one of BYOT. Australian schools seem to be further down the line, Lee and Levins (2016) give case study examples from schools that have been running BYOD or BYOT policies for five years or more. Examples of innovative ways in which secondary level students are using their own tablets and Smartphones to support their learning outside the classroom include: using cameras to capture authentic examples of chemical reactions in the home (Wishart & Ekanayake, 2014), studying natural sciences through role play in a mobile urban drama played in teams (Hansen, Kortbek & Grønbæk, 2010) or through making animations (Wishart, 2016) and to augment reality with location-triggered video and information on field trips for humanities and social sciences (Clarke, 2013). In addition, more and more students are using their own mobile devices to support them in their homework. A survey in 2012, conducted by TRU (Teenage Research

Unlimited a US research company targeting the youth market), found that more than 1 in 3 middle school students are using their mobile devices to help them complete their homework (Verizon, 2012). This is happening worldwide, for instance Ott, Haglind and Lindström (2014) report from Sweden that more than two-thirds of a class of business studies students were searching or browsing for information or for translations on their Smartphones at least weekly and even more were using them as calculators. Just over a third were also using the phone camera at least once a week to take pictures for school assignments and there was also frequent communication between peers asking for, and giving, help on such assignments via social media and texting. Such support with school work is particularly welcome in developing countries where the schools themselves are less well resourced. Mwapwele and Roodt (2016) found that nearly three-quarters of the Tanzanian school sixth form students they surveyed (73%) had used Google on their mobile phones for schoolwork with 44% saying that they had used Youtube. These students noted several concerns though including language issues, device compatibility issues and possible unreliability of academic content on some Internet sites.

As for higher education, Davies (2014) reports 72% students in a survey at one UK university as saying that they use their Smartphones for collaborating with others on their coursework, with 57% saying they used them to access course materials and 52% reporting using them for online research. From the perspective of the institutions, the UK Joint Information Services Commission (JISC) (for higher education, further education and skills sectors) adds that mobile learning can be used both for content delivery and as a performance support system (JISC, 2015). These findings too are replicated internationally, for example, Song and Siu (2017) report finding from interview with Hong Kong University teaching faculty that BYOD has seven major affordances for supporting leaning. It can be used both within and beyond classrooms: to make learning and teaching happen without time and place constraints, to bridge the gaps between lectures and tutorials extending learning tasks beyond class time, to help teachers to engage students in lectures with a large audience, to track students' learning progress providing opportunities for students to reflect on their learning and to encourage students to collaborate, e.g. in accessing resources, reviewing and commenting on other's work. However, the constraints of BYOD identified by Song (2017) include the pedagogical and technical competence of faculty as well as equity and technical issues.

The issues seen by primary school teachers working with class sets of tablet computers are also largely technical though sometimes they can be surprised by inappropriate information from home seen on students' devices. It is at secondary school, with less immediate oversight of the children's mobile device screens, where teachers' concerns really arise. For example, in the TRU survey mentioned earlier (Verizon, 2012), whilst 39% of US middle school students were reporting use of Smartphones for homework, only 6% said that they could also use their devices in class for school work. It is clear that teachers are mindful of the potential for misuse, whether harmful, as in cases of cyberbullying, or more in the form of low-level disruption such as off task texting or gaming. Indeed, Beland and Murphy

(2015) found that nearly all the 91 schools they surveyed in England had implemented mobile phone bans in the past decade or so. Interestingly, Beland and Murphy (2015) also discovered a small rise in student achievement associated with such bans and that low-achieving and low-income pupils gained the most. They link this to the ban removing the potential for distraction; however, their critics say that they ignored opportunities such as those exemplified above for using students' internet enabled phones to enhance learning. Nevertheless, ethical questions can arise even in such effective mobile or ubiquitous learning practice.

5.3 Ethical Considerations in Mobile and Ubiquitous Learning

Indeed, concerns have arisen alongside the introduction of mobile devices into educational contexts since the early days of mobile learning initiatives at the turn of the century. Even the early PDAs (portable digital assistants) were highly portable and could be used unobtrusively in class at school or university and used for recording and sharing audio, images and video online. Thus, it is clear that the design of mobile devices themselves is an obvious contributor to such concerns (Andrews, Dyson & Wishart, 2015). Mobile devices are not just easily portable, physical tools; they are gateways to cyberspace and virtual worlds.

The first reference to ethical considerations in mobile learning was made by Traxler and Bridges (2004) at the third international conference on mobile and what was then known as ambient learning that took place in Rome, 2004. Working from their perspectives of professional researchers in computer science and education, respectively, Traxler and Bridges (2004) pointed out that both their and other professional bodies publish ethical guidelines for their members of whom many would be relevant to researchers and practitioners of mobile learning. They cited professional bodies for learning technologists, educational researchers, software developers and for university-based academics. This is the rule-based or deontological approach to working ethically and such guidelines commonly emphasise participants' rights and researchers' responsibilities. Consequently, Traxler and Bridges (2004) construed the major ethical issues inherent in mobile learning to be ensuring informed consent, anonymity and confidentiality for participants and obeying professional guidance on participant risk, payment to participants and cultural differences. However, they themselves note, taking the example of informed consent, that in 'pure' mobile learning, this is potentially problematic for a number of reasons. These reasons centre on the unpredictability of research that follows the learner using a mobile device across different contexts, both virtual and real and where there may be insufficient means for would-be participants to check their understanding of the research and their part in it or even of the way the different functions of their mobile device operate. Andrews, Dyson and Wishart (2015) later point out that research in these environments can take many forms as educational researchers, including teachers researching their own practice, use data collected on students' mobile devices in, and across, private and semi-public domains, that include the classroom, the field, during workplace training, informal learning and private study in students' homes. Pachler (2010) adds that mobile learning practices are also personal, intimately bound up with the individuals concerned as well as the formation and reformation of their identity and their relationship with members of their peer group. In their original paper, Traxler and Bridges (2004) went on to highlight that mobile learning could even take place across several different countries and consequently across different legal jurisdictions which begs the question of whose ethical guidelines should a researcher be following in the first place.

Aubusson, Schuck and Burden (2009) in their review of the role of the potential of mobile learning for teachers' professional learning conclude, from interviews with teachers in Australia and the UK, that there are actually five key ethical concerns relevant to classroom-based mobile learning that teachers should bear in mind. These are cyber-bullying, potential public access to events and materials intended for a limited, school-based audience, sharing of digital materials that include student data for professional purposes, archiving and keeping records of student performance and ensuring informed parental and student consent. Similarly, Wishart (2009) also highlights five areas of potential ethical concern relevant to both teachers and educational researchers though the list differs slightly. It includes informed consent, the ownership of the mobile device, of the information on it and the data collected, images—the ease of taking, sharing and publishing them, sharing user-generated content and personal data and data protection, storage and loss. She also further questions the role of available ethical guidance from mobile learning researchers' professional associations and points out a number of situations commonly occurring in mobile learning research where change and complexity impact upon its usefulness. Aubusson et al. (2009) add concerns over how ensuring all guidance is complied with conflicts with the potential usefulness of mobile devices to teachers when used to capture aspects of their practice spontaneously. One of their teachers complained 'It has to be a pre-arranged and agreed activity'.

Fortunately, Lally, Sharples, Tracy, Bertram and Masters (2012) remind us of the role iterative and participatory research ethics can play in social science research and go on to show how they can be used to address the unpredictability of context and activity inherent in mobile and ubiquitous learning. Indeed, Carmichael and Youdell (2007) had already proposed moving away from a 'permission-seeking' approach to an iterative, fluid cycle of ethical practice when reporting on their research into the use of online, virtual collaboration environments for educational research. Lally et al. (2012) went on to add another seven major ethical considerations generated from a thematic review of the published ethical guidelines of twelve major international organisations relevant to research into mobile, ubiquitous and immersive technology enhanced learning (MUITEL). These included informed consent, access to the technology (with associated potential for discrimination even abuse), user-generated, personal content or data, potential for attachment to loaned devices, the introduction of unsuitable materials, intrusion into privacy and the blurring of boundaries. They conclude that ethical review processes are most valuable in MUITEL research if they are understood not as ‘approval’ or ‘clearance’ by an ethics committee or professional body but as contributing to, or even initiating, formative and dialogic practice. However, they point out that questions remain over exactly how you construct such a more comprehensive ethical process, particularly in boundary-crossing areas like mobile and ubiquitous learning research.

Researchers such as Wishart (2009) and Farrow (2011) propose that first considering the theories and principles behind the ethical concerns suggested above will assist mobile learning researchers in addressing these questions and in developing such a process. This is supported by Batchelor and Botha (2009) who, informed by their work in Africa where infrastructure issues meant that access to mobile technologies outpaced desktop computer access, propose that a move from a rule-based system of addressing ethical concerns in mobile learning to a value-based system could accommodate these new technology developments. Wishart (2009) started this process by looking at ethical values in other professions. For example, the four basic principles below (Beauchamp and Childress, 1983) have been largely accepted by the biomedical community for generations and now feature widely in ethics primers. They are:

- Beneficence (doing good);
- Non-maleficence (avoiding harm);
- Autonomy (respecting choice) and
- Justice (equality of access to resource).

She then cross-tabulates these with the five key areas of potential ethical concern for mobile learning researchers mentioned above to create an ethics framework where each cell in the table where a key ethical issue intersects with an underpinning ethical principle becomes an opportunity for reflection as to what is current practice and what is good practice. Farrow (2011) adopted a similar structural approach in his work to develop an analytical tool to support mobile learning researchers in understanding the nature of ethical issues beyond the more customary strategic focus on gaining research approval. Taking the concepts of deontological ethics (based on moral responsibilities or duties), consequentialist ethics (based on the outcomes on an action) and virtue ethics (based on developing as a good person) from moral philosophy he first develops them in the context of mobile learning to create a second-level taxonomy. This taxonomy comprises three concepts: responsibilities, outcomes and personal development plus three further spaces that overlap the boundaries between each pair of concepts. Farrow (2011) then cross-tabulates this taxonomy with the ethical issues highlighted by the MOTILL Project set up to identify best practices in using mobile technologies to support lifelong learning (Arrigo et al., 2010) and which it was found could be categorised into three key areas: accessibility, privacy/security and copyright.

It is noticeable though that issues such as cyber-bullying and accessing age inappropriate information do not appear in either of these two thoughtfully considered frameworks yet appear to be strongly associated with teachers and lecturers' concerns over adopting mobile learning. Mobile phones are largely seen as likely to be disruptive not just to the class teacher's pedagogy but to the learning of the entire class; indeed, they are banned from all schools in certain states in the USA and India and even in whole countries such as Brunei and Sri Lanka. Katz (2005) further classifies problems generated by mobile phone use by students in educational settings into four groups: disruption of class, delinquency (theft and bullying), chicanery (cheating and plagiarism) and erosion of teacher autonomy. Yet these groupings clearly result from pupil behaviour and not the technology per se. The development of educational research into how to effectively employ handheld mobile devices in class is currently being held back by local, and, in some cases, state or national regulatory frameworks that target the tool and not the operator. However, that said, the mobile learning research community still needs to ensure that all researchers, as well as the class teachers, are fully aware of potential ethical concerns and challenges in their work. One way forward, proposed by Andrews, Dyson and Wishart (2015), is centred on both teachers and researchers using, even developing their own, frameworks such as those described above and is presented in the conclusion to the chapter. However, in the meantime, having addressed the theoretical background, I review examples of more practical guidance from UK schools and colleges with BYOT or BYOD policies.

5.4 Policy Guidance for Teachers and Lecturers

In order to illustrate the current UK national picture of guidance over ethical concerns arising through implementing mobile learning opportunities for teenagers and young adults, a small, opportunity sample of school policy and university guidance is presented below. We need to be mindful though that, in the case of schools, RM Education (a leading educational technology provider)'s annual survey indicates that currently only 29% of secondary schools have opted for some form of BYOD (Forbes, 2016). This level, though, has already triggered concerns about equity of access with the UK National Association of Head Teachers reporting that lack of government funding is forcing schools to ask parents to pay for their children's mobile devices (Hobby, 2016). Obviously, not all parents can afford to do so

One of the earliest UK schools to put a BYOD policy in place was the Thomas Hardye School in the southwest of the country, in Dorset. This school is an academy, i.e. a state-funded community school which is directly funded by the UK Department for Education and independent of local authority control. It is a larger than the average-sized secondary school with over 2000 students from Years 9–13 (those aged 13–19) and has catered for students bringing their own mobile devices for over five years now. Their policy[1] clearly includes all devices used to access the

[1]https://www.thomas-hardye.net/documents/policies/BYOD%20Policy.pdf.

school's IT resources and communications systems whether Smartphones, PDAs, tablets, and laptop or notebook computers. Its advertised purpose is to protect school systems whilst enabling students to freely access them and it sets the way in which the school may monitor such use. It is closely coupled to the school's student ICT Acceptable Use Policy[2] which reminds students that whilst use of the latest technology is actively encouraged at the school it comes with a responsibility to protect students, staff and the school from abuse of the system and highlights responsible use solely under the class teacher's direction and e-safety issues. Lee and Levins (2016) report that there has been scant abuse of the trust accorded to the many thousands of students.

Another school that was an early adopter of BYOD is Saltash.net Community School, also in the southwest of England. Similarly, a larger-than-average secondary school, Saltash.net, is also now a stand-alone academy. Interestingly, its approach is to cover BYOD within the school's e-safety policy[3] thus prioritising the safe and responsible use of mobile devices. The school points out that it recognises that there is a wide range of rapidly developing communications technologies which have the potential to enhance learning and expressly allows both students and staff to use mobile phones both in lessons and for social networking in breaks.

On the opposite side of the country, Maidstone Grammar in Kent, a smaller yet still larger than average selective boys' school under Local Authority control with just over 1200 students, again prioritises the use of mobile devices in school for educational purposes. Indeed, its BYOD policy[4] opens with the emphasis that the use of personal devices at school is to be 'exclusively educational'. Other opening emphases are that, similarly to the Thomas Hardye school, the use of personal ICT devices falls under the school's Internet Acceptable Use Policy and that students are not permitted to connect to any external wireless or networking service whilst using a personal ICT device in school. The latter allows the school to monitor student use of its Wi-Fi network.

However, the picture in schools in England is divided and these case studies are not representative of the whole country. A survey conducted by Canvas (the VLE provider) found that more than one-third of teachers (34%) in the UK have banned personal devices like mobile phones and tablets from their classroom, significantly more than in US schools (23%) (Canvas, 2016). The survey also found that the majority of the teachers (62%) believe such technology distracts students from learning. But then, even more of the teachers, 74%, believed these mobile technologies can make their job easier, if integrated effectively and used as an educational tool rather than a leisure device.

This latter point holds sway in colleges and universities, who, with their older, often adult students, have moved more swiftly than schools to cater for students

[2]http://www.thomas-hardye.net/documents/policies/Student%20AUP.pdf.

[3]http://saltash.net/filepantry/pdf/policies/saltesafe14.pdf.

[4]http://www.mgs.kent.sch.uk/assets/Uploads/Files/Policies/Internet-E-Safety–ICT/MGS-BRING-YOUR-OWN-DEVICE-BYOD-POLICY.pdf.

bringing their own mobile devices onto campus. For example, New College Swindon, a further education college with around 3000 16–19 year students replaced its fixed Ethernet computer network with Wi-Fi back in 2011 to allow students to access the Internet using their own devices (Saran, 2011). Even in those days it was reported that 1500 different devices were logging onto the network each day. Within the higher education sector, the most recent survey by UCISA (the Universities and Colleges Information Systems Association) of over one hundred UK universities found that the most common ways in which universities are promoting the use of mobile devices are through the establishment of BYOD policies and by loaning out devices to staff and students (Walker et al., 2016). Indeed, only 15% of institutions responding to the survey did not promote the use of mobile devices to support learning. The range of online services that the institutions are currently optimising for access by mobile devices include access to course announcements, email services, course materials and associated learning resources and, in slightly fewer institutions, library services.

JISC, the aforementioned UK advisory body for digital resources and network technology in post-16 and higher education, includes the following key concerns for ethical and legal practice in universities and colleges in its guide on mobile learning for academics (JISC, 2015). These include concern that opening up the system to student mobile access increases the risk of compromising its security, increases the likelihood of copyright infringement and will result in loss of personal or confidential data. Additionally, it points out that 'mobile access means greater anonymity and access for students to others resulting in increased internet safety issues'[5] Consequently, nearly all universities, as well as schools, expect students to sign up to acceptable use policies before allowing their device to access its Wi-Fi provision.

5.5 Conclusion

However, whilst the examples of policies and guidance presented above provide useful advice on potential issues occurring with mobile devices in the classroom for teachers and lecturers, they again represent the rule-based, deontological approach originally presented in the context of mobile learning by Traxler and Bridges (2004). As educational researchers and practitioners encouraging new mobile learning practices, we need to consider how to enable teachers and lecturers to support young people with any associated issues arising where such rules are less obvious or even non-existent, i.e. outside of the classroom. It is with this aim in mind that Andrews, Dyson and Wishart (2015) put forward their workshop-based approach of engaging educational practitioners in developing their own ethical frameworks (described above in the previous section). Using these frameworks in

[5] https://www.jisc.ac.uk/guides/your-students-mobile-devices-law-and-liability.

discussions to develop scenarios (such as those published by the International Association of Mobile Learning[6]) enables teachers and lecturers to be better informed and more confident in dealing with breaches of privacy, inappropriate access or data loss, i.e. those ethical rather than legal challenges that may occur when students bring their own devices to class. Indeed, Howard-Jones (2016) recently pointed out, in an interview for the UK national press, that it is important for teachers and parents to understand the ways in which children are using mobile devices and the internet. If we are to ban them from the classroom or lecture hall, it makes it impossible to gain that information. This applies equally to older university students.

Glossary

BYOD bring your own device (school will cater for specified personal mobile devices)

BYOT bring your own technology (school will cater for all students' personal mobile devices)

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Author Biography

Dr. Wishart an experienced teacher educator, has worked with science and information technology teachers for 20 years now. She became involved in mobile learning through her interest in using handheld devices to support teacher trainees on placement in schools. She ran several small scale projects for the UK Teacher Development Agency that have shown such devices can be useful in supporting both learning and teaching and any technical issues arising from their use resolved. However, the current school culture in England, where there is debate over using mobile phones in school, meant trainees tended not to feel comfortable about using a handheld device in a classroom context. This led Dr. Wishart to research further into social and ethical issues associated with using personal devices like mobile phones to support learning and to develop support for new researchers and teachers in addressing these new ethical concerns. She has been a member of the International Association for Mobile Learning since its creation and is currently its Membership Secretary. She was also a member of the Kaleidoscope EU Network of Excellence Mobile Learning SIG Steering Group.

Chapter 6
Mobile Virtual Reality: A Promising Technology to Change the Way We Learn and Teach

Elena Olmos, Janaina Ferreira Cavalcanti, José-Luís Soler, Manuel Contero and Mariano Alcañiz

Abstract Even when Virtual Reality (VR) is included in the new technologies set, we have to be conscious about how old is the idea of representing reality in an artificial way. Since centuries ago, human beings have tried to take advantage of synthetic realities in order to make out of them learning tools, because of their capabilities to arise emotions, intrinsic motivation and to make users immersed in what they are trying to learn. Technological evolution and new pedagogical strategies, represented by affordable, high-quality head-mounted displays (HMDs), and neuroeducation, have set a new environment for using mobile VR (mVR) in educational contexts. This renaissance of virtual reality as a disrupting tool for training and education has to be supported by pedagogical innovations with the objective of being global, massive, and effective. The aim of this chapter is to discover how the relationship between VR and education has evolved and its effectiveness along diverse educational stages/topics, since its early approaches to present didactic strategies. In addition, we want to go deeper in how schools could use VR in their pedagogical practice, setting the focus in the manner neuroeducational theories inform VR instructional design. Lastly, we are going to establish a realistic multidimensional baseline (based on hardware and software capabilities, software, economic, and sociocultural conditions and teachers' skills and motivation) that could effectively promote mVR massive adoption in education.

Keywords Virtual reality · Education · Neuroeducation
Head-mounted display · Technology-enhanced learning

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_6

6.1 Introduction

Technologies related to Virtual Reality (VR) have been under development for the last fifty years. From Heilig's unipersonal console Sensorama in 1962, considered as the first commercial application of multimodal technology, to current development of low-cost VR systems based on smartphones, there have been a great number of pioneers who have tried to use VR to improve learning and training processes.

First virtual environments in education were oriented toward learning mechanical interactions, as driving or piloting, or reproduction of spaces and places in social sciences as early stereographic photographs. However, widespread use of VR technology at real educational settings always has been a chimera due to:

- High cost associated with the required hardware and software.
- Problems linked to the utilization of these early VR systems (cyber-sickness).
- Low quality of the environments' instructional design.

Mobile virtual reality learning (mVR-Learning) can really break some of these barriers thanks to supporting blended learning and its affordable cost.

There is a need to review the evolution of educational uses of VR, both from technical and pedagogical perspectives in order to discover the foundations of this topic and try to set a road map to massive deployment of this technology, exploding its capabilities and avoiding weaknesses of past approaches.

6.2 Evolution of HMD (Head-Mounted Display)-Based Virtual Reality Educational Uses

Virtual reality technology is strongly linked to a perennial aspiration of humanity: the capture of reality. Democritus of Abdera (fourth century BC), also known as the "laughing philosopher," considered "sensitive perceptions, such as hearing or vision, are explicable by interaction between the atoms of the effluvia the thing perceived throws and receptor's atoms. This justifies the relativity of sensations" (English, 1915).

Interest about how humans perceive reality has not ceased. Moreover, greater understanding of these cognitive phenomena has generated, since ancient times, the need to recreate that perceived reality for its timeless and ubiquitous use.

6.3 First Steps (1800–1925)

If we focus on our visual perception, providing depth to two-dimensional images (first drawings and photographs after) has been investigated in the past two centuries. In 1840, Charles Wheatstone was awarded the Royal Medal of the Royal Society for his explanation of binocular vision, research that led him to make stereoscopic drawings and construct the stereoscope. He showed that the "solidity" (from the Greek "stereos," solid) is obtained by the combination in the mind of two separate images of an object taken by both eyes from different points of view (Wheatstone, 1838).

This laid the foundation of everything that has happened in the VR technological evolution. Six years later, Sir David Brewster improved the model replacing the mirrors by transparent prisms and, five years later (1851), coinciding with the development of the printed image, Oliver Wendell created the "mobile" stereoscope (hand sized).

This could be considered as the first widely used commercial product based on what we call now virtual reality: synthetic images that recreate the way we perceive (mainly visually) reality. Surprisingly, the technological concept gap between the first Wheatstone stereoscope and Google's Cardboard launched in 2014 is relatively small. Both of them, saving the resolution gap, show images stereoscopically activating different cognitive mechanisms than flat images' viewing does.

From this first moment, society has been aware of the potential of this technology because of its ability to recreate pseudo-real sensations from artificial elements. As we read in Bendis (2003), the stereoscopic views were "a marvel of realism" and were "the best substitutes for a real visit" (Holmes, 1904). In 1897, the booklet "Land of the Pharaohs," designed to be viewed with the perfescope, an updated stereoscope, was a great success and contained 100 stereoscopic photographs of Egypt (DeLeskie, 2000).

In the first quarter of the twentieth century, the Keystone View Company was the winner of a hard fight with rivals (mainly Underwood & Underwood) in the quest to dominate educational market. The company managed to sell many units of its Keystone 600 viewer, with a collection of stereoscopic images specifically selected for educational use. A group of 62 educators chose them and divided them into different themes: history, agriculture, nature, geography, art, and travelogues, among others. As we read in their manual (Keystone, 1922), "… as the stereographers provide a third dimension or depth to the scene, they have much resemblance to reality causing the child the same reactions that cause the actual view of what is shown in the picture." Specific sets for military training (warships recognition) and medical (anatomical dissections) were also created.

6.4 Going Digital (1950–1990)

With the advancement of technology, stereography became virtual reality, similar to what we know today, being its first flagship the Sensorama, made by filmmaker Morton Heilig (U.S. Patent No. 3,050,870, 1962). It consisted of a cabin with a 3D monitor, vibrating seat and an odor generator. In his mind, it would become a massively deployed one-person immersive cinema, but it was never mass-produced.

Next crucial step in the history of virtual reality was taken by Ivan Sutherland (1968) with the "Sword of Damocles" which laid the foundation of the concept we have today of head-mounted display (HMD). It had a mechanical arm hanging from the ceiling, holding a display that is held in the user's head (here comes its curious name). Arm joints were equipped with potentiometers measuring changes in orientation of the user's head. Computer-generated stereoscopic pairs of images (wireframe perspective projections), which were sent to the display system, allowed the user to view 3D objects. User movements that were detected by arm joints' sensors were sent to the computer in order to change the orientation of the point of view. However, limited computing power of that time processors was not enough to create really immersive experiences.

The innovation that certainly sparked interest in this technology was the introduction of high-quality computer graphics and interaction capabilities. The potential of these technologies for training and education was quickly unveiled, and some companies started creating first flight simulators, mainly for military aviation (Gigante, 1993), (McLellan, 1996), because they had lower operational costs and were safer. With those simulators, it was also possible to replicate hazardous situations that could not be reproduced in actual practice. The interface was mainly physical, an exact replica of the controls, so they were not reusable in other trainings, what made them very expensive.

Later, the next field that firmly adopted VR as a learning tool was surgical training. Surgical simulators are complex and eminently physical environments (Cooper & Taqueti, 2008), mainly based on haptic feedback. Today, they are still one of the most mature examples of the use of VR in a training environment. While it began as a realistic way to simulate certain professional, physical, and mechanical processes (Tate, Sibert, & King, 1997), if we analyze the reasons for using virtual reality in education, we find different motivations, in clear chronological evolution.

6.5 Technological Fast Development, Looking for a Pedagogical Model (1990+)

With technology available today, supporting high-resolution real or synthetic images in lightweight, affordable HMDs with incredible interaction possibilities due to scale room tracking and/or object/hands tracking (as we can see in HTC Vive, Oculus Rift, Samsung Gear VR, among others), the challenge remains in our capacity of design immersive experiences aiming to be fully beneficial for education and training users. Technology is not now the limiting barrier but experiences design.

Firstly, as indicated by Winn (1993), immersive VR provides first-person non-symbolic experiences to help students in their learning process specifically learn material. These experiences usually cannot be obtained in formal education as regular teaching practice promotes symbolic third-person learning experiences. On the other hand, Mantovani (2001) focuses on the benefits of VR in education in "learning in difficult or impossible contexts to be experienced in real life, increased motivation, adaptability and custom educational content creation and great potential as an evaluative tool for its ease to monitoring sessions in the virtual environment."

Dalgarno and Lee (2010) analyzing the main affordances provided by 3D virtual learning environments identified enhanced spatial knowledge representation, experiential learning, increased motivation/engagement, improved contextualization, and more effective collaborative learning when compared to 2D alternatives. If we consider that these findings are obtained from studies based on "desktop VR," these affordances will be fostered by "true" VR. In a recent meta-analysis by Freina and Ott (2015), we see that the most used argument for including VR in the classroom is "that it gives the opportunity to live and experiment situations that cannot be accessed physically."

New pedagogical studies state that emotions act as anchorage for new knowledge, fixing it (Immordino-Yang & Faeth, 2010). If new immersive technologies have this ability to arouse emotions, we are able to think that the moment has arrived to consider them as a powerful tool for learning.

The importance of emotion and intrinsic motivation, and the modulation capability of these factors that virtual reality offers open the window to integrate these elements into the instructional design to promote a more effective learning process. This requires a deeper analysis about the neuroscientific vision of the learning process that is developed in the next section.

6.6 Neuroeducational Basis for Virtual Reality Effectiveness Applied on Learning

Applying neuroscience to the educational field supposes a new way of understanding learning processes through a better scientific knowledge of how our brain works, how it learns and, from this baseline, try to improve teaching practice and students' knowledge acquisition. The new discipline of neuroeducation was born from interaction between neuroscientific knowledge and education. The name itself references the interconnection between mind, brain, and learning. It is a multidisciplinary area that was already identified by Bruer (1997) when he proposed to connect neuroscience and education through cognitive psychology. As noted by Ansari, de Smedt, & Grabner (2012), current development of techniques such as near infrared spectroscopy (NIRS), electroencephalography (EEG), and functional magnetic resonance imaging (fMRI) provides tools to identify which brain regions are involved in the typical neurocognitive functions related to learning activities.

One of the more interesting elements that have emerged during the development of the neuroeducation discipline is the importance of emotions in learning. Our brain retains better information when it comes together with an emotional load. In fact, positive emotions are the ones which awake curiosity and help students to fix attention. This is one of the reasons that justifies that we are not able to separate emotion from learning (Mora, 2013).

Immordino-Yang & Damasio (2007) highlight that those aspects of cognition that traditionally are worked at school such as attention, memory, decision making, and social abilities are very related to the processes of emotion. Regarding knowledge retention, it becomes stronger and more efficient when students' experiences emerge from emotional activities. With an emotion-focused teaching, students are able to better retain their advances (Immordino-Yang & Faeth, 2010). This is an important change from classical educational practices where learning should be distinct and dissociable of emotion, making emphasis on learning as a rational process. In that context, emotions could be an obstacle, and they were considered a distractor. However, we are emotional beings, and from an educational point of view, avoiding emotion is a weakness. Educators know there is an indissoluble relationship between body (learning by doing and interaction with the environment) and emotion to promote learning (Butler-Kisber, 2011).

Taking into account all the previous indications about the importance of emotions in the learning process, virtual reality offers sophisticated tools to integrate them into the learning experience considering that from a constructivist point of view, virtual reality is able to stimulate expressions, attitudes, and emotions by students (Huang, Rauch, & Liaw, 2010). As noted by Pantelidis (2010), VR has its own characteristics, which can be employed to create immersive experiences where emotions and intrinsic motivation can be used to promote learning. VR efficacy on emotional induction has been analyzed in studies such as the EMMA project (Alcañiz, Baños, Botella, & Rey, 2003) where it was demonstrated that virtual environments are able to generate emotions in their users. Another study developed by Riva et al. (2007) confirmed the possibility of using immersive virtual reality as an emotional induction tool in order to achieve relaxation or anxiety states.

Regarding the experiential factor in learning, the immersive capability of VR produces in students a sensorial experience that makes easier gaining knowledge (Fowler, 2014; Chittaro & Buttussi, 2015). The combination of emotional aspects and the experiential component of VR-based learning is one of the fields where additional research must be carried out to provide guidelines for the design of VR-based learning contents, that in the near future will be able to be deployed due to the possibility of overcoming the main barriers to the real adoption of this technology that will be described in the next section.

6.7 Conditions for Widespread Use of Virtual Reality in Education

Although technologies related to VR have evolved at fast pace, its deployment in formal education still seems very difficult and complex. Mass adoption in different educational environments has always been a challenge due to reasons far from its effectiveness (Meltzoff, Kuhl, Movellan, & Sejnowski, 2009), such as the high cost associated with the necessary devices, the problems associated with the use of these first virtual reality systems (dizziness, disorientation, etc.), or the low quality of instructional design environments associated with virtual reality, especially mobile virtual reality (Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014).

Today, with evolution and cheaper prices of technologies we are able to configure a virtual reality environment using a headset based on smartphone suitable for classroom use, with a very low economic investment, solving one of the biggest entry barriers. This hardware setup can be extremely cheap adopting Google Cardboard and low-cost smartphones. As an initial contact with the VR concept this setup can be an interesting option. New developments such as the Expeditions app by Google (www.google.com/edu/expeditions) can show a guide for future deployment of this technology in the classroom, where the teacher can act as the leader of the VR learning experience. However, it is important for the teacher to be properly trained. This signals a critical issue for the future success of mobile VR as a learning and teaching tool. Orchestration of mVR-learning resources inside the classroom requires specific tools to support teacher role as a knowledge facilitator. Google Expeditions is a good example of a preliminary intent to provide an integration path for this technology in the regular activities in the classroom.

From a technical point of view, high-quality educational VR contents should provide an engaging experience based on high usability (efficiency, learnability, and satisfaction), proper functionality to support the learning activity (easy navigation, easy interface condition), and aesthetics (Salzman, Dede & Loftin, 1995; Pereira, 2000). Current mVR solutions provide good immersive visual experiences. However, interaction with the virtual environment is constrained by available hardware. In the case of Google Cardboard, gaze menu selection and magnet sliding switch limit the way of interacting with the virtual environment. Samsung Gear VR provides a button and a lateral touchpad with more interaction capabilities. Both systems can be paired with an external gamepad, but this introduces an additional cost and complexity in the user interface. New Google Daydream VR platform to be launched in the near future (vr.google.com/daydream) introduces a low-cost headset and a simple controller whose rotation and orientation can be tracked with high accuracy that also includes a clickable touchpad and two buttons.

In the near future, gesture recognition through time-of-flight (TOF) cameras included in smartphones (such as Google's Tango smartphone), or low-cost data gloves will support more natural interactions and additional technological development will support user positional tracking that currently is not possible in available mVR platforms.

Attending to those conditions, if we summarize all needs for a global deployment of mVR in a multidimensional baseline, we obtain that the three major limitations showed previously in this chapter are close to be overcrowded.

- Socioeconomic dimension: High cost usually associated with HMD-based VR is now overwhelmed by low-cost systems based on low-end smartphones and cheap plastic headsets based on Google Cardboard design. Even this configuration does not provide the best experience because of the computational and graphical power of these entrance-level devices, they allow a good immersive experience, as we can see in Zimmons & Panter (2003).

- Indeed, it is possible to use mVR in classrooms in a BYOD (*Bring your own device*) model, at least in most advanced economies, where 68% of population (18+) has a smartphone (Poushter, 2016).
- Interaction dimension: Due to the continuous improvement of VR engines and smartphones, there are fewer problems associated with the utilization of early VR systems, such as cyber-sickness. In addition, new interaction devices as the controllers provided in Google Daydream and Samsung Gear VR 2017 model will make possible to introduce more natural interaction capabilities that will facilitate more accessible game/learning mechanics and increase embodiment, so important for situated learning (Rambusch & Ziemke, 2005).
- Instructional dimension: In the last few years, large effort has been made in serious games design in order to bring together the motivational power of games with the learning potential of interactive virtual environments (de Freitas & Liarokapis, 2011; Arnab et al., 2015; Bellotti, Berta, & de Gloria, 2010). These advances allow us to design and develop compelling environments and interactions video games inspired, with fully integrated learning strategies. This new kind of learning environments, of course, requires to train teachers and, moreover, includes some new curricula contents in pre-service teachers' formal education.

These multidimensional conditions provide a sound, strong baseline where massive educational deployment of mVR could rely.

6.8 Conclusions and Future Work

Globally, VR has always been expected to act as a trigger of an educational revolution often announced. Many visionaries have predicted that the transformation of education will come from technology, but year after year, we renew these predictions changing the catalyst (PCs, netbooks, interactive whiteboards, tablets, smartphones, etc.) without remarkable success.

Although the fact that no technology will have the disruptive impact that we hope if it does not come accompanied by an equally profound change in teaching methodologies, mobile VR can contribute to the transformation of educational practices. If we want to deliver first-class, immersive learning experiences that boost student's intrinsic motivation, mVR has a great role to be played.

From its perspective, mVR has unique conditions to be considered a game changer educational tool, combining the strengths of mobile learning such as ubiquity, continuous and situated learning support, and its applicability in both formal and informal learning situations, with the engaging and motivational capabilities of virtual reality, where a new world of learning experiences can be created to support a constructivist way of learning.

Our research has found that we have a strong baseline in order to build an extensive deployment of mVR in our educational systems due to these characteristics of today's mVR systems:

(a) Cost effectiveness.
(b) Easiness of use and interaction capabilities.
(c) Solid empiric foundations about learning efficacy.

This work should empower educational authorities to start pilot projects to introduce this methodology/technology to teachers. However, there are some challenges we have to face simultaneously. There is a lack of authoring tools for the creation of educational contents by teachers, and quality and quantity of educational contents provided by publishers are still very limited. Perhaps, currently the main bottleneck for the real implementation of this technology are the missing educational contents.

Additionally, even considering that technology itself will not cause any disruption, it will play a decisive role in pushing the stakeholders in the education community to change. For this reason, we need to convince and train our teachers in how to include mVR activities in their syllabus. Further scientific research has to be done on how teachers perceive the pedagogical capabilities of mVR after having been formally trained in it.

Finally, we want to send a very positive message about mVR. Today and largely due to the commercial thrust of global technology corporations, mVR-learning is not a utopia. If quality educational contents are developed accompanied by the proper pedagogical methodologies, a new stage in educational history will be given birth.

Glossary

Cyber-sickness sickness resulting from immersion in a virtual reality world.

First-person experience when you are the subject/author of the action.

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Chapter 7
Mobile Learning Pedagogical Quality Standards for Higher Education Institutes in Developing Countries

Hend Merza

Abstract The Mobile Learning literature tends to focus on technological aspects, e.g., accessibility, flexibility, internet connection speed, errors, and security, rather than the vital pedagogical aspects of m-learning. Bearing in mind that Pedagogical Quality Standards for Mobile Learning in higher education cannot be ignored, this chapter presents an in-depth discussion of pedagogical quality in Mobile Learning. A rubric consisting of fifty Mobile Learning review indicators clustered into three pedagogical standards and eight substandards distilled from current literature on Mobile Learning. The indicators addressed and examples provided are of special interest to various stakeholders including instructional designers, teachers, and Mobile Learning developers at higher education institutions, as they draw attention to pedagogical factors for effective Mobile Learning and takes them beyond technological applications. For example, the indicators can be applied to assess progress and improve the design and preparation of Mobile Learning for lessons, courses, or entire programs. The overall outcome will be to create a high-quality learning experience. This will increase learners' interactions and satisfaction with Mobile Learning and enable them to demonstrate competencies after completion that reflects achievement of the intended high-order learning and thinking goals and objectives required for the twenty-first century learner and worker.

Keywords Mobile Learning · Mobile Learning Pedagogical Quality Standards Rubric · Higher education institutions

7.1 Introduction

There are numerous definitions of Mobile Learning. Kalini and Arsovski (2009) described Mobile Learning as an approach in electronic learning (e-learning) that utilizes mobile devices. Also, UNESCO (2013) identified Mobile Learning as the

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_7

use of mobile technology, alone or in combination with other information and communication technology (ICT) to enable learning anytime and anywhere. Learning can unfold in a variety of ways: people can use mobile devices to access educational resources, connect with others, or create content inside or outside of classrooms. Mobile Learning also encompasses efforts to support broad educational goals such as the effective administration of school systems and improved communication between schools and families. Crompton (2015) included four constructs in her definition of Mobile Learning as learning across multiple contexts, through social and content interactions, and using personal electronic devices. Finally, Hayman (2015) stated that Mobile Learning takes place when the learner uses mobile devices to acquire institutional materials to increase his or her knowledge, given limits set forth by a course facilitator and based on the target mobile device, mode of delivery, and content quality necessary to achieve skill mastery.

From the above-mentioned definitions, and based on Crompton's (2015) constructs of Mobile Learning, the author describes Mobile Learning as a process that takes place when a learner, at their convenience, accesses higher education course content for a given subject via mobile device and experiences various interactions with content, facilitators, and peers through Mobile Learning delivery methodologies such as games, storytelling, presentations, simulations, role-play, discussions, debate case studies, and reflection. Such content and interactions enable learners to achieve the intended high-order learning and thinking goals and objectives required for twenty-first century learners and workers.

To avoid the quicksand of semantic precision, UNESCO (2013) chooses to embrace a broad definition of mobile devices, recognizing simply that they are digital, easily portable, and usually owned and controlled by an individual rather than an institution. Such devices can access the internet, have multimedia capabilities, and can facilitate a large number of tasks, particularly those related to communication.

One question arises from above-mentioned definitions of Mobile Learning: what are the devices used for Mobile Learning? Traxler (2009) lists several devices: PDA, Palmtop, handhelds, smartphones, iPod, Tablets (as cited in Compton, 2015). Mobile technologies are constantly evolving. The diversity of devices on the market today is immense and includes, in broad strokes, mobile phones, tablet computers, e-readers, portable audio players, and handheld gaming consoles. Tomorrow the list will be changing even faster. The author agrees with Traxler that Mobile Learning should not be confined to those devices mentioned because new generations will be produced and used whenever and wherever the learners need them.

Park (2011) maintains that Mobile Learning has unique technological attributes that provide positive pedagogical affordances. Specifically, portability is the most distinctive feature distinguishing handheld devices from other emerging technologies, and this factor makes other technological attributes such as individuality and interactivity possible.

Kochattil (2016) stated that the use of mobile phones is skyrocketing, as is the power and speed of internet connectivity. These two trends have a pronounced impact on Mobile Learning, leading to a spectrum of Mobile Learning trends. It is predicted that in the near future, mobile devices will be produced in much greater numbers with lower prices and smaller sizes than desktop PCs (Kalini & Arsovski, 2009).

Researchers and practitioners of Mobile Learning have pointed out limitations such as physical attributes of mobile devices, content and software application limitations, network speed and reliability, and physical environment issues (Park, 2011). Nonetheless, there are benefits for implementing Mobile Learning for individual learners, institutions, and countries, described as follows:

7.1.1 The Individual Learner

Al-Okaily (2015) surveyed a group of students about whether using mobile devices increases the quality of a lesson. The results showed that 62% felt they had become more active when using their mobile in the classroom as part of the lesson, and 73% felt that it enabled them to learn more and to find information independent of the instructor. The findings reflect the educational trend toward enhancement of educational outcomes by providing learning experiences that help learners to be self-determining to achieve the high-order learning and thinking goals and objectives for twenty-first century learners and workers.

Mobile Learning programs also respond to the need of workers for flexible higher education programs to pursue professional development without giving up jobs. Mobile Learning programs will put into practice new forms of education that are flexible and that help learners to overcome time and place barriers to access information, services, and learning materials from anywhere, at any time, and through any mobile device without being tethered to an electrical outlet. These features enable Mobile Learning to enhance lifelong learning and continuing education opportunities for those who cannot enroll in traditional universities.

7.1.2 Higher Education Institutions

It is predicted that in the near future mobile devices will be produced in much higher number with lower prices and sizes than other devices (Kalini & Arsovski, 2009). The availability of cheaper and lighter untethered Mobile devices is an opportunity for more competitive status through opening new Mobile Learning programs in different specialties. Such programs will support local community development by enabling young employed or unemployed citizens in developing or developed countries to become college degree holders with better chances for social and economic mobility.

An important benefit of Mobile Learning is the enhancement of traditional teaching strategies; Srinivasan (2016) stated that Mobile Learning is spontaneous, private, informal, and interactive. Park (2011) has highlighted that Mobile Learning can support effective face-to-face communication when students use devices in the classroom instead crowding around one computer.

7.1.3 Developing Countries

Developing countries around the globe face political, social, and cultural changes along with economic problems, pollution, and limited resources, in addition to increasing demand for highly skilled workers holding higher education degrees. Thus, it is important that their national strategic educational plans call on all universities, traditional and non-traditional, to adopt Mobile Learning programs that meet such demands without comprising the quality standards of higher education.

Another distinctive benefit of Mobile Learning is sustainability. Ally (2013) stated that Mobile Learning is green learning since it reduces the use of print and minimizes travel. The author agrees that this unique and sustainable feature qualifies higher education Mobile Learning programs to be adopted by many universities in developing counties as well as in developed countries.

Ally (2013) stated that "Mobile Learning will be the future of education whether we like it or not". Thus, he recommends that great efforts be put into the field of Mobile Learning, including, for example, international collaborative research projects and sharing of best practices. Ally's (2013) recommendations and the literature reviewed on Mobile Learning inspired the author to write this chapter, which presents an in-depth discussion of Mobile Learning Pedagogical Quality Standards, substandards, and fifty review indicators. Pedagogical factors of effective Mobile Learning are highlighted and discussed beyond technological applications; this topic is important for various stakeholders.

7.2 Mobile Learning Standards and Frameworks

Some existing frameworks address pedagogies and learning environment design. Koole (2009) created a "Framework for the Rational Analysis of Mobile Education" (FRAME), a Venn diagram comprising three circles (aspects): (1) device; (2) learner; and (3) social aspects. The four intersections of the circles are: interaction learning (LS), device usability (DL), social technology (DS), and Mobile Learning (DLS). FRAME can be used to assess the degree to which areas of the model are utilized in Mobile Learning situations. FRAME is very well organized and was adopted as a checklist to guide development and assessment of Mobile Learning environments.

Peng, Su, Chou, and Tsai (2009) proposed a visual, hierarchal framework of ubiquitous knowledge, with (1) learners and tools as the base; (2) the middle level of pedagogical methods focusing on constructivism and lifelong learning; and

(3) the top level, a vision of achieving ubiquitous knowledge construction. Peng et al. highlighted issues of ubiquitous learning to be addressed by educators and designers in promoting and implementing Mobile Learning effectively. At the foundational level, important issues are the educational digital divide, classroom management, network literacy, and building partnerships. At the middle level, the issue is training teachers in cultivating constructivist learning and lifelong learning. At the top level, the issue is scaling up with support of empirical evidence regarding effects of ubiquitous computing on learning.

Park (2011) adopted transactional distance (TD) theory to review educational applications of mobile technologies, producing a pedagogical framework categorizing them into four types: (1) high transactional distance socialized m-learning; (2) high transactional distance individualized m-learning; (3) low transactional distance socialized m-learning; and (4) low transactional distance individualized m-learning. These types are all mediated by mobile devices. He claims the framework can be used by instructional designers of open and distance learning to learn about concepts of Mobile Learning and how mobile technologies can be effectively incorporated into teaching and learning.

Kearney, Chuck, Burden, and Aubsson (2012) proposed a pedagogical framework for Mobile Learning consisting of three circular layers: (1) The inner layer consists of use and organization of time-space in the learning experience; (2) the second layer includes three constructs, personalization, authenticity, and collaboration, as distinctive Mobile Learning features; (3) the outer layer, consisting of aspects such as conversation, data sharing, contextualization, situatedness, customization, and agency. The framework contains bidirectional arrows showing the close relationship between the inner time-space layer and Mobile Learning features.

Ng and Nicholas (2013) proposed a person-centered visual framework for sustainable learning in schools focused on people involved and interrelationships between stakeholders: management, teachers, parents, students, and technical support personnel. The model shows relationships, levels of interaction, and interactions with devices. Ng and Nicholas used this framework to examine implementation of a learning program and stakeholder actions in an Australian school from 2007=2010. This study showed three aspects that should be addressed for a successful and sustainable Mobile Learning program. First, developing positive attitudes in students and teachers toward the program by providing sufficient, real-time technology (hardware and software) and technical support. Second, ensuring effective communication between stakeholders to prevent tension and misunderstandings. Third, delegating responsibilities with trust from management to teachers, and from teachers to students, is critical.

The Quality Matters program (QM) proposed the Quality Matters Higher Education Rubric, Fifth Edition (2014), a set of eight general standards: (1) Course Overview introduction, (2) Learning Objectives, (3) Assessment and Measurement, (4) Instructional Materials, (5) Course Activities and Learner Interaction, (6) Course Technology, (7) Learner Support, and (8) Accessibility and Usability. The standards are used to evaluate the design of online and blended courses. A scoring system and set of online tools facilitate the review by a team of Peer Reviewers.

Cookson (2015) prepared a practical guideline providing step-by-step instructions for creating hybrid or online courses. The seven steps are: (1) build the instructional design; (2) draft the instructional narrative; (3) integrate multimedia; (4) add learning activities; (5) plan assessments; (6) pilot and evaluate the course, and (7) revise the course.

All the above-mentioned Mobile Learning frameworks are examples addressing pedagogical themes. Some the educational issues emphasized in these frameworks are: stakeholders, vision, learning outcomes (affective and cognitive), Bloom's Taxonomy, learners, content, attitudes, trust, interactions, learning experience, personalization, authenticity, dialogue, communication, structure, collaboration, orientation, etc.

7.3 Proposed Mobile Learning Pedagogical Quality Standards

Whereas the author has benefited from the above-mentioned literature on Mobile Learning standards, frameworks, and instruction, there is still a need for Pedagogical Quality Standards for Mobile Learning because education is a complex phenomenon associated with many issues that need to be highlighted when designing or implementing Mobile Learning.

It is essential to start with the simplest definition of quality as "fitness for use"; the Oxford dictionary describes it as: "The standard of something as measured against other things of a similar kind; the degree of excellence of something". Philip Cosby affirms that Quality is conformation to requirement. Lately, some institutions are moving toward a higher level of quality, excellence in exceeding customer needs and expectations.

Related to Quality, the term "standard" has to be clarified. According to the Oxford dictionary, a standard is: "Something used as a measure, norm, or model in comparative evaluations". The European Telecommunications Standards Institute (2016) describes a standard as a document that provides rules or guidelines to achieve order in a given context.

Ehlers and Pawlowski (2006a, 2006b) emphasized that quality standards support quality developments in organizations according to their specific needs and requirements. Standards should improve flexibility, reusability, transparency, and comparability and should be widely accepted in the community. They acknowledged that in the field of learning, education, and training, a variety of standards can be roughly classified into three classes: (1) Generic Quality standards that can be used in different sectors; (2) specific Quality standards concerning process or products; (3) related standards that are used to assure specific aspects of quality. They added that to design a quality approach and standards, the following aspects have to be specified: (1) The Context and Scope for which the approach is intended (e.g., school, higher education, etc.); (2) which quality objectives can be achieved by an approach (e.g., cost, learner satisfaction product reliability); (3) the focus or the quality approach to process, product, or competencies; (4) which stakeholders and from which perspective was a quality approach designed (e.g., developers, administrators, learners); (5) which methods and instruments are used (e.g., benchmarking criteria catalogue, guidelines); (6) which indicators and criteria are used to measure success (e.g., dropout rate, return on investment, learner satisfaction).

Based on Ehlers and Pawlowski's (2006a, 2006b) method of classifying standards, the author proposes three Pedagogical Quality Standards intended for use by higher education institutes to provide a high-quality Mobile Learning experience that increases learners' interactions and satisfaction with Mobile Learning and enables them to demonstrate competencies reflecting the achievement of high-order learning and thinking goals and objectives required for twenty-first century learners and workers. The following stakeholders can benefit from such standards: (1) administrations of higher education institutes for implementing Mobile Learning projects properly; (2) instructional designers and teachers for assessing their progress and improving the design and preparation of Mobile Learning for a lesson, course, or entire program; (3) individual mobile learners can also go through Mobile Learner Standards to raise their awareness about what they are supposed to do when enrolled in Mobile Learning courses or programs.

The Pedagogical Quality Standards are as follows:

- Standard 1: Mobile Learning Curriculum
- Standard 2: Mobile Learning Learner
- Standard 3: Mobile Learning Teacher

Each standard consists of a number of substandards and review indicators distilled from current literature on Mobile Learning and shown in Tables 7.1, 7.2, and 7.3.

Standard 1: Mobile Learning curriculum

The Great Schools Partnership (2016) defined curriculum as typically referring to the knowledge and skills students are expected to learn. This includes the learning standards or objectives they are expected to meet; the units and lessons taught; the assignments and projects given to students; the books, materials, videos, presentations, and readings used in a course; and the tests, assessments, and other methods used to evaluate student learning. Table 7.1 presents Standard 1, Mobile Learning curriculum, consisting of four Pedagogical Quality substandards and 24 review indicators. The substandards are: 1.1 Mobile Learning Objectives, 1.2 Mobile Learning Assessments, 1.3 Mobile Learning Instructional Materials, and 1.4 Mobile Learning activities

1.1 Mobile Learning goals and objectives

Goals and objectives are the building blocks of any traditional or Mobile Learning course or program. In order to design them properly, it is crucial to identify the learners' characteristics. As shown in Table 7.1, pedagogical quality indicator

Table 7.1 Pedagogical Quality Standards for Mobile Learning, Standard 1: Mobile Learning curriculum

Substandard	Pedagogical quality indicator	Assessment rating (points)		
		Excellent (2)	Sufficient (1)	Deficient (0)
1.1 Mobile Learning goals and objectives	1.1.1 Identifying the context and scope for which Mobile Learning is intended (e.g., school, higher education, etc.)			
	1.1.2 Identifying and analyzing target Mobile learners' needs and key attributes or characteristics such as age, knowledge, experience, nationalities, etc.			
	1.1.3 Establishing measurable program/course high-order learning and thinking goals and objectives as required for twenty-first century learners and workers			
	1.1.4 Developing program/course objectives suitable for the level of the course/program and directing Mobile learners at every stage of the learning process to Instructional Materials to help them achieve these objectives			
	1.1.5 Organizing and sequencing earning objectives, e.g., from general to specific, simple to complex, or easy to difficult			
1.2. Mobile Learning Assessments:	1.2.1. Designing and administering assessment tools that measure higher-order learning outcomes, e.g., open book exams, take-home exams, quizzes, peer assessments, computer marked assessments, etc.			
	1.2.2 Creating and using grading rubrics to assess the quality of student work or performance			
	1.2.3 Communicating assessments, grading criteria, appeals, and general policies to Mobile learners in early stages of the program/course			
	1.2.4 Providing immediate feedback after completion of formative and summative assessments			
	1.2.5 Using multiple constructive evaluation and feedback resources from stakeholders to improve Mobile Learning curriculum and projects			

(continued)

Table 7.1 (continued)

Substandard	Pedagogical quality indicator	Assessment rating (points)		
		Excellent (2)	Sufficient (1)	Deficient (0)
1.3. Mobile Learning Instructional Materials	1.3.1 Referring to more than one Mobile Learning theory (e.g., Transactional Distance theory, Cognitivism, Behaviorism, Constructivism, Situated learning, Collaborative learning, Conversational learning, activity theory, Problem-based learning, Context awareness learning, Sociocultural theory, Lifelong learning, or informal learning) when building course/program Instructional Materials			
	1.3.2 Clustering Instructional Materials according to the sequence of course/program objectives			
	1.3.3 Choosing Mobile Learning Instructional Materials that are up to date, relevant, and contribute to the achievement of course/program objectives			
	1.3.4 Breaking down Instructional Materials into smaller units, and defining how much of it will be synchronous, asynchronous, fully mobile, or blended,			
	1.3.5 Developing a well-timed plan for Mobile Learning that serves as a road map and specifies human, financial, administrative, and technological resources needed			
	1.3.6 Providing Mobile learners with both mandatory and optional Instructional Materials			
	1.3.7 Designing Mobile Learning Instructional Materials that attract learners and gain their focus			
	1.3.8 Referring to Cognitive load theory to ensure effective use of Mobile Learning technologies such as smart phones, tablets, notebooks, iPads, as well as conventional E-learning tethered technologies such as desktop and personal computers to produce effective, efficient and engaging Mobile Learning			

(continued)

Table 7.1 (continued)

Substandard	Pedagogical quality indicator	Assessment rating (points)		
		Excellent (2)	Sufficient (1)	Deficient (0)
1.4 Mobile Learning activities	1.4.1 Consistency of learning activities with program/course objectives			
	1.4.2 Classifying learning activities into three groups: to absorb, to do, and to connect			
	1.4.3 Implementing Mobile Learning activities characterized by high transactional distance individualized m-learning			
	1.4.4 Inclusion of Mobile Learning materials to suit learners with different learning styles (e.g., text, photos, audio discussion, forums, lectures, assignments, take-home exams, and presentations)			
	1.4.5 Embracing Mobile Learning socialized activities to include multiple interactive and engagement strategies with peers or teachers, such as games, simulation, interactive tutorials, problem-based learning, peer tutoring, games, storytelling, role-play, discussions, and debate case studies			
	1.4.6 Embracing multiple, individualized Mobile Learning activities such as student-generated content, storytelling, presentations, reflection, etc.			
Total points				

1.1.2, "Identifying and analyzing Target Mobile learners' needs and key attributes or characteristics such as age, knowledge, experiences, and nationalities", determine to a certain degree the type and quantity of intended goals and objectives required for the twenty-first century learner and worker. There are some important aspects in the process of designing intended goals and objectives such as "Organizing and sequencing from general to specific, or simple to complex, or easy to difficult", pedagogical quality indicator 1.1.5.

1.2 Mobile Learning assessments

Mobile Learning assessments are the second substandard in Standard 1. Typically, Mobile Learning instructional designers get excited by the Mobile device features

Table 7.2 Pedagogical Quality Standards for Mobile Learning, Standard 2: Mobile Learning learner

Substandard	Pedagogical quality indicator	Assessment rating (points)		
		Excellent (2)	Sufficient (1)	Deficient (0)
2.1 Mobile Learner Orientation and Support	2.1.1. Training registered students to acquire knowledge, develop positive attitudes, and skills to use mobile devices effectively			
	2.1.2 Providing Mobile learners with a study guide, guideline, or storyboard that contains elements such as program/course prerequisite knowledge, intended goals and objectives, topics, policies, schedule, calendar, assessments dates, rubrics and assessment criteria, student feedback process, etc.			
	2.1.3 Providing Mobile learners with detailed information of the technical support offered, and procedures to obtain it			
	2.1.4 Developing and communicating Mobile Learning ethics, plagiarism issues, and conflict management to students			
2.2. Mobile Learner Performance:	2.2.1. Mobile learners introducing themselves via their profile to their colleagues and teachers			
	2.2.2. Mobile learners being proficient in writing and speaking			
	2.2.3. Mobile Learning learners being proficient in operational online competencies, using digital technologies, and ICT tools in formal educational contexts			
	2.2.4. Mobile Learning learner being proficient in academic competencies, e.g., studying, assimilation of content, working academically, and obtaining passing grades in their course or program			
	2.2.5. Mobile Learning learners being competent in relational competencies, e.g., communicating and collaborating with fellow students and with their teachers			
	2.2.6. Administering well-defined procedures to monitor student engagement and interactions with the Mobile Learning content, peers, and teachers			

(continued)

Table 7.2 (continued)

Substandard	Pedagogical quality indicator	Assessment rating (points)		
		Excellent (2)	Sufficient (1)	Deficient (0)
	2.2.7. Mobile learners being proficient in metacognitive competencies, e.g., a Mobile learner carrying out self-management in regard to learning goals, process, and evaluation			
	2.2.8. Mobile Learning learners being proficient in understanding presented material, organizing it into a coherent cognitive structure, and integrating it with relevant existing knowledge			
Total points				

Table 7.3 Pedagogical Quality Standards for Mobile Learning, Standard 3: Mobile Learning teacher

Substandard	Pedagogical quality indicator	Assessment rating (points)		
		Excellent (2)	Sufficient (1)	Deficient (0)
3.1 Mobile Teacher Orientation and Support	3.1.1 Training teachers to improve their knowledge, develop positive attitudes, and acquire skills in using Mobile technology			
	3.1.2. Training Teacher to introduce themselves to Mobile learners			
	3.1.3. Training teachers in effective management of Mobile Learning classrooms			
	3.1.4. Providing Mobile Learning teachers with Pedagogical Support			
	3.1.5. Providing Mobile Teachers with detailed information on technical support offered, and procedures to obtain it, via several communication channels			
	3.1.6. Developing and communicating Mobile Learning ethics, plagiarism issues, and conflict management to teachers			

(continued)

Table 7.3 (continued)

Substandard	Pedagogical quality indicator	Assessment rating (points)		
		Excellent (2)	Sufficient (1)	Deficient (0)
3.2 Mobile Teacher Performance	3.2.1 Mobile Learning teachers introducing themselves to students through their online profile.			
	3.2.2 Mobile Learning teachers creating and disseminating knowledge to students in various formats: videoconferences, forums, mail, social networks, fact-to-face, etc.			
	3.2.3 Mobile Learning teachers being proficient in online operational competencies, such as using digital technologies and ICT tools in formal educational contexts			
	3.2.4 Mobile Learning teacher communicates important topics, objectives, criteria of student active participation, etc.			
	3.2.5 Mobile Learning teachers facilitating learning and guiding students toward understanding course topics			
	3.2.6 Mobile Learning teachers being competent in creating an open, positive learning climate; motivation, empathy with students, etc.			
	3.2.7 Mobile Learning teachers focusing on higher-value educational responsibilities and tasks			
	3.2.8 Use of assessments tools to assess teachers' performance by Mobile Learning specialists			
Total points				

that allow them to administer flexible assessment tools which help learners to overcome time and place barriers. Such innovations are worthy if these tools are custom-made to assess intended Mobile Learning goals and objectives and provide immediate feedback. Thus, pedagogical quality indicator 1.2.1 "Designing and administering assessment tools that measure higher-order learning outcomes" helps to eliminate such practices.

1.3 Mobile Learning Instructional Materials

The third substandard in Standard 1 is Mobile Learning Instructional Materials. Considering that there are many Mobile Learning theories (e.g., Transactional Distance theory, Cognitivism, Behaviorism, Constructivism, Situated learning, Collaborative learning, Conversational learning, activity theory, Problem-based learning, Context awareness learning, Sociocultural theory, Lifelong learning, Inquiry-based Learning or informal learning), it is wise to refer to more than one Mobile Learning theory upon which Mobile Instructional Materials are constructed. This point is illustrated in pedagogical quality indicator 1.3.1.

There are some important hints for the process of designing instructional material such as: alignment between intended objective and content; the originality of Mobile Learning content; relevance and richness to improve learners' performance; and breaking down learning content into smaller units. Such efforts will make Mobile Learning content attract learners and gain their focus. These points and others are listed in pedagogical quality indicators 1.3.2–1.3.8.

1.4 Mobile Learning activities

There are many points considered in this substandard, such as Implementing Mobile Learning strategy as a part of a blended learning approach, and in combination with other strategies such as E-learning, online learning, face-to-face sessions, etc. Also, Mobile Learning materials have to be diverging to suit learners with different learning styles, e.g., text, photos, audios discussion, forums, lectures, assignments, take-home exams, and presentations. It is important that Mobile Learning content includes multiple interactive learning strategies such as games, simulation, interactive tutorials, problem-based learning, student-generated content, and peer-to-peer tutoring. Other strategies are games, storytelling, presentations, simulations, role-play, discussions, debate case studies, reflection, etc. Such activities will motivate the learner to actively interact and perform multiple academic, metacognitive, and operational competencies.

With regard to substandard 1.4, Mobile Learning activities, the author prefers to include within this substandard Parks' (2011) type 2 Mobile Learning activities which are characterized by high transactional distance individualized m-learning in which (1) the learners are separated by more psychological and communication space from the teachers or instructional support; (2) the individual learners receive highly structured and well-organized content and resources such as recorded lectures or readings via mobile devices; (3) the individual learners receive the content and control their learning process in order to master it; and (4) the interactions mainly occur between the individual learner and the content. Park detailed that this type of activity allows for greater flexibility and portability of Mobile Learning for students in rural areas. This point is shown in Pedagogical quality indicator 1.4.3.

Standard 2: Mobile Learning Learner

As in traditional learning, Mobile Learning strategy is learner-centered; the learner is the central and most important dimension in the learning process. The aim of such strategy is to meet the needs of learners to master their personalized academic goals. Table 7.2 presents Standard 2, which consists of two substandards and twelve pedagogical quality indicators.

2.1 Mobile Learner Orientation and Support

With regard to substandard 2.1, Mobile Learner Orientation and Support, the results of Group's study (2008) (as cited in Bautista & Escofet, 2015) indicate that most young university students used the internet casually and were capable of carrying out multiple tasks at the same time. These young people used the internet for leisure and social purposes, but they did not use searches effectively in a formal setting. Therefore, the study concluded that the competencies for more formal use of the Internet in an educational context are not clear.

Borges & Forés (2015) argued that although university students are familiar with the use of digital technologies and tools, very few of them use these to produce content in formal education. The author agrees with Borges & Forés (2015) that for quality Mobile Learning, there should be formal orientations for registered students to acquire knowledge and skills in using mobile devices effectively. This is in addition to the provision of students with a guideline or a storyboard to direct them at every stage of the learning process to achieve intended goals and objectives. Another aspect of quality, shown in pedagogical quality indicator 2.1.4 "Developing & communicating Mobile Learning ethics and plagiarism issues, conflict management to students", such efforts will make Mobile learners aware of ethics and plagiarism issues and prevent unacceptable or illegal activities that might lead them being ejected from their universities.

2.2 Mobile Learner Performance

Borges & Forés (2015) stressed that there should be a guide or reference for students' performance online. They developed a compressive framework/approach that contains four interrelated roles the online learner should adapt to: Operational, Academic, Relational, and Metacognitive. They added that each role consists of a number of competencies required for online courses, programs, or studies. For the Operational role, a learner must perform certain competencies such as the use of online and ICT tools for learning. The Academic role requires a learner to perform certain competencies such as being competent in studying, assimilating course content, working academically, and using learning materials. For satisfactory performance, the rational role requires a learner to acquire social, affective, and communication skills. Finally, the Metacognitive role requires key competencies such as teamwork, use of communication tools, and writing and speaking efficiently. They recommended that training students in the role of online learner can contribute to quality design of online courses and programs, and satisfactory learning experiences. Since learners vary in their degree of interaction it is logical to set well-defined procedures and tools to monitor student engagement and internal or interpersonal interactions, as well as interactions with the Mobile Learning content, peers, and teachers. All those aspects are embodied in pedagogical quality indicators 2.2.3–2.2.7.

Standard 3: Mobile Learning Teacher

Schlechty (2002) (as cited in Reigeluth, 2015) stated that the teacher's role has changed from the "sage on the stage" to the "guide on the side". In other words, in the past a teacher was an active player in the learning process and played a major role in preparing lessons and teaching aids, in addition to gradually delivering information to students; today this role has changed a great deal. Reigeluth (2015) pointed out that there are three major roles involved in being a guide: the teacher is a designer of student work, the teacher is a facilitator of the learning process, and the most importantly the teacher is a caring mentor. Table 7.3 presents Standard 3, Mobile teaching Teacher, which consists of two substandards and fourteen pedagogical quality indicators.

3.1 Mobile Teacher Orientation and Support

The author agrees with the concepts of Schlechty (2002) and Bautista & Escofet (2015) with regard to the changing roles of teachers. Thus, she has introduced substandard 3.1, Mobile teacher orientation and support, within Standard 3. Orienting teachers will improve their skills in designing Mobile Learning materials and using Mobile technology. This point is represented by pedagogical quality indicator 3.1.1.

Another point that has to be considered is developing and communicating Mobile Learning ethics, plagiarism issues, and conflict management to teachers. If they are not aware of such issues, they will not be able to deal properly with mobile learner misbehavior. This point is reflected in pedagogical quality indicator 3.1.6.

3.2 Mobile Teacher Performance

Bautista & Escofet (2015) discussed a cluster of competencies that should be acquired by faculty in order to carry out the learning process in online or face-to-face settings, e.g., competencies related to use of different forms of ICT, communication, information processing, and participation and collaboration among peers and students on the internet. Bryson and Jenkins (2015) contended that the use of technology requires a mindset shift, which is as important as the skillset. Another pedagogical Quality indicator of Mobile Teacher Performance is that Mobile Learning should save teachers time and enable them to focus on higher-value responsibilities such increasing the quality of interactions with content and students, etc. All of these points are listed in pedagogical quality indicators 3.2.2–3.2.8.

7.4 Conclusion

Ally (2013) stated that "Mobile Learning will be the future of education whether we like it or not". The availability of cheaper, lighter, and untethered Mobile devices in the near future can be captured as a strategic opportunity by higher education institutions and policy makers in developing counties to expand and facilitate educational opportunities for citizens eager to become college degree holders and have better chances for upward social and economic mobility, in addition to speeding up the process of providing local markets with highly skilled workers holding higher education degrees.

Researchers have produced many Mobile Learning standards or frameworks, but there is still a need for Pedagogical Quality Standards for Mobile Learning. This chapter presents an in-depth discussion of what constitutes Mobile Learning Pedagogical Quality Standards. Fifty pedagogical quality review indicators are clustered into three Pedagogical Quality Standards and eight substandards. This topic is important for various stakeholders. Mobile Learning instructional designers, teachers, and administrations at higher education institutes can use them to assess their progress and improve the design and preparation of Mobile Learning, whether for a lesson, a course, or an entire program. The standards draw attention to the pedagogical factors of effective Mobile Learning and take them beyond technological applications. Stakeholders that can benefit from such standards include: (1) administrations of higher education institutes for implementing Mobile Learning projects properly; (2) instructional designers and teachers for assessing their progress and improving the design and preparation of Mobile Learning for a lesson, course, or entire program; (3) individual mobile learners by going through Mobile Learner Standards to raise their awareness of what they are supposed to do when enrolled in Mobile Learning courses or programs.

Glossary

Mobile Learning Mobile Learning is a process that takes place when a learner at their convenience accesses higher education course Instructional Materials (content) for a given subject via their mobile device, and experiences different kinds of interactions with content, facilitators, and peers through Mobile Learning delivery methodologies such as games, storytelling, presentations, simulations, role-play, discussions, debate case studies, reflection. Such content and interactions enable learners to demonstrate or perform the intended high-order learning and thinking goals and objectives required for twenty-first century learners and workers

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Chapter 8
Core Technologies in Mobile Learning

Qi Wang

Abstract With the development of mobile devices, networks and techniques, mobile learning has become quite an important form for both formal and informal learning. However, to make mobile learning effective and meaningful, proper strategies should be proposed to ensure the use of technology with the guidance of adaptive learning theories. The learning platform, as the support system of mobile learning, is the integration of both learning theories and techniques, as well as the carrier of mobile learning. Thus, core techniques used in mobile learning platforms are quite important in improving students' learning and teachers' instruction. This chapter will focus on some core technologies in mobile learning. Firstly, we will describe the problems of both teachers and students in the mobile learning era. Subsequently, the chapter illustrates the definition and features of mobile learning. Accordingly, the next section describes some core techniques to improve students' learning and teachers' instruction, as well as integration with learning theories. After that, a framework will be presented to guide practitioners in their use of mobile technologies. In the end, the prospects for future research in mobile techniques will be discussed.

Keywords Mobile learning · Mobile technology · Learning improvement
Core technology

8.1 Introduction

In the past decade, we have experienced the development of mobile devices, techniques, and networks. During this period, learning and teaching have been moving from indoors to the integration of both indoors and outdoors with the help

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_8

of mobile devices and mobile learning materials (Hung, Lin, & Hwang, 2010). Moreover, with the explosion of new knowledge and learning resources, one could not keep isolated from the new learning environment. Accordingly, in order to adapt to the era of knowledge economy and the meet the requirement of lifelong learning, one had better to learn new things related to his/her profession or interest (Min, Sheng, & Feng, 2016). However, on the one hand, knowledge from textbooks or other kinds of publication are not so immediate in reflecting the development of specific fields. On the other hand, textbooks are much more expensive if you want to follow the latest work. Under this condition, there are more and more online learning materials developed for learners and instructors to conduct the learning and teaching process on the online learning platform, especially on mobile learning platforms (Chen, Feng, Jiang, & Yu, 2016). From the results of many researches, it has been demonstrated that online-based or mobile-based learning has achieved great success in helping students in their knowledge construction, improving learning performance and motivating learning attitude (Hung et al., 2010; Chu, Hwang, Tsai, & Tseng, 2010; Chu, Hwang, & Tsai, 2010). Therefore, many more researchers have adopted mobile learning in their educational innovations and tried to explore some new forms of learning practice for future application (Lai, Hwang, Liang, & Tsai, 2016; Tan, Ooi, Sim, & Phusavat, 2015; Huang & Chiu, 2015). From all that is mentioned above, we have a preview of the effectiveness of mobile learning. But how can mobile learning play this role in the learners' learning process? Many of the reasons could be attributed to the technologies embedded or integrated adaptively in the mobile learning platform on the basis of some learning theories (Ally & Prieto-Blázquez, 2014; Keengwe & Bhargava, 2014). So what technology could be essential for mobile learning or what technology helps students learn with electronic resources more easily and efficiently? For example, personalized recommendation technology had helped students to locate learning resources more accurately (Yang & Yang, 2015; Hsu, Hwang, & Chang, 2013; Wang & Wu, 2011), and contextual technology (Chen & Huang, 2012) could help students adopt the most adaptive learning resource in a specific learning context. So, in this chapter, we present and introduce the core technologies which have been widely used in mobile learning platforms. What's more, some new technologies that could be helpful in improving the experience of mobile learning will also be discussed.

In order to know what technology would be crucial for mobile learning clearly, we should first know the definition and the features of mobile learning. Thus, in the second section, the definition and features of mobile learning are presented. The third section introduces some related works on technologies in mobile learning. The next section is the main part of this chapter, and it will discuss the core technologies used in mobile learning. Accordingly, in the fifth section, the author illustrates some examples to better understand how these technologies affect the learning process. Finally, there will be a discussion of prospects and conclusion.

8.2 Definition and Features of Mobile Learning

The concept of mobile learning had been proposed around 2000. From Google Scholar, if you search with the keyword ‘mobile learning,’ you could get almost nothing related before 2000. The earliest definition came from Quinn (2000) in his paper ‘mLearning: Mobile, Wireless, In-Your-Pocket Learning’ in 2000. At that time, mobile learning had been defined as ‘e-learning through mobile computational devices.’ As time went by, many researchers redefined mobile learning. Sharples, Taylor and Vavoula (2005) defined mobile learning as a state distinguished from other types of learning in which learners were continuously on the move, both in the time and the space. Traxler (2005) defined it as “any educational provision where the sole or dominant technologies are handheld or palmtop devices.” Later in 2007, Traxler improved the definition, adding the properties of “learners’ experience, ownership, informality, mobility and context,” as the previous one focused too much on technique (Traxler, 2007). Thus, most of the definitions emphasize on the mobility of the learners. In recent years, researchers tend to consider some other perspectives in learning, such as personality, contextualization, socialization, and knowledge building. Yu (2007) defined mobile learning as the following: mobile learning is a process for learners to get access to any learning resources with any device (mobile phones, PDAs, iPads, or other kinds of device with wireless communication modules) at anytime, anywhere. During this process, learners can communicate and collaborate with other social learners through networks in order to accomplish the construction of knowledge in learners’ minds. As for this chapter, we prefer the last definition, and think of mobile learning mainly as a state with intelligent services in the learning process. The state is mobility and the intelligent services help learners who are in a mobile state acquire adaptive content, resources, peers, and even instructors.

Apart from the definitions of mobile learning, to better illustrate the concept and make the definition fit the learning environment, many researchers describe mobile learning with some features. In Yu’s (2007) research, mobile learning has been tagged with 3 generations. In each generation, the emphasis is different. In the 1st generation, mobile learning emphasized the transfer of knowledge among learners. In the 2nd generation, the focus is cognitive construction, followed by the 3rd generation emphasizing situated cognition. Accordingly, the features of mobile learning have been reformed from support mobility, informality, accessibility for mobility, personalization, interactivity, multimedia, accessibility, superlinking, and connectivity (Sharples et al., 2005). Moreover, with the situated cognition illustration of mobile learning, the features of mobile learning have evolved to underline situated personalized learning. So during this period, the features of mobility, ubiquity, continuity, adaptability, connectivity, and being social, contextual and multi-mode. Each feature is described as follows:

Mobility: mobility is the most important feature of mobile learning because it defines the state of learning. Learning should not be confined to a fixed device or context.

Ubiquity: the feature of ubiquity is a supplement of mobility and is not so consistent with what we know as ubiquitous learning. It is just the narrow meaning of ubiquitous, meaning that learning can take place with any mobile device, at anytime, anywhere. That is a 3A (any content, any time, any location) learning with another confined A (any 'mobile' device). During this process, students can learn what they are interested in or need with mobile devices such as mobile phones, iPads, PDAs or wearable devices either in classroom or out of classroom.

Continuity: learning can be a kind of embedded learning integrating classrooms, workplaces, and any other places. Under this condition, one can link the in-class content with the out-of-class content seamlessly. This feature breaks the boundaries of informal and formal learning.

Adaptability: this feature extends personalization. With adaptability, each student can be a different individual. What we want to provide is not different services for different individuals but adaptive services for specific individuals. The services include learning materials, resources, helpers, and online support services. With all of these adaptability, we can benefit all learners in their mobile learning.

Connectivity: From the theory of connectivism, all factors in learning can be connected to other factors. This feature extends accessibility, meaning that learners can connect to learning resources while they can also connect to similar learners. With all these connective relations, learning can be a connective network.

Social: learning is not an isolated process. Communication with peers can be helpful in individuals' learning. Each knowledge or learning content can be related to some other learners or experts. When interacting with them, one can find the social knowledge network behind the content. So mobile learning is not only a static isolated process but also a dynamic social process.

Contextual: while learning is not an isolated process, learning can be conducted in specific contexts. The definition of context is not confined to the physical situation of learners. It also refers to other contexts such as learning context, instruction context, and emotional context. These contexts are factors influencing students' learning achievements.

Multi-mode: this feature means the form of learning can be multi-mode. Not only physical behavior will be input to evaluate, but also other forms of behavior such as emotional behavior and machinery behavior will be transferred to the mobile learning platform for further evaluation.

Knowing the above-mentioned features of mobile learning, we can understand the definition and process of mobile learning more clearly. Owing to this aspect, we can conduct mobile learning projects, courses, or experiments more easily. In the next section, we will discuss the related works in the technology-enhanced mobile learning field and list some of the challenges accordingly.

8.3 Related Works and Challenges in Technology-Enhanced Mobile Learning Contextual Multi-Mode

Technology-enhanced mobile learning simply means to use proper technology to help the implementation of mobile learning and to make the learning process more meaningful. Moreover, it aims to facilitate learning based on the above-mentioned features of mobile learning. There are many cases and experiments with technology-enhanced mobile learning that have been conducted all over the world. Some of them provided application examples for researchers and practitioners.

For mobile learning or ubiquitous learning, they all emphasize mobility and all-around learning. Learning can take place at anytime, anywhere, and with any device. The feature of mobility and ubiquity make it possible for students to make full use of spare time such as when he/she is at the subway or bus station. Moreover, this feature helps learners break the boundary between formal and informal (or indoors and outdoors). Learners can study seamlessly and continuously with the content he/she has just learnt in the classroom when it is time to go home. Chen et al. (2003) developed a mobile learning system to scaffolding the students with the bird-watching which made the learning process mobile. The result of this study shows that students using the system experienced an improvement in the learning outcome. Shih and Hwang (2010) conducted an experiment with RFID in learning about butterflies and wetland resources. The students used a PDA to scan the RFID tag to acquire the learning content. The result shows that this method can be helpful for students' learning as well as knowledge construction. Moreover, the learning process can be continuous. In these studies, mobile technology and wireless technologies are utilized.

In recent years, adaptive learning has been quite popular in education. For adaptive learning, not only the content should be adaptive, but the environment, format, and devices should also be adaptive. Some research on adaptive learning has demonstrated the effects of it. For example, Tseng (2008) created an idea of two-source personalized information for an adaptive learning system which analyzed learners' learning styles and behavior. With this idea, the researchers developed a mobile learning system and conducted an experiment with it. The result shows that it is of benefit for students' learning. This case can also reflect the multi-mode feature.

Connectivism (Siemens, 2005) supports that learners, instructors, and learning resources are all particles in the learning spaces. Learning is to connect these particles so as to form a network. It is also a feature of mobile learning. Thus, making learning a social process and having more people involved in it is very important in facilitating learning. Students' collaborative learning and teachers' collaborative lesson planning are all cased for connectivism. Wang et al. (2015) conducted an experiment on teachers' interactions in lesson planning and viewed the result of the lesson plan. The result shows that meaningful collaboration in CLP will be helpful for teachers' personal skills.

Contextualization is quite an important feature for mobile learning. It helps learners acquire resources adaptively for the present context. Huang, Liu, Lee, and Huang (2012) conducted a context-aware experiment. They adopted a nursing course as a subject and developed a mobile platform integrating the course content into the mobile devices to help nurses to study and act properly in real workplaces. The result shows that learners' learning outcomes have been improved.

From what have been mentioned above, we can see that some of the technologies have been used to support technology-enhanced mobile learning. They are used to create the mobile space, provide social connections, build adaptive learning environments, and better support personalized and contextualized learning. These applications have had some good effects and provided us some references. However, there are still some challenges for us to focus on in mobile learning. For example, though there are some good cases for mobile learning, there are rarely good mobile apps that can support large-scale learning based on learning science theories. Secondly, the context-aware cases mainly used QR code or RFID to support learning and therefore are not very efficient. Thirdly, most mobile-supported personalized learning provides contents preset in the database, so it could not adaptively support the dynamic context the learners may be confronted with. Moreover, in some majors, we still need environments which can support learners' authentic experience. Finally, the lack of student data for an efficient analysis is a crucial problem in mobile learning. Recently, the development of some technologies has been very helpful in solving these problems. In the next section, we will discuss the core technologies used in mobile learning.

8.4 Core Technologies in Mobile Learning and Their Applications

From what has been mentioned above, we describe some core technologies that may play an important role in the conduct of mobile learning. To fulfill the mobility and continuity features, mobile application technology is proposed. For ubiquity, there are many technologies that will support it, such as location-based service, VR/AR, and wearable technology. Personalized recommendation technology will support the adaptability feature. The connective and social features can be achieved by social knowledge networks as well as data- and relation-driven ontology behind the network. The feature of contextualization can be resolved by context-aware technology. The last feature, multi-modality, can be fully realized through artificial intelligence and big data technology. The core technologies in mobile learning are listed below: mobile application development technology; location-based service; VR/AR; wearable technology; personalized recommendation; social knowledge network (intelligent aggregation; linked data); ontology; context-aware technology; artificial intelligence; big data.

Mobile Application Development Technology: Mobile application development technology is not the program technology and hardware or network supporting the function of the apps. It includes the learning framework supporting various learning environments. As learning is an activity of both behavior development and cognitive development. Different people have different cognitive structures, and the structures are not as easy to represent as the process of purchasing (Albert, 1993). Thus, in developing mobile learning apps, we should first design the cognitive framework of specific subjects according to learning science theory (Thelen & Smith, 1995). After that we can integrate the framework into the development of learning apps. After the apps for several subjects are produced, we can form a mobile learning app framework supporting students' whole learning process and subjects.

Location-based Service Technology: Location-based service is another important technology in mobile learning. As mobile learning is mainly conducted outside the classroom, location-based service is quite important in telling what context the student is located in. Accordingly, the mobile learning system can provide specific guidance for the student based on the preset learning path. Many researchers have explored the effect of location-based learning (Hsiao, Lin, Feng, & Li, 2010; Unwin, Foote, Tate, & Dibiase, 2012; Choi & Kang, 2012) in environment learning, language learning, and support collaborative learning. Results of the research demonstrated that location-based learning can be helpful in students' learning outcomes as well as motivation (Hsiao et al., 2010; Choi & Kang, 2012).

VR/AR: in recent years, VR/AR become quite a popular topic in mobile learning. VR/AR can integrate the virtual context with the real context. The learners can get an authentic experience. This is an advantage in the learning process. Traditionally, students can only learn with given material in a given context, and this has led to a gap between real world and the classroom. Thus, it is quite difficult for many students to transfer knowledge into different contexts. VR/AR make it possible for students to learn with authentic experiences in an integrated context. Much research on VR/AR shows that it can benefit students' learning and attitudes (Hussein & Natterdal, 2015; Cai, Chiang, Sun, Lin, & Lee, 2016).

Wearable Technology: Wearable technology is another mobile learning technology. Wearable devices can sensitively get information from users and environments. With the information, the mobile learning system can locate the state of the learner. For example, if a student wears the device for a long time, the device can gather the behavior the student performed during this period. With this information, the mobile learning system can have an overview of the student's state, such as when will the student be tired, when will the student will be excited, if the student is sick and what was the student learning when the student was excited or tired. The state information can help the teacher or the system to intelligently analyze the student's state, preference, and to give personalized feedback (Pirkl et al., 2016). Further, we can also use deep learning technology to model the behavior (Zhu, Pande, Mohapatra, & Han, 2015). There is little research on this topic now.

Personalized Recommendation: Personalized recommendation is one of the most important technologies in mobile learning. In mobile learning, what we need is mostly from the recommendations of the mobile learning platform. From the theory of learning science and multiple intelligences, learners have different intelligences, and when they are learning, they perform differently and need different learning content and learning paths (Gardner, 1999). Using personalized recommendation technology to provide different resources, content, peers, instructors, and services for students could be helpful for their learning (Wang & Wu, 2011; Huang et al., 2012). Presently, the algorithms and models behind the recommendation are basic. The algorithms include collaborative filtering recommendation, content-based recommendation, knowledge-based recommendation, and other recommendations based on Bayes or IRE (Item Response Theory). The construction of the user model will mainly be decided by several attributes such as the learning style, subject, and the learning stage.

Social Knowledge Network: Social knowledge network is a technology to represent the relation computed by the server. Traditionally, the learning platform usually provides the relation among users or among knowledge. SKN provides a method for mobile learning systems to graphically show the relations among users and knowledge. If a learner has some problems in learning, he could find specific experts on the problem as well as specific resources. From particular users, we can also find resources relating to them. Behind the SKN, ontology technology, linked data technology, and aggregation technology are used to output the SKN service. Ontology and linked data are knowledge structures in the system. Aggregation technology can gather similar relations to provide visualized output. With these technologies, knowledge can be represented as triples (concept, property, and relation). All the visualized relations in SKN can be found or reasoned through the ontology and linked data. Research showed that SKN will be helpful in students' learning navigation and learning outcomes (Li, Zheng, & Jing, 2015).

Ontology: Ontology is a technology that can represent knowledge and the relations among knowledge (Ferreira-Satler, Romero, Menendez, Zapata & Prieto, 2010). With these relations, we can reason according to what we need. For example, if Yu is an expert on mobile learning in China, Ally is an expert on mobile learning in Canada, Ally is responsible for a journal in Canada, Wang is Yu's student and Wang has submitted an article to a Canadian journal. With the ontology, the mobile learning system will easily reason Wang probably submitted the article to Ally's journal. However, in a traditional platform with keyword search, we could not find the relation easily. Thus, ontology is quite an important technology to help create dynamic relations among resources.

Context-aware Technology: Context-aware technology is one of the most widely used technologies in mobile learning. It is mainly based on location-based service and wearable devices or sensors embedded in mobile devices to sense the learning context. The learning context contains several parts: user physical context, user learning context, user instruction context, time–space context, and resource context. Physical context describes the physical information of learners; user learning context describes the learning history or state of the learner; instruction context describes the instruction information such as the adaptive teacher or teaching style; time–space context describes when and where the learner will learn the most efficiently; finally, the resource context describes the adaptive context for the resource. With all of these context descriptions, users can get the most adaptive learning resources and services (Chen et al., 2016; Min et al., 2016).

Artificial Intelligence and Big Data: in the past several years, big data and artificial intelligence have been quite popular technologies; they have attracted many people's attention. Big Data is a data collection and analysis technology. Like SKN, it needs data from learners' daily learning behavior. Also for artificial intelligence, if we can collect enough data, we can use this data as samples to train some models under specific contexts of learning. During the training, a deep neural network is used to create prediction relations like human's brains. If the model is trained with comparable high accuracy, it could be used to predict a new learner's behavior or learning outcome. For this reason, we can use artificial intelligence to predict students' learning path and recommend them to learn with the most adaptive one. In this field, there are not very many researches focusing on the improvement of learning.

All these techniques help provide more adaptive services for mobile learners. Firstly it enhances the outside learning envrironment and then it enhances learners' interactions with learning content. Also during their learning process we can sense their learning environment, extract their personal preferences, collect their learning behavior, analyze their learning condition, provide adaptive learning activities or interactions and lastly give them learning feedbacks or suggestions. Moreover, the learning process becomes authentic and immersive instead of interacting on the surface. It would benefit the learners a lot.

8.5 Framework of Mobile Learning Technologies Application

With all the theories and technologies we could have a better understanding of mobile learning. However, in conducting mobile learning there are still some problems for learning is not only to provide technologies and services but also to provide the right person the right things. Mobile learning is a process involves many factors such as learners, learning platforms, devices, environments, learning resources, interactions and peers and experts. Without taking all these factors into consideration, some problems may occur when conducting mobile learning and our efforts may be wasted. So using the theories and technologies above to provide a framework for mobile learning would contribute to the practitioners. And in the framework mobile learning technology can help solve some problems in the mobile learning context. Figure 8.1 shows the framework of it. It is composed of an Educational Cloud Computing Center, Personalized Learning Services, Extended FOAF-based Social Networks, Adaptive technology-based presentation,

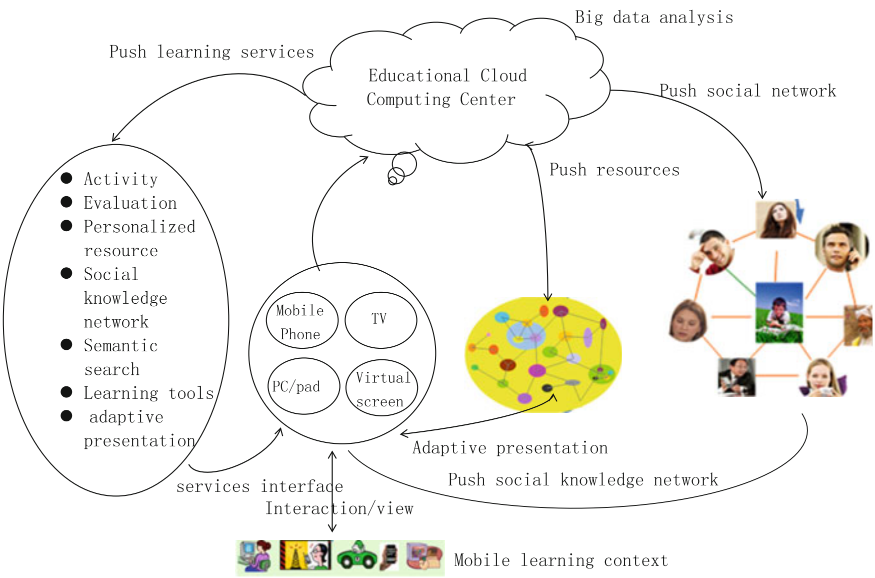

Fig. 8.1 Framework for mobile learning technologies

Ontology-based knowledge base, and a Contextual interface. All of these parts help to form a work flow in mobile learning. When a learner is learning with a title under specific context and confronted with some problems, the context-aware interface will firstly sense the learner's context using the sensors embedded in the devices or equipped in the environment and become aware of what the learner needs and then collect the context information, personal information, learning information, and other related information. All information will be transported to the Educational Cloud Computing Center. In this center, with big data technology, AI technology and semantic technology, what the learner needs, such as activities, resources, SKN, tools, and any other kind of learning services, would be aggregated. After that the content would be adaptively presented with proper devices. Further, the interactions between the learner and the aggregated content would be recorded to support the learning resources' evolution and the generation of new relations between learners, resources and ontology which is behind the resources and learners but play an important role during the process. After that a individual portrait, social knowledge network (including the learners' network, knowledge network and their blended network) will be formed for the learner and the behaviors generated will be reserved for future use. This process informs the framework which can integrate the main mobile learning technologies to facilitate learning.

8.6 Prospects and Conclusion

With the development of mobile technologies and networks, mobile learning has become a quite general learning form. Much research is based on mobile learning technologies to improve learning, such as context-aware, personalized recommendation, location-based service, and wearable technologies. Moreover, they have achieved some good feedback for learning. They are of importance in improving our learning and teaching. In the future, new technologies such as ontology, SKN, big data, and artificial intelligence will make great influence in the learning area.

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Chapter 9
Contexts of Learning and Challenges of Mobility: Designing for a Blur Between Formal and Informal Learning

Jimmy Jaldemark

Abstract The chapter will discuss challenges for design based on a context-dependent and complex understanding of mobile learning. The chapter elaborates on contextual aspects of learning and how these are related to mobility in terms of various issues involving physical space (locations), conceptual space (content), social space (social groups), technology, and learning dispersed over time. Through these aspects, mobile learning is emphasised as a complex social process that includes learning through communication between learners participating in multiple contexts mediated by personal, wireless, and mobile devices. Four challenges are discussed based on this complex understanding of mobile learning. Three of these challenges involve the relationship between learning and educational settings. The first challenge concerns how to learn at multiple intersections of physical locations and social groups. The second concerns the impact that personal, mobile, and wireless Internet-connected technology has on the monopoly of knowledge. The third concerns the blurring of the boundaries between formal and informal learning. To reach a coherent conceptualisation useful in designing for mobile learning, the chapter links these challenges to pragmatist and sociocultural ideas about the relationship between human beings and the surrounding context. These three challenges are embraced by a fourth challenge: to include the complexity of contextual aspects in conceptualisation and designing for learning. To meet these challenges, designing for mobile learning benefits from the deployment of concepts built from a transactional worldview. Such a worldview suggests the use of intersectional concepts that embrace several conceptual aspects of mobility in designing for learning.

Keywords Challenges · Communication · Conceptualisation · Content
Context · Conversation · Design · Dialogue · Educational settings
Environment · Formal learning · Informal learning · Interaction
Interactional worldview · Intersection · Learning · Learning communities
Learning environment · Lifelong learning · Location · Mobile learning

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_9

Mobility · Ontology · Transaction · Pragmatism · Seamless · Settings
Situated · Sociocultural · Social media · Space · Technology
Technology-enhanced learning · Time · Transaction · Transactional worldview
Tools · Ubiquitous · Worldview

9.1 Introduction

Since the 1960s and the first stages of development of the Internet, new opportunities for technology-enhanced learning have emerged and evolved at a fast pace. From the beginning, this development included geographically fixed technologies. However, during recent decades, mobile technologies—including devices, applications, and networks—have emerged that enhance learning in new ways (Castells, 2013). These new modes of learning involve technologies that support synchronous as well as asynchronous communication. In addition to extending communication in time, they also change the relationship between learning and space. This development has been a dynamic process that has changed the possibilities for learners to participate in interplay with aspects of the surrounding environment and other human beings. In other words, this development impacts the relationship between human beings and the contexts in which learning occurs.

The enhancement of learning through the use of mobile aspects to a great degree led to changing conditions for participation in formal and informal learning. These conditions blur the boundaries between these forms of learning by, for example, integrating work and life experiences into formal educational settings (Johnson et al., 2016). During recent years, scholars have discussed these conditions in terms of learning as a seamless (e.g., Milrad et al., 2013) and ubiquitous (e.g., Chen & Huang, 2012) phenomenon. From this position follows a potential change and extension of how the contextual aspects of mobile devices influence formal and informal learning.

The chapter aims at discussing challenges for design based on a context-dependent and complex understanding of mobile learning. Based on research about the contextual aspects of mobile learning, the chapter identifies four challenges. All these challenges also concern our understanding of the phenomenon of learning. Particularly, they relate to the relationship between learning and educational settings. They deal with how learning, as a complex social phenomenon, emerges and is designed for. The first challenge concerns how to learn at multiple intersections of physical locations and social groups. The second challenge concerns the impact that personal, mobile, and wireless Internet-connected technology has on the monopoly of knowledge. The third challenge concerns the blurring of the boundaries between formal and informal learning.

To reach a coherent conceptualisation useful in designing for mobile learning, the chapter links these challenges to pragmatist and sociocultural ideas about the relationship between human beings and the surrounding context. Moreover, these challenges also relate to discussions and ideas of recognised scholars within the field of mobile learning. Together the three challenges, pragmatist and sociocultural perspectives (e.g., Dewey, 1916; Vygotsky, 1978), and scholarly discourse within the field of mobile learning form a foundation to discuss the fourth challenge—including the complexity of contextual aspects in conceptualisation and designing for learning. This foundation is used to illustrate the necessity for solid and well-reasoned concepts that can be applied in the design process. Before discussing the challenges, a few words need to be said about the contextual aspects of mobility.

9.2 Contextual Aspects of Mobility

The link between human actions and contextual aspects is well recognised in the history of learning (e.g., Dewey, 1916; Vygotsky, 1978). Moreover, scholars linking mobility to learning emphasise the importance of such contextual aspects (e.g., Ally & Tsinakos, 2014; Traxler & Kukulska-Hulme, 2016). These aspects analytically link to mobility in terms of conceptual space, physical space, social space, technology, and learning dispersed over time (Kakihara & Sorensen, 2002; Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sánchez, & Vavoula, 2011). Together they afford a dynamic contextual understanding of the relationship between learning and mobility.

Regarding physical space (from here on discussed in terms of locations) and social space (social groups), the dynamic flexibility of mobility affords learning to occur in various physical locations and social groups. This means that mobility links to formal learning occurring in educational settings located at institutions such as kindergartens, primary schools, or universities. Moreover, mobility also links to informal learning occurring during activities at work, at home, or in leisure settings. The mobility of technology relates to the portability of devices and applications. Further, it also relates to transferability of content. This aspect affords flexibility between different devices. Conceptual space (from here on discussed in terms of content) relates to content and how learners shift their attention between different content (e.g. between different learning episodes during a day). Learning is also a cumulative process dispersed over time where learners engage in lifelong learning across formal and informal educational settings. These contextual aspects emphasise mobile learning as a complex social process of participation together with other learners in a nexus of contexts. This includes learning through communication mediated by mobile and personal devices. These contextual aspects of mobility blur the boundaries between formal and informal learning and pose particular challenges for learning-related design. Below follows the first challenge.

9.3 Challenge 1: How to Learn at Multiple Intersections of Physical Locations and Social Groups

The first challenge concerns understanding learning as an intersectional phenomenon dependent upon various physical locations and social groups (Ally & Prieto-Blázquez, 2014). It is possible for learners to be physically located in various settings while learning. Humans also learn together with colleagues, co-learners, families, and friends. It occurs at work, at home, or on leisure time as well as in formal education. However, while learners participate in formal education enhanced by technologies, they are not fixed to a single location. In effect, mobile technologies afford participation in a nexus of locations. Such a nexus could, for example, comprise homes, local study centres, university campuses, workplaces, and other physical locations. Learning in these locations occurs among various social groups, such as colleagues at work, the family at home, and other learners at the university campus or in leisure activities.

In their educational settings, learners can combine these physical locations and social groups in many ways (Jaldemark, 2008; Keller & Stevenson, 2012; Milrad et al., 2013). Besides being at a fixed location, the complexity above also includes learning that occurs while on the move between physical locations and social groups. Such possibilities challenge the boundaries of earlier physical and social limitations and support learning in a physically and socially seamless and ubiquitous educational setting.

The nexus of contextual aspects, such as physical locations and social groups, creates a certain complexity in designing for educational settings enhanced by mobile technologies, which needs to be considered. Taking this complexity into account in the design process also includes embracing the idea that a diversity of technologies supports interplay between learners. In order to enhance learning, that complex situation has to include possibilities for learners to participate in different ways. Therefore, design needs to take into account learning that is situated in different circumstances and supported by different technologies. In other words, learners need to be able to take advantage of different contexts—technologies, physical locations, and social groups—in support of their learning.

9.4 Challenge 2: The Impact Technology Has on the Monopoly of Knowledge

Another challenge concerns formal educational institutions' monopoly on knowledge. Biesta (2007) links this challenge to scientific and technological developments within society. The emergence of this challenge is linked to achievements from higher education institutions and research regarding wireless mobile technologies. Personally owned wireless Internet-connected mobile devices allow users to incorporate technological applications into their lives in ways that are not afforded by desktop technologies. Being portable, mobile devices afford learners to communicate within multiple intersections of physical locations and social groups. From a technological standpoint, such participation also relates to possibilities for communication through a wide range of different devices: from the smaller screens of smartphones to devices with much bigger screens.

Moreover, nowadays it is possible to deploy a wide range of applications to reach the same content. The consequence of this development is an enhancement of learning through applications, devices, and networks designed to support communication independent of the limitations of location and time. Bring-Your-Own-Device (BYOD) is a philosophy that suits such technological flexibility (Johnson et al., 2016; Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009; Sundgren & Jaldemark, 2016). The idea of BYOD affords the individual to use a personal device to access content, irrespective of the brand or type of mobile device. This means that it is easy for learners to carry and use smaller devices while participating in formal educational settings. For example, students of higher education can access wireless networks with laptops, smartphones, or tablets to search for information about content related to an ongoing lesson. The result of such searches could, for example, be used in discussions with fellow students or teachers.

The contextual aspects of mobility and their intersections with content afford a high degree of access to information and more possibilities for communication. Thus, they constitute a challenge to formal educational institutions to redefine the boundaries of the knowledge monopoly. Before this development, access to information and knowledge were to a high degree dependent on what was communicated about during teaching or in the mandatory literature. This means that learners have gained more power over content compared to what was possible in the earlier knowledge monopoly. The way this challenge is handled could lead to what Biesta calls the democratisation of knowledge, a state what he claims is a "crucial dimension of the knowledge society" (2007, p. 478).

9.5 Challenge 3: Blurring of the Boundaries Between Formal and Informal Learning

A third challenge concerns the boundaries of formal and informal learning. While the physical and social boundaries dissolve or blur, the boundaries between participating in these forms of learning melt. Laurillard (2009, p. xi) claims that "mobile learning blurs the division between formal and informal learning". Therefore, it is possible to claim that participation in mobile communication through a portable and wireless Internet-connected device affords the interplay between formal and informal learning (Mills, Knezek, & Khaddage, 2014; Sharples, 2000; Trentin & Repetto, 2013).

For example, it is common that students of higher education combine studies and work. If the content of their studies intersects with their work, they are in effect participating in formal learning at a higher education institution while they have access to contexts there they can process content through participation in working life. In the short term, such intersection could include the interplay between formal and informal educational settings during ongoing higher education programmes. In the long run, from a lifelong learning perspective, such interplay is a process that proceeds over time where individuals switch between different forms of learning (e.g., Ally & Prieto-Blázquez, 2014; Danaher, Moriarty, & Danaher, 2009; Johnson et al., 2016). This challenge to understand learning deals with how aspects of mobility afford experiences and knowledge learned in informal settings to influence formal learning and vice versa.

Given that mobile technologies help blur the boundaries between formal and informal learning, the challenge for the design of mobile learning is to support this blurring to help learners have high quality learning experiences. Among other things, such support needs to build a link between the content of the contexts (e.g. working life settings and higher educational settings) where formal and informal learning occurs. Moreover, contextual aspects need to build on each other to inform the learning process in an optimal way. This includes designs that support learning by allowing learners to use the most suitable physical locations, social groups, and technologies. Designs also need to be sustainable over time and support learning in different contexts.

9.6 Challenge 4: Inclusion of the Complexity of Contextual Aspects in Conceptualisation and Designing for Learning

In this chapter, contextual aspects of mobility illustrate the complexity of learning. The three challenges above are a consequence of this complexity and serve to illustrate it. These challenges concern participation in and understanding of educational settings where formal and informal learning intersect and blur. However, studies and results from research within the field of mobile learning also indicate another challenge for learning designs. This challenge concerns conceptualising and including the complexity of the contextual aspects of mobility in designing for learning (Vavoula, Pachler, & Kukulska-Hulme, 2009).

The dynamic and seamless character of the relationship between mobility and learning demands approaches and conceptualisations that discuss learning as a phenomenon that emerges in different social settings; occurs in multiple contexts or on the move between different contexts with various physical conditions; is dispersed over time; includes communication between learners; and is supported by personal, portable, wireless Internet-connected, and mobile devices. Nevertheless, this complexity of learning is not restricted to mobile learning. The contextual character of learning is not a new phenomenon; rather it is the case that support by a mobile device "exposes methodological complexities that need to be addressed" (Pachler, 2009, p. 2).

From this dynamic, seamless, complex, and contextually linked idea of learning, research about the relationship between learning and mobility points to an ontological issue—the essence of learning. This issue touches upon which point of departure in the relationship between human beings and the surrounding environment is needed to reach a coherent analysis and description of learning. In the wake of the answer of this ontological issue lies a challenge for designers of mobile learning to find approaches and conceptualisations that embrace the dynamic, seamless, complex, and contextual character of learning. In the following sections, consequences for designing for learning unfold. However, before addressing the issue of design, the chapter discusses the ontological departures for learning.

9.6.1 Ontological Departures

Historically, the ontological discussion of learning starts either from a dualistic or non-dualistic position. Dualistic positions include the idealistic philosophy, represented by Plato and others, and empiricism, popularised by Francis Bacon and others during the seventeenth century. Idealism locates the minds of human beings as the place where the real world exists. Empiricist philosophy emphasises the mind of human beings as a separate mental world, which is subject to influences from external experiences. The dualistic basis of idealism and empiricism separates the mind, body, and surrounding environment from each other. These two philosophical positions clash with the non-dualistic positions taken by scholars from the pragmatist and sociocultural movements, among others.

Dewey (1916), one of the leading scholars within the pragmatist movement, rejected the dualistic positions of idealism and empiricism. He claimed that these positions embrace isolation between human beings and separate them from the communities in which they exist. In his arguments, he emphasised the importance of the physical and social aspects of the environment for understanding human beings. From this point of view, human action is inseparable from the surrounding environment. In effect, the environment is a condition for the emergence of the human mind.

Influenced by Hegel (e.g., 1821/1990) and Marx (e.g., 1867/1990), sociocultural scholars such as Bakhtin (1935/1981) and Vygotsky (1978) expressed similar thoughts about the inseparability of the mind, body, and the surrounding environment. This movement highlighted the link between human activity and cultural, historical and social transformation. In claiming that "the influence of nature on man, asserts that man, in turn, affects nature and creates through his changes in nature new natural conditions for his existence" Vygotsky (1978, p. 60) emphasised a non-dualistic position. Human life is a complex, dynamic, and ecological phenomenon that embraces cultural, historical, and social patterning of the world.

Bakhtin (1935/1981) emphasised the inseparability of man and the surrounding world by claiming that man is in a constant dialogue with the world. In this dialogue, understanding and response dialectically merge “and mutually condition each other; one is impossible without the other” (Bakhtin, 1935/1981, p. 282). Therefore, human life means participating in intertwined responses of dialogues.

Dewey and Bentley (1949/1960) discussed different conceptualisations of the relationship between human beings and the surrounding environment in terms of a distinction between interactional and transactional worldviews. These two worldviews have different consequences for understanding the relationship between learners and contexts in mobile learning.

Transactional worldviews (Fig. 9.1), such as those built on pragmatist and sociocultural ideas, reach across time and space. They are dynamic and ecological and emphasise the relationship between learners and context as a complex phenomenon (Dewey & Bentley, 1949/1960) meaning that “there are no separate elements … the whole is composed of inseparable aspects that simultaneously and conjointly define the whole” (Altman & Rogoff, 1991, p. 24). Such worldviews emphasise situations in terms of intersections of action, context, learners, and the environment.

Interactional worldviews (Fig. 9.2), such as idealism or empiricism, emphasise the relationship between learners and context as a rather simple and fragmented phenomenon. Such worldviews derive from Newton’s law of motion, meaning that what occurs in a context is a question of action and reaction. Based on this distinction, interactional worldviews demarcate human action in one context from that in other contexts. They also separate between the human mind and body from the surrounding environment. The implications of such worldview for the relationship

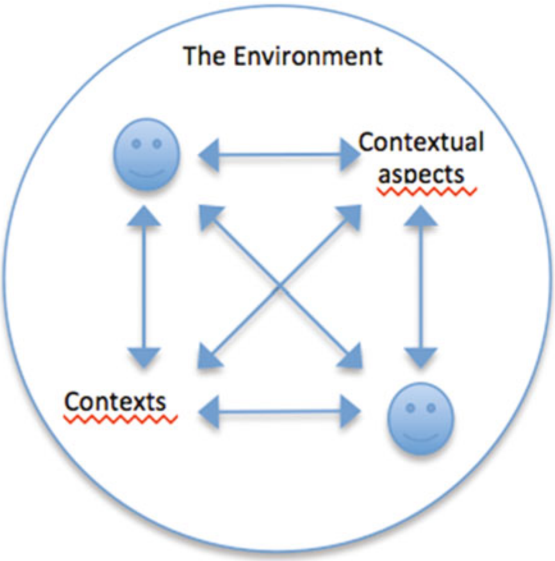

Fig. 9.1 A graphical representation of transactional worldviews. *Arrows* represent non-dualistic intersections in terms of the interplay between learners, contexts, and aspects in the surrounding environment

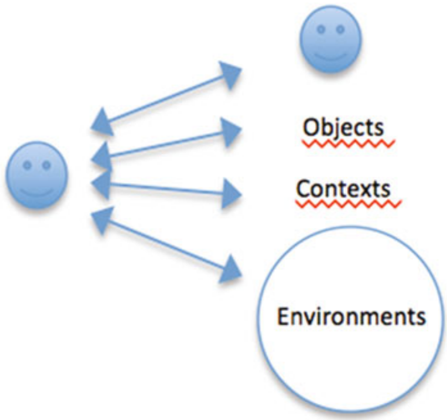

Fig. 9.2 A graphical representation of interactional worldviews. *Arrows* represent dualistic interactions between a learner and other features in various contexts and environments, e.g. objects and other learners

between mobile learning and contexts is that experiences and feelings are not necessary to understand learners' actions and that online and offline features of mobile learning are separate and can explain mobile learning without each other. If mobile learning and its relationship to context are understood as complex phenomena, interactional worldviews represent a disadvantage in understanding and designing for mobile learning.

Using a non-dualistic transactional worldview as a point of departure would emphasise the complexity of the relationship between mobile learning and contextual aspects. Therefore, it is better suited to meet the challenges identified above. Such a worldview allows an understanding of the relationship between mobile learning and context as participation in a nexus of multiple settings that embraces processes of change as well as spatial and temporal aspects of learning.

In addition to the philosophical arguments above, reasons for building on a transactional non-dualistic worldview can be found in the mobile learning literature. This is particularly true if the departure point for understanding mobile learning is the five contextual aspects of mobility (Kakihara & Sorensen, 2002) that many leading scholars within the field highlight (e.g., Kukulska-Hulme et al., 2011). That departure point emphasises a strong relationship between mobile learning and the surrounding environment. Among these scholars, Milrad et al. (2013, p. 95) discuss mobile learning as a cross-contextual phenomenon that "can enable a continuous learning experience across different settings, such as home-school, or workplace-college". In other publications it is discussed as a phenomenon where context is a "construct that is shaped by continuously negotiated dialogue between people and technology" (Sharples, Taylor, & Vavoula, 2016, p. 64).

Leading scholars in the field emphasise mobile learning as a social and situated phenomenon linked to various contexts. Similar to state-of-the-art research in learning, scholars within the field emphasise learning as an emerging communicative process depending on various tools (in terms of technologies and devices) that link to contextual aspects of situations and settings (e.g., Ally & Tsinakos, 2014; Hwang, Yang, Tsai, & Yang, 2009; Pachler, Bachmair, Cook, & Kress, 2010; Traxler & Kukulska-Hulme, 2016). These scholars link to ideas of Dewey (1916) and Vygotsky (1934/1987, 1978) and their modern successors such as Engeström (1987) or Lave and Wenger (1991).

9.6.2 *Designing for Learning from a Blurred Mobile Perspective*

The argument in this chapter suggests that designing for learning should avoid concepts that derive from or link to an interactional worldview. One reason for such a suggestion is that the use of concepts built on interactional worldviews limit our understanding of learning as a "passive acquisition or absorption of an established (and often rigidly defined) body of knowledge" (Koschmann, 1996, p. 5). The interactional rhetoric brings such limitations to the design process. Another reason for avoiding interactional rhetoric in the design process is also to avoid the indistinctness of unclear applications of key concepts (Jaldemark, 2012).

A limited understanding of learning is absent in a transactional rhetoric because such rhetoric embraces intersectional concepts that afford a complex understanding of learning. Such understanding is applied below in the discussion about suitable concepts in designs for learning. This chapter suggests that design for mobile learning benefits by utilising concepts that fit within a non-dualistic ontology. Conceptualisations that embrace an intersectional character secure a coherent link between mobile learning and the contextual aspects of mobility. Moreover, embracing such concepts in the design process is a way to meet the challenges discussed above.

The relationship between human beings and the surrounding environment is a critical ontological issue. The concepts of transactional rhetoric highlight the inseparability of learners and the environment. Using the concept of the environment as a singular phenomenon would secure such non-dualistic link. In other words, the environment is conceptualised from the ontological departure that there exists only one environment. This conceptualisation avoids the dualistic trap of discussing the environment in terms such as learning environments, online environments, and offline environments. Deploying such concepts in mobile learning derives from the dualistic idea that there exist online and offline worlds. Such a dualistic idea suggests that mobile learning is understandable without one of these worlds. Mobile learning becomes a fragmented and simple phenomenon that needs limited links to contextual aspects. Transactional worldviews avoid such a simplified idea of the relationship between learners and the environment. Instead, the environment is an inseparable phenomenon that consists of aspects of an intersectional character. Therefore, design for mobile learning benefits from transactional worldviews by utilising concepts such as contexts or settings; these are concepts that avoid ontological ambiguities.

From the earlier discussion in the chapter, it is obvious that the concept of interaction is problematic. Nevertheless, it is widely applied in research about learning. However, that is not a good reason to use it. In addition to the ontological issues related to the deployment of this concept, the incorporation of it in designs for learning gives rise to other issues that need to be dealt with. Interaction is a concept with different meanings. So and Brush (2008, p. 331) claim that it is a reciprocal "process between human and human or between human and non-human". This double meaning brings an ambiguous and unclear understanding of the concept to the design process. Therefore, possibilities for confusion are inherent in using the concept of interaction in designing for educational settings. Deploying one concept for human/human processes and another concept for human/non-human processes is one way to facilitate a distinct understanding in designs for mobile learning.

Designing for mobile learning faces other ambiguities concerning human and non-human processes. These ambiguities relate to the relationships between humans and content and between humans and technology. If the departure for design is a complex worldview that embraces contextual aspects of mobility, use of interactional rhetoric limits understanding of these relationships. Through the lens of complex transactional and non-dualistic worldviews the human/content relationship typically in effect involves a relationship between human beings. The intersection of time and content inevitably brings a human being into the production of content. In other words, there is usually at least one author behind products such as texts. This author communicates asynchronously with the listener or reader. Or, in other words, the listener or reader participates in an ongoing time-separated dialogue with the speaker or writer. Technologies mediate this dialogue independent of time or physical location. This is particularly true in the context of mobile learning, given its seamless and ubiquitous character.

The relationship between humans and technology is a complex phenomenon that needs a clear conceptualisation in designs for mobile learning. However, technology needs to be linked to other concepts that afford a relationship to the contextual aspects of mobility. Without human beings, technology is just a thing. As such, it could be useful as a concept in design for learning. Nevertheless, in its use, it becomes part of the context of learning. Such use includes technologies such as applications, devices, and networks, which include offline as well as online aspects. Therefore, the contextual aspects in design need to include links between learners and technologies. Examples of such concepts are mobile learning, social media, technology-enhanced learning, and tools.

From the point of view of transactional rhetoric, learners who participate in mobile learning are in a constant dialogue with the context, and particularly in dialogues with other learners. In design, such understanding implies the need for concepts that link learners to each other. In the mobile learning literature, such concepts are widely applied, for example, in definitions including the terms conversation (Sharples et al., 2016) and communication (Pachler et al., 2010). Another concept that might indicate such interplay is dialogue (e.g., Berge & Muilenburg, 2013). Moreover, to emphasise gatherings of learners, concepts such as communities of practice, computer-mediated communication, learning communities, or mobile learning communities might be useful (Cochrane, 2014; Danaher et al., 2009;

Jones, Scanlon, & Clough, 2013; Kukulska-Hulme, 2012). Such concepts highlight the importance of understanding learning as a collaborative endeavour.

The discussion above embraces examples of intersectional concepts based on a transactional worldview. They are included because they secure the link between learning and contextual aspects of mobility. It makes them suitable for deployment in designing for mobile learning. Other concepts not discussed above might also be suitable. However, the message from the chapter is to be conscious of contextual aspects of mobility in designing for learning. Such consciousness builds on concepts that share a common worldview.

9.7 Conclusions

The rapid pace of development within the field of information and communication technology has blurred the boundaries between formal and informal learning. In particular, this blurring relates to the impact mobile applications, devices, and networks have on the relationship between learners and context. This relationship is complex and emphasises aspects of locations, social groups, technology, and time as well as content-related aspects. This development poses challenges to understanding and designing for mobile learning. To meet these challenges, designing for mobile learning benefits from the use of concepts that derive from a transactional worldview. Such a worldview suggests the use of intersectional concepts that embrace several contextual aspects of mobility in designing for learning.

Glossary

Formal learning Learning linked to participation in formal educational settings. Such learning occurs in institutions built for learning as the primary activity.

Informal learning Learning linked to participation in everyday, leisure, or work settings. Such learning is a spin-off while participating in everyday, leisure, or work activities.

Interactional worldview A dualistic worldview that de-emphasises contextual aspects of human actions. It separates mind, body, and the surrounding environment from each other. Such a worldview is less complex and is built around the Newtonian idea of action and reaction.

Intersection Used to describe an inseparable link between two or more aspects of a particular phenomenon.

Transactional worldview A non-dualistic worldview based on the idea that mind, body, and the surrounding environment are inseparable. It emphasises that human action is situated within and has a dependent relationship to context.

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Chapter 10
Supporting Training of Expertise with Wearable Technologies: The WEKIT Reference Framework

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Abstract In this chapter, we present a conceptual reference framework for designing augmented reality applications for supporting training. The framework leverages the capabilities of modern augmented reality and wearable technology for capturing the expert's performance in order to support expertise development. It has been designed in the context of Wearable Experience for Knowledge Intensive Training (WEKIT) project which intends to deliver a novel technological platform for industrial training. The framework identifies the state-of-the-art augmented reality training methods, which we term as "transfer mechanisms" from an extensive literature review. Transfer mechanisms exploit the educational affordances of augmented reality and wearable technology to capture the expert performance and train the trainees. The framework itself is based upon Merrienboer's 4C/ID model which is suitable for training complex skills. The 4C/ID model encapsulates major elements of apprenticeship models which is a primary method of training in industries. The framework complements the 4C/ID model with expert performance data captured with help of wearable technology which is then exploited in the model to provide a novel training approach for efficiently and effectively mastering the skills required. In this chapter, we will give a brief overview of our current progress in developing this framework.

10.1 Introduction

"In 2016, keeping the skills of your workforce up to date in this fast-changing world will be more important than ever. Harnessing this peer-to-peer learning can be an efficient and cost-effective way of increasing skills, and the knowledge

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_10

transferred is likely to be relevant because it is delivered by people who understand your organization's culture." (Matassa & Morreale, 2016)

In a 2016 PwC global survey of more than 1000 CEOs from all major industries, 61% of global chief executives and 78% of US respondents said that they were somewhat or very concerned about the speed of technological change in their industry. This creates a challenge for the companies to keep the work force up to date with the new knowledge and skills that are ever increasing. In addition, the experienced employees retire or leave the company taking the vast experience that they have accumulated overtime along with them. They are then replaced by the new inexperienced employees who need to be trained, which requires time and investment.

WEKIT[1] (http://wekit.eu/) which stands for Wearable Experience for Knowledge Intensive Training is a European project supported under Horizon 2020 to develop and test within three years a novel way of industrial training enabled by smart wearable technology. In WEKIT, thirteen partners representing academia and industry from six countries in Europe are striving actively to meet the highest degree of standards in the delivery. WEKIT is making significant progress toward meeting the demands of industries by exploring and implementing the best of pedagogical and technological opportunities.

The framework identifies twofold approaches to address the above-mentioned industrial issue: (1) to capture the expert's performance by means of wearable technology (WT) and sensors and (2) to foster efficient training with the help of expert's performance data using augmented reality (AR) and WT. Capturing expert's performance should take into consideration what methodologies may be used to capture certain aspects of the performance in a meaningful manner such that they are useful and shareable to the new trainees. Using AR and WT, the trainees can "wear" the expert's performance and track the differences between their own performance and that of an expert. Therefore, the framework posits great potential for efficient training of skills with the help of captured expert's performance to provide new novel approaches to technology-assisted apprenticeship.

10.2 Concept Space: Supporting Training of Expertise with Wearable Technologies

Expertise may be defined as the knowledge and skills behind an expert's performance. In Ericsson and Smith (1991), expert performance is defined as consistently superior performance on a specific set of representative tasks. Representative tasks are structured and managed drills where essential attributes of expert performance naturally occur because of which the consistency of the performance can be replicated and measured. Ericsson (2006) defines representative tasks as an

[1]Wearable Experience for Knowledge Intensive Training: Project No 687669.

appropriate methodology to correctly evaluate an expert performance under standardized conditions in a controlled setting, such as a laboratory. Representative tasks engage the same set of knowledge and skills that are used in real-world tasks, ensuring that the expert performance is accurately captured. When the expert performance can be reliably reproduced in a controlled situation such as the representative task, this performance can then be analyzed to assess its mediating acquisition mechanisms.

The basic underlying of attaining expertise is to collect experience. However, the notion of expertise based on the length of experience in a domain (over ten years), which assumed that the trainee progressed orderly to an expert under instruction, training, and experience (Hoffman, 2014), has been observed to be only partially true. The length of experience has been frequently found to be a weak correlate of job performance beyond the first two years (McDaniel, Schmidt, & Hunter, 1988). Most novices make large gains at the beginning, but fail to push further. Only individuals who indulge in deliberate practice achieve the superior expertise (Ericsson, 2006). The notion of deliberate practice dictates that simply executing the skill repeatedly does not account for improved performance. In order to develop expertise, the executions of skills should be aimed at improvement in that particular skill by collecting new experience in every execution.

Ericson (2006) stressed the importance of a mentor for deliberate practice, stating that the apprentice does not engage in deliberate practice spontaneously. An expert mentor would design practice sessions that improve the apprentice's performance gradually which complies with the definition of deliberate practice. By doing so, the mentor "shares" his/her experience with the apprentice in an explicit manner, ensuring that the apprentice achieves the desired level of performance efficiently. For example, Schulz and Curnow (1988) found that throughout the history of the Olympic Games, the best performance for all events has improved—in some cases by more than 50%. This is because experts have been consistently pushing the boundaries of their performance by practicing deliberately (Ericsson, 2006).

In conclusion, an expert is impertaive to the efficient training of the trainee. Therefore, the framework, taking the importance of expert into consideration, adapts a twofold approach of: (1) capturing the expert performance and (2) supporting training with the help of expert performance.

10.3 Background

Experience may be defined as the knowledge gained through involvement in or exposure to an event. In vocational trainings, the expert "shares his/her experience" by demonstrating and mentoring the trainee through hands-on experience rather than from written manuals or textbooks. However, Wagner and Sternberg (1990) stated that experience may be shared by sharing the environment in which the expert performed the task. Sharing environment involved sharing not only the workplace but also sharing the environmental stimulus perceived by the expert (Sternberg, 2000). Therefore, in order to share the experience, the expert must not only demonstrate his/her performance and mentor the trainee, but should also be able to share the environmental stimulus. AR and WT have huge potential to capture and support the reenactment of the expert's performance and the environment in which he/she performs. The framework leverages on this potential of the technology to envision new training approaches by sharing experience of the expert with the trainee. In the following, we provide a review of AR and WT training approaches based on the twofold approach of the framework.

10.3.1 Capture of Expert Performance

Numerous studies have presented the potential of sensor-based technology and WT (Schneider, Börner, van Rosmalen, & Specht, 2015) for learning. Similarly, Bower and Sturman (2015) also did a review on affordances of WT and observed that the WT posits new possibilities for supporting training. Sensor-based technologies and WT track the expert's interaction with the physical environment in which he/she demonstrates, enabling the capture of the expert performance. The framework adapts the approach defined by Collins (1991) who emphasized two important kinds of performance capture: (1) capturing of the expert performance and (2) capturing of the process in the world. Capturing of the expert performance includes making the cognitive process of the expert explicit to the apprentice while capturing the process involves making invisible aspects of the task visible. Such an approach would incorporate capturing the physical environment, the expert's interaction with it, and the cognitive processes, capturing the essence of a complete process.

However, experts are scarce and becoming an expert is a difficult and time-consuming endeavor. In addition to the shortage of experts in many domains, learning from expert is a difficult task. Feldon (2007) stated that an expert is unable to explain his/her superior performance because the amount of expertise inhibits his/her explanation skills. This is because an expert typically has more knowledge than he/she can verbalize (Patterson, Pierce, Bell, & Klein, 2010), which impedes the capability of the expert as a mentor. In addition, an expert is unaware of the factors behind his/her superior performance. For example, an expert is able to notice features and meaningful patterns of information without conscious effort that are not noticed by an apprentice. Due to this, an expert tends to underestimate how difficult it can be for the apprentice (Hinds, 1999) and thus omits the information an apprentice would find valuable (Hinds, Patterson, & Pfeffer, 2001). Therefore, capturing expert performance at the right level of abstraction, while still retaining all relevant details, is complex, even from the technological point of view (Fominykh, Wild, & Alvarez, 2015).

Conventional approaches, such as video recording, provide only limited points of view, significantly reducing the wealth of information available from direct experience. In contrary, WT provides a rich multimodal and multisensory medium for the capturing the expert performance and also a multiperspective opportunity for training. For example, Kim, Aleven, & Dey, (2014) explored different physiological sensors and other WT such as eye tracking concluding a strong possibility to use the physiological sensors to be able to record cognitive process. Many recent projects (see Kowalewski et al., 2016; Zhao et al., 2016) have used WT to explicitly capture expert's performance based on physical attributes such as motor movements to provide guidance and feedback to the trainee using AR. AR complements WT by providing a rich multimodal and multisensory medium for the apprentice to visualize the expert performance and collect rich experience from the perspective of the expert. In the following, we elaborate on AR as a suitable platform to support expertise development with use of expert's performance data.

10.3.2 Supporting Expertise Development with Expert Performance

Bacca et al. (2014), suggested that AR along with sensors posits a rich versatile educational potential for training skills. In addition, several studies suggest that technical skills acquired in virtual simulators transfer well into real-world and improve performance in areas such as laparoscopic surgery (Haug, Rozenblit, & Buchenrieder, 2014) and anesthesia (Naik et al., 2001). Although the idea to use AR and WT for training dates back to the early 1990s (Caudell & Mizell, 1992), only a handful of projects have made it successfully into industry. With the technology, still new and major works such as STARMATE and ARVIKA (Friedrich, 2002) focusing mostly on technical aspects, the educational potential of the AR and WT remains unexplored. Now, the WEKIT reference framework aims at exploiting the affordances of AR and WT for supporting the pedagogic training approaches to extract the educational potential of the technology.

Zhou, Dun, and Billinghurst (2008) defined the implementation of AR in terms of three main characteristics: (1) the combination of physical and virtual elements, (2) interactive in real time, and (3) registered in three-dimensional spaces. For AR to truly fulfill these requirements, it must be equipped with sensors and WT to measure and analyze the data from physical environment. Therefore, AR and WT have the potential to create a truly immersive platform which places the trainee in real-world context engaging all of his/her senses. Bjork and Holopainen (2004) stated that an immersive environment creates perceptual and cognitive immersion by stimulating the sensory organs directly with relevant stimuli and cognitive content. Therefore, AR and WT have the potential to amplify perceptual stimuli based on the captured expert performance to enhance the trainee perceptions which will allow the apprentice to create new experience similar to the expert's experience.

10.4 The WEKIT Reference Framework

Most industrial tasks are complex real-world problems which are ill-structured and require more than an algorithmic approach to be solved. Mastering such complex task requires complex learning. Sarfo and Elen (2006) have emphasized the close relation between complex learning and deliberate practice. In order to practice deliberately, the apprentice needs to indulge in extremely targeted practice where new goals are met and learning path is constantly monitored and adapted (Ericsson et al., 1993). This concept is in close alignment with the principles of the 4C/ID model (Neelen & Kirschner, 2016). Sarfo and Elen (2006) in their results indicated that the 4C/ID model promoted the development of technical expertise. Therefore, we built the framework upon the 4C/ID model-based training methodology by using the captured expert performance to supplement the model, with the help of AR and WT to guide and provide feedback to the trainee. The training will be done in an authentic context with the help of AR and WT while supporting the trainee with feedback and scaffolding.

The 4C/ID model is a holistic design model which deals with complex task, without losing sight of the separate elements and the interconnections between them (van Merriënboer, Clark, & Croock, 2002). It is a nonlinear and systematic processing model for designing complex learning environments. Melo and Miranda (2014) investigated the effects of 4C/ID in teaching and concluded it to be effective for acquisition and transfer of complex skills. The 4C/ID model consists of four components, namely (1) learning task, (2) supportive information, (3) procedural information, and (4) part-task practice.

1. **Learning task**: Learning Tasks are authentic, whole task experiences that are provided to the trainee in order to promote schema construction for nonrecurrent aspects of the task. It supports rule automation by compilation for recurrent aspects of the task. Instructional designers primarily adapt induction that emphasizes the importance of task modeling through mindful abstraction from the concrete experiences. Task modeling is the construction of cognitive schemata of the task by the trainee. For example, by first demonstrating examples of how a particular concept is used, the expert allows the trainee to come up with the correct solution using the cognitive schemata that he/she created while observing the expert performance.
2. **Supportive information**: Supportive information is the information provided to support the learning and performance of nonrecurrent aspects of learning tasks. Instructional designers for supportive information aim at elaborating the task model by establishing nonarbitrary relationships between new elements and what learners already know.
3. **Just-in-time information**: Just-in-time information is the prerequisite information to the learning and performance of recurrent aspects of learning tasks in a just-in-time fashion. Instructional designers primarily aim at embedding procedural information in rules such as the condition action pairs.

4. **Part-task practice**: The last component of the 4C/ID model is the part-task practice which recognizes that some parts of the task are automatic and recurrent. In order to develop the automation of the skill, it is required that the learner practices the task repeatedly. Part-task practice items are provided to learners in order to promote rule automation for selected recurrent aspects of the whole complex skill.

The 4C/ID model is acknowledged as an effective instructional design model for designing powerful training environments that facilitate task modeling. (Sarfo & Elen, 2006). Evidence about the effectiveness of training environments designed in line with specifications of the 4C/ID model for the acquisition of expertise in training contexts has been documented by van Merriënboer and Paas (2003) and Merrill (2006). This framework aims at guiding the design and development of training applications based on 4C/ID model and the expert performance in order to expertise development.

After an extensive review of different prototypes designed for training which were identified from the literature from major databases such as SpringerLink, ScienceDirect, and SAGE, we identified and extracted instructional methods used by them. We use the term "transfer mechanisms" to describe the instructional strategies or methods that exploit AR and WT technology for training purposes. However, only those methods that support or embellish the expert–trainee relationships in a technological platform have been selected. After analyzing the transfer mechanisms, we have further defined the transfer mechanisms to have three general characteristics which are portrayed in Table 10.1. Each transfer mechanism possesses attributes that answer questions such as what is the type of skill being trained. The other characteristics include requirements for recording such as hardware and software and requirements for enacting by the apprentice which may include

Table 10.2 provides the list of the transfer mechanisms that were identified from the review of studies that exploited AR for training of expertise. We have selected studies performed after 2010 to date to understand the state-of-the-art in AR- and WT-based expertise training.

With an aim to support the design and development of the AR- and WT-based platforms to integrate the 4C/ID model for training, the framework classifies the

Table 10.1 Attributes of transfer mechanism

Description How can the features be described? What skills are being addressed?
Requirements for recording How is the mechanism enabled during the recording? What types of sensors are required?
Requirements for enactment How is this feature enabled by/for the learner? Which conditions need to be me to allow this feature to be present? Which interaction means does the learner have? What type of sensor/display technology does the learner require?

Table 10.2 List of transfer mechanisms

Transfer mechanism	Description	Requirements for recording	Requirements for enacting
Augmented paths	Augmenting virtual information atop the physical world in a way which allows the trainee to guide his motion with precision	• Tracking of expert's hand motion • Motion sensors • Depth camera	• Visualizing guidance paths using AR • Provide haptic or visual feedback • Comparison to expert data by capturing apprentice movement with sensor
Augmented mirror	Augmented display where the apprentice can track his/her body similar to dance rooms	• Record and track body postures • Posture sensor such as Kinect	• Large display where the apprentice can see himself/herself • Posture tracker to provide visual feedback
Highlight object of interest	Highlight physical objects in the focus area indicating the trainee that the expert found that object of interest	• Eye tracker • Video recording • Record gaze behavior of the expert	• Eye Tracker for formative feedback • AR display to highlight the image
Directed focus	Visual aids for locating objects outside the visual area	• Eye tracker and video recording • Record gaze behavior of the expert • Record the procedure	• Eye tracker for formative feedback • AR display • Visual indicator
Point of view video	Provides unique trainee/expert point of view video which may not be available in a third person perspective	• Head-mounted camera • Interaction mechanism to initiate, stop recording, and zoom into subject	• Interaction and inference mechanism • Zoom into video
Think aloud Protocal	Audio recordings present the procedural information or the explanations and mental process (think aloud protocol) of the expert during the task execution	• Think aloud protocol to record expert explanations • Microphones • Reduce unnecessary noise	• Audio headphones • Interaction and inference mechanism • Amplify the sound
Cues and clues	Cues and clues are pivots that trigger solution search	• Take a picture save video and audio or text • Use a physical object in real world as anchor	• Display on demand • Inference mechanism
Annotations	Allow a physical object to be tagged with virtual information	• Methods to tag media into physical object. • Manual annotation or done by expert on the fly	• AR display mechanism to read the annotations • Mechanism for unobtrusive relay of information

(continued)

Table 10.2 (continued)

Transfer mechanism	Description	Requirements for recording	Requirements for enacting
Object enrichment	Provide information about the physical artifact	• Use a physical object in real world as anchor • Tags or infrared light emitters and camera	• Object recognition • Control over information displayed • Camera with image recognizer
Contextual information	Provide information about the process that is frequently changing	• Knowledge of procedure information that depends on the context and required for the task	• Method to know when and where to provide the information
3D models and animation	3d models and animations assist in easy interpretation of Complex models and phenomena which require high spatial processing ability	• Modeling 3d object • Creating 3d animation • Defining interaction mechanism	• AR display • Interaction mechanism such as gestures
Interactive virtual objects	Manipulate to practice on virtually objects with physical interactions	• Realistic 3d objects • Sensors for motion recording	• Haptic and visual feedback • Detecting collision between physical and virtual entity
Haptic feedback	Force feedback relating to the perception and manipulation of objects	• Fine motor tracking • Defining of criteria for errorless operation • Inertial sensors	• Tracking the trainee motion with inertial sensor • Motors for providing haptic feedback
X-ray vision	Visualizing the internal process or mechanism not visible to the eye.	• Simulation of the phenomena • Interaction mechanism	• Visualization of the phenomena • Interaction mechanisms • Object recognition
Feedback	Provide summative and formative feedback	• Mechanism to infer mistakes in process based on expert data • Mechanism to assess the overall performance	• Measure of performance • Mechanism to evaluate the overall performance

transfer mechanism according to the four components of the 4C/ID model. The first component learning task encapsulates the notion of task modeling along with other attributes such as task scaffolding. Task modeling entails methods for scheme construction by the trainee about the task being performed. Table 10.3 maps the transfer mechanism that supports learning task against the performance attributes they aim at training.

Table 10.4 depicts all the transfer mechanisms that have been identified in order to provide supportive information. Supportive information deals with nonrecurrent

Table 10.3 Transfer mechanisms that support learning task component

Learning task	Performance attributes				Literature
Transfer mechanism	Fine motor Skills	Cognitive motor skills	Collaborative skills	Perceptual motor Skills	1. Juanes, Gómez, Peguero, and Ruisoto (2015) 2. Hahn, Ludwig, and Wolff (2015) 3. Meleiro, Rodrigues, Jacob, and Marques (2014) 4. Ke, Lee, and Xu (2016) 5. Lok et al. (2014) 6. Roads et al. (2016) 7. Jarodzka, Van Gog, Dorr, Scheiter, and Gerjets (2013) 8. Henderson and Feiner (2011) 9. Milazzo, Farrow, and Fournier (2016) 10. Djajadiningrat (2016) 11. Gallegos-Nieto, Medellín-Castillo, González-Badillo, Lim, and Ritchie (2017) 12. Haug et al. (2014) 13. Nilsson, Johansson, Jönsson, Orn Johansson, and Onsson (2011) 14. Chia and Saakes (2014) 15. Jang, Kim, Woo, and Wakefield (2014) 16. Radu, Doherty, DiQuollo, McCarthy, & Tiu (2015) 17. Datcu, Cidota, Lukosch, Oliveira, and Wolff (2014) 18. Rozenblit et al. (2010) 19. Chang, Kang, Chang, and Liu (2015) 20. Chinthammit et al. (2014) 21. Bordegoni et al. (2014) 22. Sand, Büttner, Paelke, and Röcker (2015)
Augmented path	1, 2, 12, 18				
Augmented mirror	14	3, 25			
Interactive virtual objects	15	4, 16	5, 13, 17		
Highlight object of interest		2, 22		6	
Directed focus		7, 33		8	
Point of view videos	20	10, 11	17, 20	9	

Table 10.4 Transfer mechanisms that support supportive information component

Supportive information	Performance attributes				Literature
Transfer mechanism	Perceptual motor skills	Cognitive motor skills	Collaborative skills	Spatial skills	23. Martín-Gutiérrez, Saorín, Contero, and Alcañiz (2010) 24. Freschi, Parrini, Dinelli, Ferrari, and Ferrari (2015) 25. Kwon, Lee, Jeong, and Kim (2014) 26. Manuri, Sanna, Lamberti, Paravati, and Pezzolla (2014) 27. Wang and Dunston (2011) 28. Buń, Górski, Wichniarek, Kuczko, and Zawadzki, (2015) 29. De Ravé, Jiménez-Hornero, Ariza-Villaverde, and Taguas-Ruiz (2016) 30. Condino et al. (2016) 31. Allain et al. (2015) 32. See (2016) 33. Sabine et al. (2011) 34. Sanfilippo (2017)
Object enrichments	30			22	
3D models and animation		1, 25	26	16, 28	
X-ray vision	24	23, 27, 29		23	
Setting cues and clues	30	32, 19			

aspect of the task. Supportive information can be declarative information that can be found in books and other resources. Supportive information can be on demand depending on the context or information required for the whole subtask.

The following Table 10.5 maps the transfer mechanisms that support the just-in-time component. This component deals with procedural information required to perform the recurrent task which must be provided in a just-in-time fashion. The information can be presented as a step-by-step instruction or a feedback. It requires the condition action pairs to be identified that drives the routine behaviors and the prerequisite knowledge involved in the step.

The last component of the 4C/ID model is the part-task practice which recognizes that some parts of the task are automatic and recurrent. In order to develop the automation of the skill, it is required that the learner practices the task repeatedly. As such, there is no transfer mechanism identified that supports this component, which may be for a simple fact that it's straight forward.

Table 10.5 Transfer mechanisms that support just-in-time information component

Just-in-time information	Performance attributes				Literature
Transfer mechanism	Perceptual motor skills	Cognitive motor skills	Collaborative skills	Fine motor skills	35. Yarnall et al. (2014) 36. Poelman, Akman, Lukosch, and Jonker (2012) 37. Sano, Sato, Shiraishi, and Otsuki (2016) 38. Matassa and Morreale, (2016) 39. Lahanas, Loukas, Smailis, and Georgiou (2015) 40. Funk, Heusler, Akcay, Weiland, and Schmidt (2016) 41. Chang et al. (2015) 42. Zao et al. (2016) 43. Perlini, Salinaro, Santalucia, and Musca (2014) 44. Wei, Yan, Bie, Wang, and Sun (2014) 45. Sousa, Alves, and Rodrigues (2016) 46. Stunt, Kerkhoffs, Horeman, Van Dijk, and Tuijthof (2016) 47. Asadipour, Debattista, and Chalmers (2016) 48. Zhu, Ong, and Nee (2014) 49. Jang et al. (2014) 50. Chia and Saakes (2014) 51. Meleiro et al. (2014) 52. Liu, Mei, Zhang, Lu, and Huang (2016)
Annotation			17, 35		
Contextual information	24	34, 10, 47	13, 36		
Haptic feedback	43, 46, 29	18, 36, 38		37	
Feedback	37	39, 40		34, 41	
Audio instructions	33				

10.5 Conclusion

The presented reference framework for training expertise with AR and WT delivers methodologies that enable efficient and effective training of industrial skills. The reference framework combines the state-of-the-art transfer mechanisms identified in the literature with the 4C/ID model for supporting the design and development of training applications. By classifying transfer mechanisms, the framework supports the instructional designers to design effective expertise training applications using AR and WT. The framework may have some limitations such as zero recorded transfer mechanism to support automation. It also helps in identifying gaps in the literature; for example, on certain transfer mechanisms, there are several or no studies. It may be argued for the fact that it is a simple matter of practice; however, various factors such as motivation have to be accounted. Thus, the framework is also a great starting point to explore how the boundaries of expertise development can be further pushed back.

The framework is an ongoing task and new transfer mechanisms will be documented as work progresses. However, as the framework stands now, it is sufficient to inform any training application designers with the technological and pedagogic overview he/she may need in order to design and develop an effective training platform. The framework is the conceptual support for the WEKIT project design and development. Further task involving the framework includes documentation of guidance and recommendations to handpick the transfer mechanism that caters the instructional designer needs. The framework needs to be evaluated in terms of what makes out an optimal set of transfer mechanisms. Therefore, we believe the framework is a significant step in merging the best of the AR and WT with technology-enhanced learning approaches.

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Chapter 11
Formal and Informal Learning Using Mobile Technology

Abdelwahed Elsafi

Abstract In recent years, mobile devices have become a key issue for researchers. Mobile devices are becoming ubiquitous and a part of our everyday life. People are using mobile devices at educational institutions (universities, colleges, and schools), at home, at work, and for leisure. This chapter highlights the possibility of using mobile apps technology in formal and informal learning, for students inside and outside higher educational institutions together. Additionally, the chapter considers the challenges that hinder implementation of mobile technology in education. This chapter is constructed as follows: First, a brief definition and concept of mobile learning is presented; second, the concepts of formal and informal learning are discussed and compared; third, the potential of mobile learning technology is explained and followed by the challenges of implementing mobile learning inside and outside higher educational institutions. Fourth, the different dimensions of mobile applications technology are presented. Finally, this chapter reports on formal and informal learning enabled by mobile technology and concludes with main ideas for future research on the use of mobile learning technology.

Keywords Formal learning · Informal learning · Mobile learning technology
Mobile apps

11.1 Introduction

Since a few years ago, with the rapid development of technology, there has been growing interest in research on mobile technology applications in education (Sampson, Isaias, Ifenthaler, & Spector, 2013). Mobile technology has become popular for most people, especially students in higher education. This phenomenon has motivated many researchers to investigate the potential use of mobile learning for teaching and learning purposes (Mehdipour & Zerehkafi, 2013; Mtega, Bernard,

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_11

Msungu, & Sanare, 2012). The most important issues are the benefits of applications of mobile technology in education (Sampson et al. 2013). The use of mobile devices such as smartphones and tablets enables students to perform various learning activities, such as searching for information, sending/receiving e-mail, and completing their learning tasks. Also, mobile learning technology permits students to engage, share, and collaborate in a wide range of communication.

Nevertheless, the increasing productivity of new generations of mobile devices such as tablets and their computing capabilities (e.g., power, screen size, operating system, storage, and battery life) is leading many researchers to go so far as to emphasize advancing mobile learning and how those devices can be used to expand learning and teaching opportunities into educational institutions (Baran, 2014; Khaddage, Muller, & Flintoff, 2016; Mulatu, 2015). Furthermore, Churchill, Lu, Chiu, and Fox (2015) reported that mobile learning technology can offer varieties of tools for teachers, students, and twenty-first-century educational opportunities. These devices can run apps, record audio and videos, send and receive e-mail messages, and enable designing interactive learning environments.

In the context of formal and informal learning, mobile devices such as smartphones and tablets add new options for learning to take place in anywhere at anytime. The transmitting of the learning from traditional school settings—face-to-face classroom—to informal school settings or outside educational institutions now is being possible by incorporationg mobile technology in education. It could be understood that smartphones and tablets have extended learning opportunities; with mobile apps, the gap between formal and informal learning can be blended or dissolved.

Clearly, this means students inside schools (formal learning) and students outside schools (informal learning) could work together, exchange their thoughts and ideas, collaborate, interact, and increase motivation. More specifically, the use of mobile apps for educational purposes can connect between traditionally located learning environments, allow mobility of learning, and meet learner interests.

The traditional ways schools provide and deliver teaching and learning should be changed to meet the younger generation's interest (Khaddage et al., 2016). Nowadays, most university students own smartphones provided with varieties of apps technology, which can be incorporated for teaching and learning applications; also they have potential to transfer learning and deliver of course materials. Therefore, mobile learning has advantages from being among all of the technology used for teaching to meet the situation of modern school settings.

The purpose of this chapter is to push inside the debate of blurring the gap between formal and informal learning and highlight future research directions. This chapter first discusses the concept of formal and informal learning; a brief review of studies will be presented. Then the chapter will explain the concept and definition of mobile learning, followed by discussion of mobile learning technology, regarding its benefits and challenges, as well as mobile learning applications. Finally, this chapter discusses formal and informal learning enabled by mobile technology and concludes with the main ideas for future research on the use of mobile learning technology.

11.2 Formal and Informal Learning

This section discusses the concepts of formal and informal learning and describes relevant research studies briefly and then presents a comparison between two types of learning.

Formal learning is that in which an expert determines learning objectives or requirements outcomes for successful completion (Frerichs, 2014). Formal learning has an institution system that goes from preschool to graduate studies (Schugurensky, 2000). Formal learning seems to be highly systematic, organized, and approved by the ministry of education or any other official organization in most countries. Thus, the term formal learning could mean a curriculum designed with a very structured manner and schedule, and the learning content, materials, and activities could be delivered via school. The term of informal learning has been defined as any activities which involve learning that occurs outside the classroom settings or formal school curricula of an educational institution (Livingston, 2000). Informal learning seems to be a kind of learning that occurs when the learners felt they are not in an actual learning situation, and it is not part of the educational curriculum (Scot, 2015). Particularly, informal learning is more dynamic than formal learning, and it takes place where learners located and not organized in the form of, e.g., teaching methods, presentation of learning materials, assessment or teacher-lead instruction. Additionally, informal learning seems to include self-directed activities, which are unplanned, unorganized, and emerge when students are engaging or interacting with others. As a result, the term informal learning means learning that occurs in anyplace outside the school environment (e.g., visiting museums, libraries, zoos, parks, or trips).

Regarding studies of how learning would occur in formal and informal school curricula, researchers have studied the possibility of dissolving the gap between formal and informal learning (Barbosa, Bassani, Martins, Massmann, & Barbosa, 2016; Cook & Pachler, 2011; Kukulsaka-Hulme, 2015; Wright & Parchoma, 2014). With the affordances of mobile technology, students can engage in and interact with highly interactive learning environments (Grant, 2015; Looi et al., 2016). Other researchers like Khaddage et al. (2016) have developed an approach to blend formal and informal by using mobile apps technology; their approach was based on the Science, Technology, Engineering, and Mathematics (STEM) subjects. All these studies highlighted the affordances of mobile apps, and how those apps can be used to facilitate and design learning activities in different contexts. Therefore, teachers can design and deliver learning via various mobile apps to be accessed in or outside the school setting.

The differences between formal and informal learning are given in Table 11.1.

From the table, we understood that formal and informal learning is viewed as antithesis or contrast of each other. Malcolm, Hodkinson, and Colley (2003) point out that formal and informal learning is seen as two separated paradigms—formal learning is organized and defined as vertical knowledge, acquisition, and individual,

Table 11.1 Formal versus informal learning

Formal learning	Informal learning
Curriculum designed and approved by the ministry of education or official organization	Does not necessarily follow school curriculum
According to the teaching methods	It is not significant pedagogically
Takes place in educational institutions	At work, at home, while moving, at the zoo …, etc.
Learning objectives are stated and defined	Does not use learning objectives
Including presentation of learning materials	Does not involve the presentation of learning materials
Teacher-lead instruction and time is scheduled	Informal learning—driven by the learners
It aims to meet learning objectives	To improve learner's emotions and motivations
Interaction student-to-student and teacher-to-student	Online interaction student-to-student

while informal learning seems to be horizontal knowledge, not well organized and appears as learning through everyday practice and non-educational settings.

Understanding the difference between inside and outside the school learning environments could help to recognize that, formal and informal learning is situated in varieties of learning contexts. To realize the capabilities of mobile learning, we have to think about "what do mobile devices bring to formal and informal education? How can smartphones and tablets contribute to reduce the gap between the two forms of learning?" Answering these questions requires thinking and considering to what extent mobile technologies can play a significant role in facilitating learning across multiple contexts (Grant, 2015; Zhang et al., 2010). Meanwhile, mobile devices (smartphones and tablets) have many mobile apps technologies, which are described in this chapter, designed for different applications and which can be useful to accomplish educational goals.

No matter students being inside or outside the school environment, the use of mobile technologies reduces the restrictions or barriers of time and location of learning, expands the mobility of learning, and enables educating all groups of people in different situations in anyplace at anytime.

Sangra and Wheeler, (2013) asserted that the blurring of formal and informal learning is essential, because when formal and informal are blended together, that means educational institutions have knowledge and skills they need to provide, while simultaneously catering for what students need to have: a collaborative and creative learning environment through their mobile technology, in which self-directed learning takes place.

The blending of these two types of learning (formal and informal) using the affordances of mobile technologies is now possible. Such devices enable accessing learning materials from remote locations, collaboration, peer-to-peer interaction, engagement, and sharing knowledge and experiences. Thus, mobile learning technology can play a role in facilitating learning in different learning environments.

11.3 Mobile Learning—Definition and Concept

Mobile learning has been defined in myriad ways. The reason behind that is mobile learning is still a new field of study. Traxler (2010) views mobile devices as a pervasive medium that help users in combining work, study, and leisure. Mobile learning is computing devices allowing access from anywhere and at anytime (Ally, 2009). The definition also refers to capabilities of using mobile devices, including smartphones and tablets, for teaching and learning purposes. Another definition of mobile learning is a process of teaching and learning that occurs with the use of mobile devices to provide flexible, on-demand access, without time and device constraints, to learning resources, experts, peers, and learning services from anyplace at anytime (Kukulska-Hulme, 2009; Traxler, 2009). Therefore, mobile learning should be "restricted to learning on devices which a lady can carry in her handbag or a gentleman can carry in his pocket" (Keegan, 2005, p. 33). Looking at the definitions of mobile learning, it is significant to consider that mobile learning should focus on a learning-centered approach, and not focus on a technology-centered approach, because the focus on the technology approach might not help to understand the nature of learning. Additionally, mobile learning enables a wide range of educational applications which support teaching and learning processes. Moreover, mobile learning has the ability to increase the transmission and delivery of multimedia learning materials.

Mobile learning is now becoming pervasive and ubiquitous as technological tools to be used in the educational sector are increasingly changing the nature of knowledge acquisition and ways of accessing it (Hashemia, Azizinezhad, Najafia, & Nesari, 2011). This in turn alters the two forms of learning (formal and informal learning) from static (face-to-face classroom) to dynamic (anywhere, at anytime) and from classical learning to modern school settings.

Consequently, the concept of mobile learning can emphasize formal learning and large-scale deployment of informal learning. If we think about mobile learning in a wide concept—anywhere, at anytime, or no physical restriction among users—we can recognize that teaching and learning will become more dynamic than ever. Considering the attributes of mobile devices (e.g., interactivity, mobility, personalization), the nature of formal learning (face-to-face classroom setting) should become more dynamic through mobile learning technology. Other researchers have asserted that the traditional form of learning could be changed to meet the younger generation's learning interests (Leone, 2013; Wang, Novak, Shen, & Pan, 2009). Nowadays, most of our students in higher education have smartphones; research studies stated that many college students have a smart mobile phone (Alfawareh & Jusoh, 2014). The key element is that the mobile devices offer ubiquity, multi-functionality, personality, and network connectivity. Smartphones and other mobile devices (e.g., tablets) can be useful didactic resources for developing academic subjects for formal learning and informal learning to benefit students and teachers in higher education institutions (Esteban, 2014). Moreover, they could be used to increase interactivity between students with their teachers.

It is apparent that mobile technology innovation has a large impact on students' learning (UNESCO, 2013; Wang et al. 2009) The advantages of smart phone and tablet usage during class lecture are that students can connect to the Internet, access a variety of social media networks (e.g., YouTube, Facebook, blogs, wikis), send or receive e-mail messages, converse and interact.

Obviously, with mobile learning's added contribution to teaching and learning, smartphones and tablets can be used inside and outside the classroom. These devices enable students to access a rich interactive learning environment using mobile technology.

11.4 Mobile Learning Technology

In recent years, most of educational institutions (e.g., schools, colleges, and universities) are moving toward using mobile devices in and out of classrooms in order to take advantage of new smartphones that offer many facilities and choices to fulfill educational purposes. The use of mobile technology has been expanding students' learning opportunities more than ever. Today, mobile devices such as smartphones and tablets have offered new options to facilitate learning to be accessed, in which learning can occur or take place (Michelle, Heather, & Crystal, 2016). It is very important to note that the key issue that makes mobile learning unique is that learning can occur in different environments under different situations. Mobile learning can connect learners around the globe, creating communities of learning and supporting lifelong learning (Hashemia et al., 2011). As noted by Brown and Mbati (2015), another significant issue for using mobile devices for teaching and learning purposes is that mobile devices emphasize the mobility of learners, so that the learning is within the control of the learners; they can complete their learning activities independently of their teachers. However, it can be recognized that using mobile learning enhances students' learning in different aspects (e.g., exchange of knowledge, support, communication, increases in motivation, promoting and developing personal skills among formal and informal learning circumstances). Moreover, the applications of mobile technology enable students to achieve different learning activities (doing assignments, access to quizzes, peer-to-peer interaction, accessing digital learning materials).

The major benefits of mobile learning have been reported by many scholars, for example: Ally and Prieto-Blázquez (2014), Fezile and Nadire (2011), Jeferry and Scott (2013), Nana 2013, Sharples and Roschelle (2010); they created a list of benefits of using mobile devices which includes:

- Mobile learning facilitates the mobility of learning—learning can occur anytime and at anyplace.
- The mobile learning process is not constrained or limited to one place.
- Mobile learning increases students' motivation and enhances interaction between teachers and students. Mobile learning supports lifelong learning and

offers opportunities for learners to learn while on the move, at work, or at leisure.
- The use of mobile learning can facilitate collaboration among students and instruction via synchronous and asynchronous communication.
- Mobile learning offers new options for learning beyond traditional learning classrooms.
- It can be useful to reduce the gap between formal and informal school settings.
- Mobile learning supports activities in an out-of-school ambiance.
- Mobile learning increases self-confidence and gives freedom to students.
- Mobile learning provides different learning styles based on the students' preferences.
- Educate people who cannot move or cannot travel to access educational institutions.
- Mobile learning enables educating students who dropped out of schools, by designing learning to be accessed by their mobiles in their own time.

Despite the benefits of mobile learning, it should be considered that any technology has positive and negative aspects, and mobile devices (smartphones and tablets) are no exception. The major negative aspect of using mobile devices is that when students are online accessing the internet, they might spend much more time surfing the Web using their mobile devices for entertainment. Consequently, the mobile devices may disrupt students and shift their attention from the learning.

Regarding implementation of mobile learning in higher education, there have been some problematic issues, including the lack of a solid theoretical framework which guides instructional designers to evaluate the quality of a mobile learning program (Park, 2011). However, smartphones and tablets still present challenges in meeting educational institutions' demands. Khaddage et al. (2015) reported four challenges that may hinder the implementation of mobile technology in higher education, as listed below:

- **Pedagogical challenges**: These types of challenges include curriculum and the structures of learning, when focusing on student-centered learning, and how to use mobile devices in a pedagogical context.
- **Technical challenges**: This area of mobile challenges includes technical aspects of mobile software–hardware, infrastructure and network, apps' usability for mobile devices, navigation, access and implementation.
- **Policy challenges**: Implementing mobile learning in an effective way for teaching and learning goals requires formulating policy at all levels (school, district, national, and international). Policy makers, school leaders and teachers, and parents should recognize the benefits of mobile technologies and support formulating strategy on how devices such as smartphones would be used in an educational context.
- **Research challenges**: Mobile learning needs more research or case studies on the impact of using mobile apps technology in both formal and informal learning.

To help overcome these challenges in implementing mobile devices in a wide range of education, it is important for all stakeholders (policy makers, parents, teachers, students, and practitioners) to recognize that mobile learning is a way of getting students excited about learning; it is going to be the future of learning and enables meeting students' diverse needs and interests with outstanding learning activities.

Additionally, the best way of making learning sustainable is using technologies that students bring with them. Most of the students in universities and colleges have smartphones, why not provide them learning to be accessed via their mobile devices? All we need are formulated standards and mobile learning models to solve all problematic issues—"ethical considerations, pedagogical aspects, and curriculum design"—which will become a guide for implementing mobile learning in higher education.

11.5 Mobile Learning Applications

Alongside the increase of smart phone applications, more than 40 million smart phone users have downloaded more than 1 billion applications from the app store since 2009 (Suen & Fung, 2016). The reasons behind this are that people use mobile apps technology not only for communication, commercial purposes, or entertainment purposes but also for access to learning materials. Additionally, the increase of productivity of mobile apps can allow both teachers and students to access learning content and use it in innovative ways, as well as students enjoy dynamics as they move and share experiences in a real-virtual world (Herrington, 2012).

Mobile applications or apps are defined as the software that runs on mobile devices such as smartphones and tablets. Most of these devices are equipped with data network, camera, accelerometer, and location-based technology.[1] Also, the term can be used to describe the application software that is designed for mobile devices to fulfill a specific purpose (Nickerson, Varshney, Muntermann, & Isaak, 2007). Most of mobile apps can be freely downloaded from one of the common app stores on the web.

Mobile applications have abilities to serve values such as ubiquity, time-criticality, spontaneity or immediacy, accessibility, convenience, localization, and personalization (Hwang & Kim, 2010). Thus, mobile apps seem to be understood according to their functions; they can provide an interactive learning platform which supports students' learning characteristics.

There are huge numbers of mobile apps applications which are designed specifically to achieve different activities. In educational contexts, there are many educational apps that are developed specifically for educational applications, for

[1]https://www.techopedia.com/definition/2953/mobile-application-mobile-app.

example, apps for reading eBooks (e.g., OverDrive and Kindle), apps for productivity (e.g., Todo, Fantastical 2 for iPhone and LogMeIn), apps for research and references (e.g., Wikipedia Client, DuckDuckGo), apps for taking notes and writing (e.g., Evernote, Handwriting and Drawing and iTalk Recorder), apps for multimedia (e.g., MoMA and Diptic), apps for social media (e.g., Hootsuite, Buffer and WordPress), apps for communications (e.g., Hangouts, Imo, Wechat and WhatsApp Messenger), apps for content creation and curation (e.g., Keynote and Haiku Deck), apps for going beyond the library catalog (e.g., RedLaser, Kiosk Pro, and Layar—Augmented Reality) (Hennig, 2014).

The categories of mobile apps mentioned above show the possibilities for using mobile applications technology in different learning aspects, so as to cover a wide range of educational activities which provide students with opportunities to share knowledge and experiences, collaborate and interact with others.

As a result, using mobile technology for teaching and learning purposes can extend students' learning opportunities, and provides new learning environments (e.g., inside and outside learning environments) that are highly interactive and engaging. Nowadays, smart phone devices equipped with applications could be useful for learning and make mobile devices a highly personalized platform that could be used for communication, delivery of information, and production (Suen & Fung, 2016). More specifically, mobile apps technologies have the ability to support learning regardless of the students' locations (e.g., face-to-face classroom, out-of-school learning environments), in which conversation and interaction can occur and provide learners greater chances to access information.

Indeed, mobile technologies have the ability to support numerous educational purposes and learning styles from K-12 to higher education, and from formal to informal learning settings, particularly extending learning opportunities for students to build knowledge communities in multiple ways, such as conversation, discussion, interaction, sharing and engagement between all communities, in different learning environments, so that they can function to blur the gap between formal and informal learning environments.

Meanwhile, the use of mobile technology is increasing services for learning and clearly appears as a useful and flexible tool for transmitting learning. Students can have more venues for developing the critical twenty-first-century skills using mobile technology (Looi et al., 2016).

11.6 Conclusion

This chapter presented the possibility of dissolving the gap between formal and informal learning using mobile apps, considering the challenges of implementing mobile learning for educational purposes. It would be concluded that mobile learning technologies are changing and extending the nature of learning from traditional learning environments to the new interactive learning environments so as to enable learners to learn in different learning contexts.

Moreover, the dissolving gap between formal and informal learning means that educational institutions are alongside the changes and challenges that occur in society. Additionally, bridging formal and informal learning using mobile apps can enable students to build conceptual knowledge by connecting, sharing, and engaging in learning activities inside and outside the classroom. It is significant to recognize that the design of standard curricula in which formal and informal learning can be bridged is not necessity for the future of learning. In addition, mobile learning requires more case studies to cover migrants, refugees, and disabilities to reflect to what extent mobile learning enables educating all groups of people in different situations.

However, it is important for stakeholders (policy makers, administrators, school leaders, teachers, parents, and practitioners) to take into consideration the following points:

- The impact of technology has been changing all aspects of our life and it will keep changing, and the educational system is not an exception. These changes will continue to affect education systems. More specifically, mobile technologies should find their way to educational purposes.
- The educational curriculum should be redesigned or reformed to become more flexible and dynamic with the mobility of learning.
- The use of app technology is becoming more popular than ever, especially among university students. Using these technologies (app technologies) for education will meet learners' interests and motivation.
- Mobile technology/digital literacy skills are becoming more significant for both teachers and students. They need to be aware of mobile technology applications and how to implement mobile technologies in everyday teaching and learning activities.
- Using mobile technology for formal and informal learning means responding to the changes and challenges that our society faces and making schools more social.

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Part II
Research and Applications

Chapter 12
Supporting Mobile Instructional Design with CSAM

Robert Power

Abstract Teachers' proficiency with emerging technologies has been identified as a cornerstone of a well-rounded modern curriculum that includes the development of students' digital literacy skills. The central role of teachers' technical knowledge is one of the bases of the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra in Teachers College Record, 109(6):1017–1054, 2006, The handbook of technological pedagogical content knowledge (TPCK) for educators. American Association of Colleges of Teacher Education and Routledge, New York, pp. 3–29, 2008; TPACK.org & Koehler, n.d.; Unwin in Bulgarian Journal of Science and Education Policy, 1(1):237–247, 2007). While frameworks such as TPACK have been promoted as useful tools for guiding teacher professional development initiatives, they have been criticized for failing to provide direction in exactly how technical knowledge can be promoted (Perk in Pedagogical reflections, 2009; Voogt et al. in Journal of Computer Assisted Learning, 29 (2):109–121, 2012). At the same time, teachers' lack of confidence in their technical skills has been identified as a barrier to greater integration of mobile technologies in instructional design (Ally et al. 2013; Ally, & Prieto-Blázquez in RUSC, 11(1), 142–151, 2014; Kenny et al. in 2010; Power, 2015). The Collaborative Situated Active Mobile (CSAM) learning design framework (Power in Learning and Teaching in Higher Education: Gulf Perspectives, 10(2), 2013, 2015) was developed as a tool to provide scaffolding to instructional design decisions involving mobile technologies and reusable learning objects. CSAM is grounded in prominent learning theory and reflects the instructional design practices represented in recent mobile learning literature. Through the scaffolding of mLearning decision making, CSAM can be used to boost the effectiveness of instructional design, increase teachers' perceptions of self-efficacy, and fill in gaps to compliment TPACK in the development of teacher professional development strategies. This chapter describes the components of the CSAM learning design framework, as well as its theoretical underpinnings. This chapter also highlights support for the use of CSAM in research and mobile learning literature, and describes how CSAM compliments

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_12

frameworks such as TPACK to help prepare teachers and instructional designers to better integrate mobile technologies into modern curriculum.

Keywords Collaborative situated active mobile learning design framework (CSAM) ID4ML · Instructional design · Micro-MOOC · MOOC · mRLO Reusable learning object · RLO · Self-efficiacy · TPACK · TPCK

12.1 Introduction

Digital literacy skills have become increasingly important at all levels of formal education systems. Levy (2016, May 9) noted that the digital skills sought by employers have "permeated the classroom as well," and that teachers who possess and demonstrate digital literacy skills will "foster a sense of strong sense of digital citizenship in our students." However, Finger, Jamieson-Proctor, and Albion have lamented that changes in available technologies to enhance learning and teaching "have not always translated into practice which has resulted in a focus on the need for improvements in pre-service teacher education programs and professional development of practicing teachers" (2010, p. 114). They highlighted that teachers are already well prepared in the areas of pedagogical and content knowledge, and pointed to a need to focus on competencies with technical skills and effective pedagogical approaches to the integration of technology in teaching and learning.

The addition of technological knowledge to the focus of teachers' requisite skill sets and the intersection of technological knowledge with pedagogical and content competencies, are the foundation of the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2006, 2008; TPACK.org & Koehler, n.d.; Unwin, 2007). The three primary components of TPACK are technological knowledge, content knowledge, and pedagogical knowledge. These elements intersect to generate four additional components, including Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). Figure 12.1 illustrates the relationships between the seven components of the TPACK framework.

TPACK was developed by Koehler and Mishra (2006, 2008) as a "conceptual framework for educational technology [that]… attempts to capture some of the essential qualities of teacher knowledge required for technology integration in teaching" (2006, p. 1017). TPACK posits that in order to effectively integrate technology, teachers must have adequate knowledge in each of the areas of technology, pedagogy, and content. Nicholson (2015, February 9) explained that TPACK not only adds technological literacy to the skills needed by teachers, but that is also explicitly calls for drawing connections between technology integration and learning content, and for a "spectrum of approaches to teaching and learning." Gur and Karamete (2015) noted that TPACK continues to figure centrally in the literature on teacher training, and that many institutions and organizations continue to focus on how to use TPACK to guide professional development. Koh, Chai, and

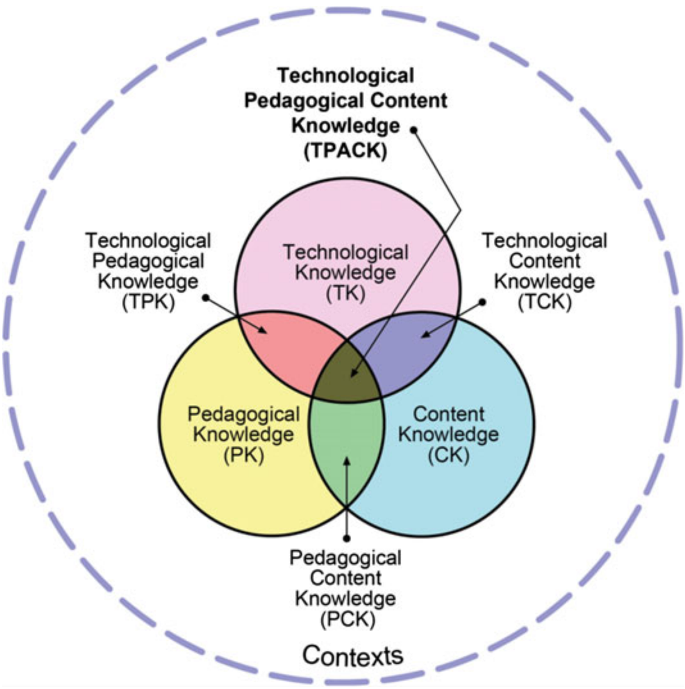

Fig. 12.1 Components of the TPACK framework. Reproduced with permission (TPACK.org, 2012)

Lim noted that participation by teachers in Singapore in a prolonged professional development process has "had positive effects on teachers' confidence for technological pedagogical content knowledge for 21st century learning and lesson design practices" (2016, p. 1)

12.2 Shortcomings in Teacher Preparation for Mobile Instructional Design

As a part of a large-scale initiative in the United Arab Emirates, Cavanaugh, Hargis, Munns, and Kamali (2013) found that "TPCK was considered to be foundational to effective teaching in a mobile learning environment" (Kennedy, 2013). However, TPACK has been criticized as a focus for teacher professional development (Perk, 2009; Unwin, 2007; Voogt, Fisser, Pareja, Tondeur, & van Braak, 2012). Perk (2009) asked "where are the students in this framework?" He criticized TPACK as being overly teacher-centric and failing to consider the role that learners play in determining pedagogical decisions and the appropriateness of technology. Unwin (2007) also suggested that TPACK fails to place emphasis on the role of the learner in the process of pedagogic design. Perk (2009), Unwin (2007), and Voogt et al. (2012) also criticized the notion posited by TPACK that technology has become so intertwined with modern life that it is in danger of becoming invisible in pedagogical decision making. Unwin stressed that the pedagogic design process always "requires collaborative communities of practice that include ICT 'enthusiasts' within any course team" (2007, p. 231, emphasis in original). Unwin's suggestion is that not all teachers will have high levels of technological knowledge, and that educational technology enthusiasts will continue to play a significant role in helping their peers to make decisions about how to integrate technology.

Power (2015) discussed the role of various models and frameworks in preparing teachers to use mobile learning strategies and noted that:

> The TPACK framework provides a holistic picture of instructional design that integrates technology with teachers' knowledge of content and pedagogy. However, the criticisms of TPACK suggest shortcomings in the provision of guidance on how to achieve this integration (p. 57).

A lack of guidance on how to achieve integration has been identified as a contributing factor to difficulties with integrating mobile learning strategies in instructional design. During a panel discussion on mobile learning initiatives at the 12th World Conference on Mobile and Contextual Learning (mLearn 2013), Athabasca University mobile learning researcher Mohamed Ally discussed the impact of lack of guidance on perceptions of efficacy (Ally et al., 2013). In response to a question on barriers to mobile learning initiatives at educational institutions, Ally discussed the impact of perceptions of the pedagogical efficacy and teachers' self-efficacy with integrating mobile learning resources into their own practice. Tschannen-Moran and Woolfolk Hoy noted that perceptions of self-efficacy can influence a teacher's "levels of planning and organization" and "willingness to experiment with new methods to meet the needs… of students" (2001a, p. 783). Kenny, Park, Van Neste-Kenny, and Burton (2010) cautioned that a lack of training and guidance in the pedagogical considerations for the integration of a specific type of technology, such as mobile devices, can have a negative impact on teacher's perceptions of self-efficacy.

The TPACK framework emphasizes the importance of competency with technology and of understanding pedagogical strategies for connecting technology integration with other curricular requirements. However, the criticisms of TPACK point to a need for an additional tool to scaffold teacher preparation and professional development in the areas of technological knowledge (TK) and Technological Pedagogical Knowledge (TPK).

12.3 FRAME: Providing Context But Not Guidance

One of the most widely referenced models related specifically to mobile learning design is Koole's (2009) Framework for the Rational Analysis of Mobile Education (FRAME). FRAME presents three core aspects present in any mobile learning

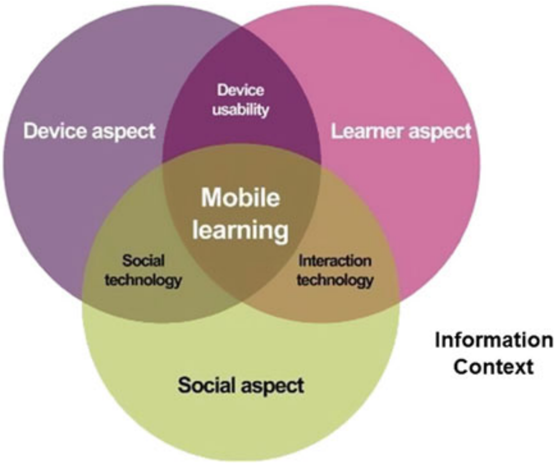

Fig. 12.2 The FRAME model (Koole, 2009, reproduced with permission)

context, which are the device, the learner, and the social aspect. The intersections of the domains in the FRAME model are depicted in Fig. 12.2.

FRAME has been described by Park (2014) as useful to educators because it provided “criteria and examples of each aspect and interaction and [a] checklist that might help educators plan and design mLearning environments” (p. 32). FRAME was presented in Ally (2009) alongside a number of case studies on mobile learning and offered as a tool for grounding reflection on a wide diversity of learning objectives, instructional design approaches, and technical solutions. However, Power (2015) noted that “that grounding of diversity highlights the limitations of FRAME in providing focused advice for specific types of learning objectives and activities, such as the facilitation of collaborative learner interaction” (p. 23). Power (2015) described the need for a new instructional design framework to provide scaffolding for educators because FRAME “does not provide guidance on the pedagogical elements needed to utilize mobile technologies” (p. 42).

12.4 What Is CSAM?

Power (2013) developed the Collaborative Situated Active Mobile (CSAM) learning design framework as a response to the lack of pedagogical guidance in models like FRAME. Power described CSAM as a “synthesis of established learning theories and analytical frameworks that have been frequently referenced in the mLearning Literature” (2013, p. 1), which emerged from a “qualitative analysis of case studies of mobile learning involving collaborative pedagogical approaches that have been facilitated by mobile reusable learning objects” (2015, p. 6). A qualitative meta-analyses of mobile learning literature published between 2009 and 2014 (Power, 2015) found that “eighty-two percent of the [mobile reusable

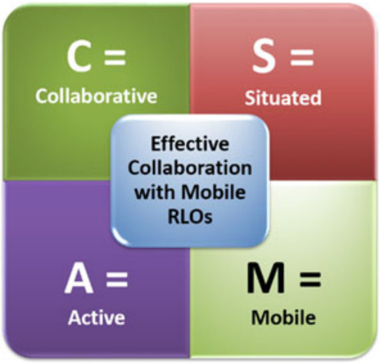

Fig. 12.3 The Collaborative Situated Active Mobile learning design framework

learning object] examples either explicitly or implicitly described the inclusion of all four CSAM learning design framework pedagogical elements in their instructional design" and that "ninety-six percent of the RLO examples represented three of the four CSAM elements" (p. 40). Figure 12.3 depicts the CSAM pedagogical elements that form the core of instructional design for collaborative learning facilitated with mobile learning strategies.

CSAM draws heavily upon activity theory, the zone of proximal development, and transactional distance theory. Power (2015) explained that CSAM is also "consistent with the considerations espoused by… the TPACK framework," but that it "aims to provide more targeted guidance… on a narrower range of considerations specific to pedagogical decision making" (p. 49). The CSAM learning design framework posits that Instructional Design for Mobile Learning has consistently focused on the facilitation of collaboration. CSAM contends that mobile learning should be situated in a realistic and meaningful context, and that learners engage in active learning that result in the production of artifacts of learning. CSAM also maintains that learning should leverage the capabilities of mobile technologies, and that learners should be afforded special and temporal mobility so that they can engage in learning activities where and when that learning is most opportune and effective.

12.5 Addressing Self-Efficacy with CSAM

Competencies with technology and technological pedagogies have been identified through TPACK as fundamental to current teacher preparation and professional development, and teacher self-efficacy has been identified as a barrier to achieving and implementing those competencies into practice with respect to mobile learning. However, Kenny et al. (2010) have noted that:

> While a significant body of research exists on learners' feelings of self-efficacy concerning computer technology, online learning, and even podcasting… this concept does not yet appear to have been examined in any detail in a mobile learning context (p. 2).

Power (2015) drew upon the CSAM framework to address shortcomings with teacher training and perceptions of self-efficacy with mobile learning strategies. That research involved the development of a four-week professional development course dedicated to instructional design for mobile reusable learning objects (RLOs), which was offered in a micro-MOOC (Massive Open Online Course) format. Figure 12.4 illustrates the conceptual framework of the research study, which examined how using the CSAM framework affected teachers' confidence with using mobile learning approaches.

Participants in the course included graduate-level education students and practicing educators. The course topics included an overview of mobile learning concepts and mobile RLOs, the principles of CSAM, and using CSAM to plan the instructional design, and build a prototype of a new mobile RLO. To determine the

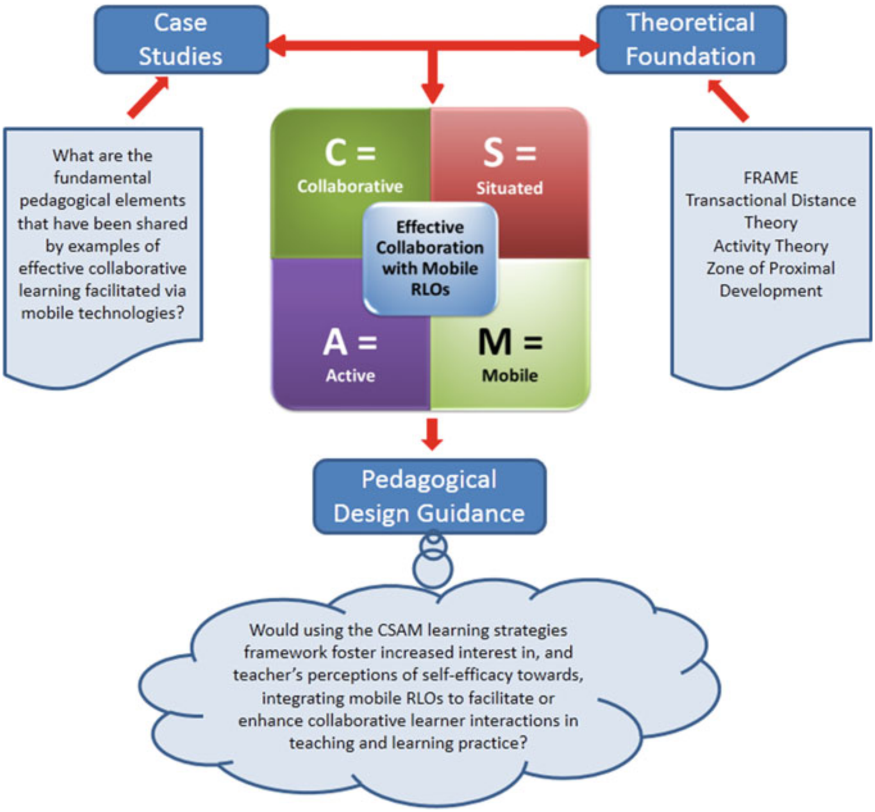

Fig. 12.4 Conceptual framework for evaluating the CSAM learning design framework (Power, 2015, p. 10)

impact of the CSAM framework on participants' perceptions of self-efficacy, free online tools that required minimal technical expertise were used in the construction of RLO prototypes. Additionally, the course design and content were independently reviewed using the Quality Matters™ (2012) self-assessment rubric, to ensure that course design did not have a negative effect on participants' results.

12.6 Testing CSAM

Power (2015) used a mixed-method approach to determine how training on the use of the CSAM framework affected teachers' perceptions of self-efficacy. Tschannen-Moran and Woolfolk Hoy's (2001a, 2001b) Teacher's Sense of Efficacy Scale (TSES) was adapted for the collection of quantitative data. The original TSES measures teachers' confidence along the domains of Student Engagement, Instructional Design, and Classroom Management. Benton-Borghi (2006) adapted the TSES to measure self-efficacy along the same domains with respect to tasks related to inclusive education for students with learning disabilities. Power (2015) used the processes outlined by Benton-Borghi to similarly adapt the TSES within a mobile learning context. The combined TSES and Mobile Teacher's Sense of Efficacy Scale (mTSES) were used to measure changes in participants' self-efficacy with mobile learning compared to their TSES scores. Power (2015) also conducted a qualitative analysis of participants' responses to survey questions and post-course interviews.

12.6.1 Overall Trends

Quantitative data were collected by Power (2015) using the combined TSES and mTSES scales. Participants' mTSES and TSES scores were reported using a nine-point scale and were compared from the beginning of the training to the end of the MOOC. After accounting for potential maturation effects, participants showed an increased confidence with mobile learning across all three subdomains. The greatest increases in self-efficacy appeared on the Instructional Strategies (0.68 points) and Student Engagement (0.57 points) domains. The positive impact demonstrates that training on the use of a pedagogical framework to scaffold mobile learning instructional design can address teachers' needs in developing Technological Pedagogical Knowledge. Figure 12.5 shows the overall changes in perceptions of self-efficacy with mobile learning.

Qualitative analysis of participants' responses to survey questions and follow-up interview questions provided further insight into changes in teachers' confidence with mobile learning. A total of n = 278 comments from the survey and interview transcripts were coded based on general themes. The results showed positive perceptions toward the CSAM framework and the training, and increased interest in

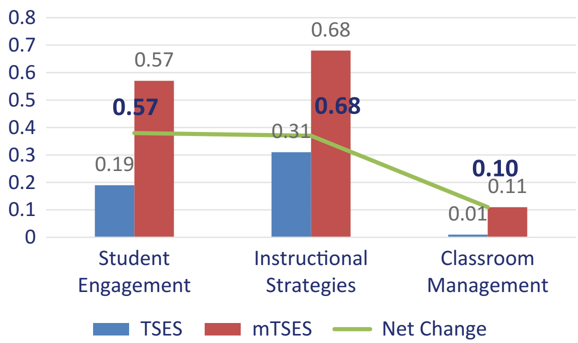

Fig. 12.5 Net changes in perceptions of self-efficacy with mobile learning (Power, 2015)

Table 12.1 Frequency counts of primary comment codes

Primary codes	Descriptions	n_{Survey}	$n_{\text{Interviews}}$	n_{Total}
000	Not coded	7	37	44
100	Framework strengths	21	35	56
200	Framework weaknesses	1	12	13
300	Course strengths	1	50	51
400	Course weaknesses	6	12	18
500	Self-efficacy	0	0	0
600	Interest	11	31	42
700	Other barriers	1	22	23
800	Other supports	6	25	31
Totals		54	224	278

using mobile learning strategies. Table 12.1 presents the general themes of participants' responses.

Speaking about the CSAM framework as a tool for scaffolding instructional design,

Multiple participants described the benefits of CSAM as a tool for scaffolding instructional design to help them to focus on critical pedagogical components. As one survey respondent commented:

> CSAM provides a way to consider and develop collaborative learning tools. It helps me to think about situating those activities so they are meaningful for the learner and to help them to actively develop new knowledge (vs. passive reception). In my teaching environment, students are disadvantaged in an academic and cognitive sense. Therefore, I feel an mRLO can help to stimulate self-direction and critical thinking, even on a simple and practical level.

One interview participant remarked that the CSAM framework helped him to recognize when important pedagogical elements were missing. He also noted that

CSAM provided a basis for reflecting on the justification for either integrating or omitting those weak or missing components:

> If I felt that there wasn't, say, for instance, a collaborative element, that was weak there, or something, then saying, well is that something that, to which there is benefit that I beef up, I somehow integrate that or can I justify leaving it just as it is? Or some other aspect of the framework that perhaps is not there at all and, is that a problem, or does it matter?

One survey respondent explained that CSAM helped with the recognition of pedagogically beneficial factors that are often overlooked in instructional design, such as "asking if it is situated." The respondent remarked that "I think we often think about creating activities where students work together and are active and mobile, but really analyzing if the lesson is situated… is very useful."

Speaking about his overall experience with the design of the CSAM professional development course, one interview participant commented on the benefit of contextualizing the framework with hands-on learning activities and remarked:

> I liked the whole idea of the course…that everybody chose their own little project that they thought would be suitable for their context and we used the framework when we were planning to help us guide our thinking about what we were doing… then afterwards we went back to the model and evaluated whether we had actually used a, or created a… a model learning object.

Other participants indicated a desire for more time to experiment with and test their own mobile RLO designs. One interviewee felt that a formal practicum module would be beneficial "because the object that I created in the course is one that I haven't yet trialed with a real audience and that's the next step."

Supports. Survey and interview respondents provided feedback as to what supports they saw as necessary to help them move forward with using mobile learning strategies in their own teaching and learning practice. Figure 12.6 shows the types of supports that teachers most frequently referenced.

Having support from an informal community of practitioners was indicated by teachers as one of the most important factors that would influence their confidence with mobile learning strategies. Informal peer support was noted to be as important, if not more so, than access to institutional support, access to face-to-face training, or opportunities to build and experiment with mobile learning resources. One survey respondent commented that "you like to know that you have a support group there" in case "you run into troubles or difficulties, or you want to bounce an idea off someone." Another survey respondent discussed the importance of having a local informal support group "with our immediate context" because "we can go through lots of media to talk about what's happening in California, what's happening in South Africa… I want to see it on the ground here."

Barriers. Participants also commented on what they saw as current barriers to their ability to make better use of mobile technologies. The most frequently identified barriers are highlighted in Fig. 12.7.

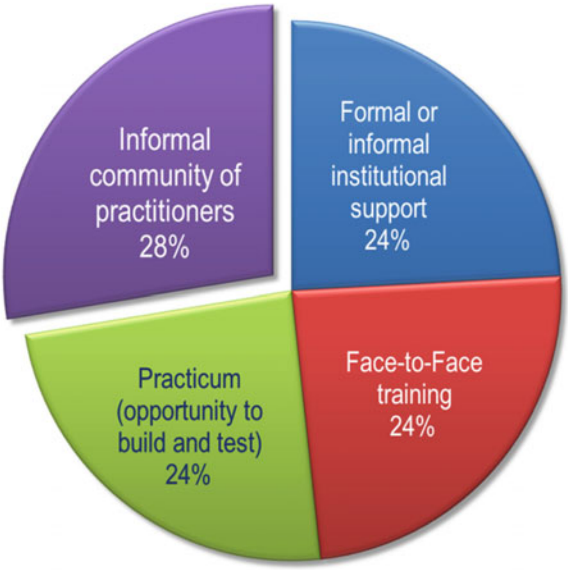

Fig. 12.6 Supports needed to integrate mobile learning strategies

Fig. 12.7 Barriers to mobile learning integration

A lack of institutional interest and negative institutional perceptions of mobile learning constituted nearly half of all of the survey and interview comments about barriers to mobile learning. The remaining barriers that were identified related to lack of experience, lack of technology, and lack of mobile learning development resources.

12.6.2 Taking a Second Look

The CSAM framework was used as the foundation of a module on instructional design planning in another professional development MOOC in May to June 2014 called *Instructional Design for Mobile Learning* (ID4ML) (Power, Cristol, Gimbert, Bartoletti, & Kilgore, 2016). Approximately 2100 people enrolled in ID4ML, including practicing teachers, teacher trainees, instructional designers, mobile technology enthusiasts, and others who took the course out of general interest. ID4ML participants were asked to complete the mTSES at the beginning and again at the end of the four-week course. Figure 12.8 shows the overall changes in respondents' perceptions of self-efficacy with mobile learning.

The analysis of the ID4ML mTSES survey results showed an increased confidence with the use of mobile learning on the Student Engagement subdomain. However, participants' confidence decreased for the subdomains of Instructional Strategies and Classroom Management.

Power et al. (2016) identified course design and participant demographics as potential contributing factors to the differences in mTSES results compared to those from Power (2015). Both MOOCs introduced CSAM as a tool for scaffolding instructional design scaffolding. However, exposure to CSAM in ID4ML was limited to just one week, and participants were not asked to either develop new instructional design plans, build prototype mobile RLOs, or engage in reflection on such instructional design activities. Such activities were identified as the most influential by participants from the original professional development course. Additionally, 78% of participants in the original MOOC were practicing educators, compared to just 53% of respondents from ID4ML. The original course was predicated on the premise that removing the cognitive load of learning new educational technology tools, combined with the use of CSAM, would help teachers transition their content knowledge and pedagogical knowledge into new confidence in the Technological Pedagogical Knowledge domain. Power et al. (2016)

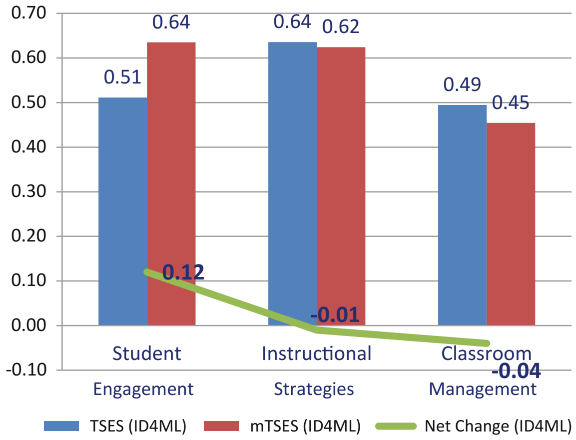

Fig. 12.8 Net changes in perceptions of self-efficacy with mobile learning (Power et al., 2016)

speculated that lower overall levels of teaching experience and pedagogical expertise may have contributed to increased apprehension on the Instructional Strategies and Classroom Management subamong ID4ML participants.

12.7 Complementary Tools: CSAM and TPACK

TPACK provides an overall picture of the types of competencies that teachers need in order to effectively integrate technology into their teaching and learning practice. However, TPACK has been criticized for not providing specific guidance on how to achieve these competencies (Perk, 2009; Unwin, 2007; Voogt et al., 2012). The CSAM framework can be used to compliment the strengths of TPACK, as well as to resolve some of the criticisms of the framework. CSAM presumes that teaching professionals already possess both content and pedagogy knowledge. CSAM draws upon teachers' existing pedagogical and content expertise and provides a framework for deciding how to deploy mobile learning strategies to create a collaborative learning environment for students. The characteristics and needs of learners are therefore included in the instructional design process. The CSAM learning design framework could be used as a tool to incorporate mobile technologies with teachers' existing pedagogical and content knowledge for the purpose of moving the holistic picture of instructional design into the central, TPACK region of the TPACK framework.

Teacher preparation and professional development that focuses solely on how to use specific technologies is not likely to succeed in helping teachers to develop Technological Pedagogical Knowledge competencies. Koehler and Mishra (2008) noted that technology-centric professional development initiatives are likely to be unsuccessful because they do not take into account the contexts in which teachers must apply the technologies, thus "traditional methods of technology training… are ill suited to produce the 'deep understanding' that can assist teachers in becoming intelligent users of technology for pedagogy" (pp. 1031–1032). In contrast, an emphasis in professional development on clearly defined competencies such as pedagogical decision making can help teachers to feel more confident with the use of new technologies (mdk12.org, 2014). Participants in a CSAM-focused professional development MOOC (Power, 2015) indicated that an informal community of practice would be one of the most useful supports as they learn new technologies that they would like to integrate them into teaching practice. Drawing upon peers who are innovators and early adopters of technology (Rogers, 1974) could thus be a key step to helping teachers develop technological knowledge competencies. Knowing that they have the support of their peers will help teachers who lack experience with mobile learning strategies to develop technical skills. The CSAM framework allows teachers to bridge such technical skills with their existing content knowledge and pedagogical knowledge, thereby increasing their competency in the Technological Pedagogical domain in a mobile learning context. As illustrated in Fig. 12.9, the use of the CSAM framework could help teachers to increase their

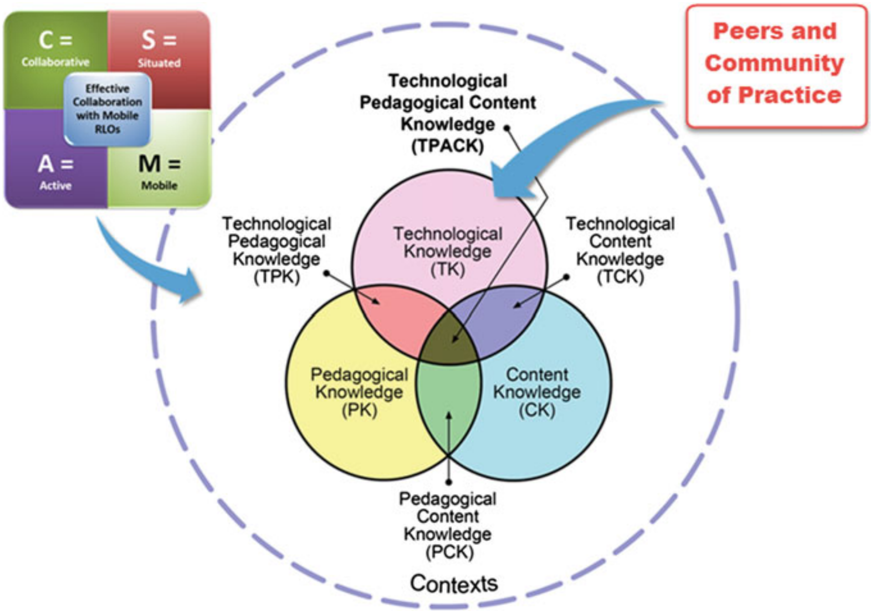

Fig. 12.9 Filling the gaps in TPACK guidance

TPACK competency levels, while still allowing room for them to collaborate with more technologically knowledgeable peers to progressively expand the range and complexity of the types of technologies they integrate into their teaching practice.

12.8 Conclusion

The TPACK framework aims to demonstrate the essential competencies required of teachers to effectively integrate technology into teaching and learning practice. TPACK is frequently drawn upon to inform training to prepare teachers for curricula that increasingly incorporate technology enhancements and digital literacy skills. However, TPACK has been criticized for failing to provide guidance on exactly how to achieve the technological knowledge and Technological Pedagogical Knowledge competencies that it promotes as critical domains. The CSAM framework was developed from the central pedagogical design elements of mobile reusable learning objects. CSAM provides teachers with scaffolding for instructional design decision making in a mobile learning context. Professional development focused on using CSAM to guide instructional design decisions, and to reflect upon mobile learning implementation, has been shown to be effective at increasing teachers' confidence in the Technological Pedagogical Knowledge domain. When combined with the support of peers and a formal or informal community of practice, the CSAM framework can complement TPACK by providing the specific missing guidance in a mobile learning context. However, in order to most effectively support teachers in their development of technological knowledge and Technological Pedagogical Knowledge competencies, schools and institutions need to show explicit support for those efforts. Teachers also need time and resources to experiment with mobile technologies, and professional development initiatives should draw upon CSAM to put an explicit focus on understanding pedagogical approaches to mobile learning.

Glossary of Terms

CSAM The Collaborative Situated Active Mobile learning design framework

ID4ML Instructional Design for Mobile Learning

Micro-MOOC A Massive Open Online Course (see MOOC) designed to be conducted over a limited time frame and with a fixed or limited number of participants (Coulter, 2014; Klassen, 2014)

MOOC Massive Open Online Course. A MOOC is "a model for delivering learning content online to any person who wants to take a course" (Educause, 2014)

mRLO Mobile reusable learning object

Reusable learning object "Any digital object that can be reused to facilitate and support learning activities" (Polsani, 2003; University of Wolverhampton, 2016).

RLO Reusable learning object

TPACK The Technological Pedagogical Content Knowledge framework (TPACK.org, 2012)

TPCK TPACK

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Chapter 13
A Study of Learning Achievements in Collaborative Construction Knowledge Space in Seamless Learning

Shengquan Yu and Na Ren

Abstract In the field of seamless learning, there are some common research topics, including the use of situational awareness technology, location-aware or tag information to extract learning resources from seamless learning space. Therefore, organizing resources to build the knowledge space of seamless learning is one of the key elements to help students improve their learning achievements. However, in previous studies, the knowledge space of seamless learning was preset by the teacher and remained unchanged in the learning process. In this learning approach, students passively acquire knowledge through sensor technology and wireless network in the real learning environment. This study proposed a collaborative knowledge construction seamless learning method where knowledge space is no longer preset in advance by the teacher, but built by students themselves in a dynamic manner. In order to verify the validity of this model, the researcher designed authentic learning activities for fire safety education, in which the experimental group used the proposed collaborative knowledge construction seamless learning method to learn, and the control group used the conventional seamless learning method, in which knowledge space is preset by the teacher for students to learn. The experimental results showed that there was a significant difference in learning achievements and learning performance between the experimental group and the control group. Moreover, the experimental group showed significantly higher mental effort than the control group. Therefore, not only the situation perceived by technology, but also designing effective learning activities and promoting the depth of interaction are very important in context-aware seamless learning.

Keywords Collaborative knowledge construction · Knowledge space of seamless learning · Learning achievements · Learning attitudes

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_13

13.1 Introduction

With the aid of pervasive computing and the Internet of Things, information space and physical space can be seamlessly integrated. This facilitates the formation of virtual-real synthesis and ubiquitous information space, which makes building a seamless learning space possible. Seamless learning space is a special learning space that has the following features: breaking the constraints of time and space, perceiving learners' real learning situation, connecting formal learning with informal learning, bridging individual learning and social learning, and connecting digital learning resources with real learning space (Chan et al., 2006).

In the past few years, many experts and scholars have begun to conduct research in the field of seamless learning. Looi et al. (2010) developed a seamless learning system based on video playback with mobile devices. Seamless learning systems seamlessly integrate the indoor learning environment with the outdoor one with an aim to help learners understand the application of knowledge in real-life situations through video players on mobile devices. In addition, Hwang and Chang (2011) proposed a model of context-aware seamless learning based on RFID (radio frequency identification) technology and PDAs (Personal Digital Assistant). In this leaning process, students could perceive information consistent with their situation by scanning the RFID tag. Moreover, it also demonstrated that context-aware seamless learning not only improves students' learning interest and learning attitudes, but also plays an important role in students' learning performance.

Currently, there are many studies on seamless learning in the field of educational technology. To be more specific, building a seamless learning space and using context-aware technologies and location-aware or tag information to extract resources in seamless learning space are some common topics in these studies. However, seamless learning space is created by teachers or researchers in these studies, in spite of the fact that students in real situations do use location identification technologies such as QR (quick response), RFID (radio frequency identification), or NFC (near-field communication) to obtain learning resources and exercises. In the model of context-aware seamless learning, technology can only promote the association of learning knowledge and learning environment, it is still a learning model in which the content is presented by teachers and students passively accept the knowledge. Although the context is regarded as a guidance, the learner does not really interact with the situation in depth, and there is no established deep link between the knowledge and learning situations.

Nevertheless, constructivist theories point out that the learning process is not a simple knowledge transfer process, but a process of meaning construction (Hein, 1991). In this learning model, students' knowledge is formed by the interaction of the learners' previous and new experiences, and the knowledge structure can be enriched and modified. Teaching is not to transfer the external knowledge from teachers' mind to students' , but to guide students to construct new experiences from their original ones. Therefore, designing a knowledge space in which learners are actively engaged and knowledge can be actively built is a noteworthy research direction. This study proposes a model of collaborative knowledge construction of seamless learning. Different from traditional seamless learning space, the knowledge space of collaborative construction seamless learning is no longer preset by teachers, but built through the method of students' collaborative knowledge construction, and then students can do seamless learning in the knowledge space.

13.2 Literature Review

13.2.1 Review of Seamless Learning

In the one-to-one mobile device-supported learning environment, students can use seamless learning in a learning environment that has no limitation of time and space (Looi et al., 2009). Seamless learning is a learning model that combines formal learning with informal learning, individual learning with social learning, and real-world with digital learning resources (Wong & Looi, 2010). Based on the above three features of seamless learning, Wong and Looi analyzed seamless learning-related research from 2006 to 2010, and proposed nine kinds of seamless learning model. They are: (1) the fusion of formal and informal learning, (2) personal and social group learning, (3) learning across time and place, (4) the extraction of knowledge, (5) learning across physical space and digital space, (6) the use of a variety of IT equipment, (7) the convergence of various learning tasks, (8) knowledge integration, and (9) a variety of teaching and learning modes (Wong & Looi, 2011).

In summary, the advantages of seamless learning are that it can mix different contexts together, such as formal learning and informal learning. Therefore, students are able to seamlessly learn from indoor to outdoor in this learning process.

Seamless Learning Research

The seamless learning space is a new learning environment. It can obtain learners' situational information and offer learning resources to learners according to various learning environments. However, in the research field of seamless learning, how to build a knowledge space for seamless learning is a crucial research issue. Although many researchers have developed seamless learning spaces, the space is still preset by teachers. For example, Chu, Hwang, and Tsai (2010) established a seamless learning space in a butterfly garden. Students in the butterfly garden use mobile devices to read the RFID tags posted on butterflies through a wireless network to obtain digital learning resources from seamless learning system. However, the digital learning resources of the knowledge space were created by teachers in the learning process; students passively accept learning objects in the real learning environment. Chen and Huang (2012) built a seamless learning space mainly composed of a wireless network, RFID tags, and real learning objects in a cultural museum. However, the knowledge space is also preset by teacher in the learning model; students can acquire learning content corresponding to learning objects by scanning RFID tags in a suitable learning environment. Hsu and Hwang (2014) developed a seamless learning space of personal computer assembly activities based on RFID, pad devices, and a wireless network. In this learning process, computer components were regarded as learning objectives. Students obtained the learning content by scanning RFID tags on their own. However, the knowledge space of the learning model is preset by the teacher as well; the students only obtain the learning content in the real environment. Zhang, Yin, David, Xiong, and Niu (2016) also constructed a seamless learning space which was proposed by experts in a workshop. In this seamless learning space, the seamless learning system can provide learning resources and peers to learners according to their learning environments.

Effects of Seamless Learning

Although seamless learning achieves the integration of digital learning resources and real situations, it is still a teacher-centered learning approach. In this learning process, students only have an experience of using new technologies for learning, but do not have in-depth interaction with learning content. In addition, for teachers, the workload is not decreased or even increased in the seamless learning process. In the process of traditional teaching, teachers only need to prepare learning resources and transfer the knowledge to students. However, in the seamless learning process, teachers not only prepare learning resources, but also design teaching strategies that connect the real world with digital learning resources.

As an important research direction of computer-supported collaborative learning, collaborative knowledge construction allows students to successfully construct their knowledge structure from peers' communication, experience sharing, and discussion (Barthel, Ainsworth, & Sharples, 2013).

Liaw, Chen, and Huang (2008) proposed a model of collaborative knowledge construction applied in the field of online learning. In this study, the process of collaborative knowledge construction was that teachers assigned learning tasks, and students collaboratively learn as a group. This study verified that the model of collaborative knowledge construction can motivate students' learning interest and promote learning attitudes. Su, Yang, Hwang, and Zhang (2010) studied of a model of collaborative knowledge construction and individual knowledge construction based on group interaction in the field of e-learning. In their process of collaborative knowledge construction, students communicate and share learning experiences as a group under the guidance of a teacher. This study found that the model of collaborative knowledge construction has a key role in enhancing learning interest and the learning outcomes. Baloian and Zurita (2012) developed a model of collaborative knowledge construction for mobile learning. This model achieved the goal of individual knowledge from internal to external. Mayordomo and Onrubia (2015) analyzed collaborative knowledge construction in small groups. In a small-group work space, students were engaged in information exploration and learning with the same learning goals. This study suggested that collaborative knowledge construction can improve learning motivation. Moreover, Pérez-Sanagustín, Muñoz-Merino, Alario-Hoyos, Soldani, and Delgado Kloos

(2015) conducted a study of the effectiveness of collaborative knowledge building for learning outcomes. It adopted a learning community to improve students' interaction and discussion with each other in the process of collaborative knowledge building. As some research supports the same results or opinions, no need to elaborate them separately. We may say that, for example, collaborative knowledge construction motivates students.

Therefore, we propose an innovative model of seamless learning based on collaborative knowledge construction. In collaborative knowledge building seamless learning space, the knowledge space is not preset by teachers, but built by students. Then, students are able to learn in this learning environment through QR codes, PDAs, wireless networks, and a context-aware seamless learning system. To investigate the effectiveness of collaborative knowledge construction in seamless learning with regard to learning attitudes and learning performances, thus we designed an experiment.

13.3 Experiment Design

This study designed authentic learning activities for learning fire-fighting equipment in a junior high school. In addition, this study assessed learning performance and learning attitude through questionnaires.

13.3.1 Participants

The participants were two classes of students, 49 in total, at a junior high school in Beijing. Their average age was 13. One class (twenty-four students) was assigned as the control group and the other (twenty-five students) was the experimental group. The students in the control group used a context-aware seamless learning approach, in which the system guided students to learn learning objects in a knowledge space built by the teacher. The students in the experimental group used the collaborative knowledge building seamless learning approach, and the knowledge space of seamless learning was constructed by students based on the theory of collaborative knowledge construction. In order to assess learning outcomes, the seamless learning system evaluated students after learning sessions.

13.3.2 Measurement Tool

In order to evaluate the learning outcomes of the students, teachers developed pre- and post-tests. The pre-test was composed of 30 questions to choose one correct

Table 13.1 Sources of the post-questionnaire

Dimensions	Sources
Learning attitude	Hwang and Chang (2011)
Self-efficacy for learning	Klobas, Renzi, and Nigrelli (2007)
Cognitive load	Leppink, Paas, Van der Vleuten, Van Gog and Van Merriënboer (2013)
Learning satisfaction	Chu, Hwang, and Tsai (2010)

answer, and 10 questions to decide true or false. The full score is 100 for 40 questions. The pre-test was designed to detect student's preliminary knowledge and ability of fire protection in an authentic learning environment. The post-test was composed of 10 questions to fill in the blank and 3 questions to answer. The full score is 100. The post-test was aimed to evaluate students' comprehension after learning fire protection.

In addition, a questionnaire with a 5-point Likert scale was designed to measure the students' interest and attitudes, self-efficacy, cognitive load, and learning satisfaction with the collaborative knowledge building seamless learning approach. The Likert scale, ranging from 1 to 5, respectively, represents strongly disagree to strongly agree. In the questionnaire, there were four questions toward students' "learning attitudes". The Cronbach's α value was 0.73, which indicated a high degree of reliability. In order to assess the performance of the students, four questions were designed. Two of the four were for mental load, with a Cronbach's α of 0.76. Two of the four were for mental effort, and the Cronbach's α was 0.74. There were three items for self-efficacy. This was modified from Klobas, Renzi, and Nigrelli (2007). The Cronbach's α of this dimension was 0.76. Moreover, there were four items to explore the experimental group of students' willingness to use the collaborative knowledge building seamless learning system. The Cronbach's α value for learning satisfaction was 0.89. These items were modified from highly reliable questionnaires, and the source of the items is shown in Table 13.1.

13.3.3 Collaborative Knowledge Building System

In a computer-supported learning environment, collaborative learning is an effective method for learning (Kreijns, Kirschner, & Jochems, 2003). Therefore, this study proposes an innovative approach of knowledge space construction in seamless learning. Moreover, the process of collaborative knowledge building is based on the Learning Cell System (LCS).

LCS is a platform for organizing ubiquitous learning resources. The resources are open, evolving, cohesive, social, and context-aware (Yu, Yang, & Cheng, 2009; Yu, Yang, Cheng, & Wang, 2015). On this platform, the model that organizes learning resources is called a Learning Cell, and it is open and evolving.

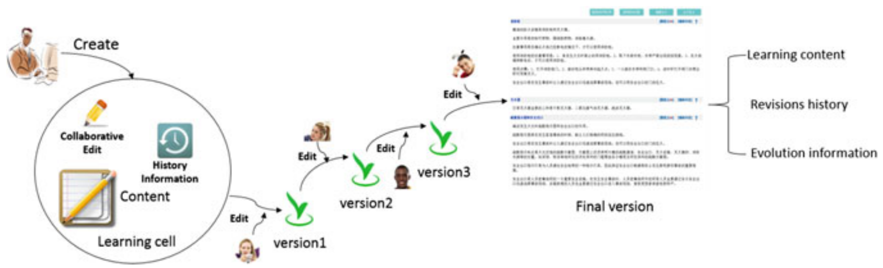

Fig. 13.1 The collaborative editing process based Learning Cell System (LCS)

Everybody, including teachers and learners, is able to edit a Learning Cell anywhere and anytime in the LCS, and the platform could record the changing process of the Learning Cell. In this study, the Learning Cell was regarded as learning content, so students collaboratively construct Learning Cells through the function of full text editing of the LCS. Figure 13.1 shows the evolutionary process of a Learning Cell, which is the process of collaborative knowledge building. Each Learning Cell has a corresponding QR code, which is regarded as a situation mark to guide students' learning in an authentic learning environment.

13.3.4 Experiment Procedure

The learning procedure is shown in Fig. 13.2. In the first week, the experimental group and control group both were engaged in the basic knowledge of fire protection and the training with the context-aware seamless learning system. The pre-test assessed the relevant knowledge of fire protection for the two groups prior to learning activities of fire protection. After the pre-test, students in the experimental group were randomly divided into six small groups and four students for each.

From week two to week four, students in the experimental group learned fire hydrants, fire extinguishers, and emergency exits in the knowledge space built by the model of collaborative knowledge construction. Students in the control group learned the content of fire control facilities in the knowledge space preset by the teacher.

In the experimental group, firstly, students studied outside to find the learning object with a QR code and they used the context seamless learning system to scan the QR code to obtain a summary of fire control facilities through a wireless network. They observed the learning object and read learning content via this guidance. Secondly, in the process of collaborative knowledge building seamless learning space, students returned to the classroom and created a Learning Cell on the LCS. Peers could immediately see the Learning Cell of fire control facilities and modified the content according to their comprehension of fire control knowledge according to the requirement of the learning task. Students could also explore fire safety knowledge from Baidu.com, textbooks, and TV shows. Finally, when the Learning Cell was edited completely by students in small groups, the QR code corresponding to the Learning Cell was attached to the learning object. Students in the experimental group learned in the knowledge space built by themselves based on collaborative knowledge construction. Figure 13.3 shows the process of collaborative knowledge building.

In the control group, the knowledge space in seamless learning was created by a teacher. A teacher created the content of Learning Cell of fire control facilities on LCS and then attached the QR code to the learning objects. Students went out of the classroom to use the context-aware seamless learning system to find the learning objects and observed them by carrying out learning tasks.

In week five, two groups returned to the classroom and completed the post-test (40 min) and post-questionnaires (20 min).

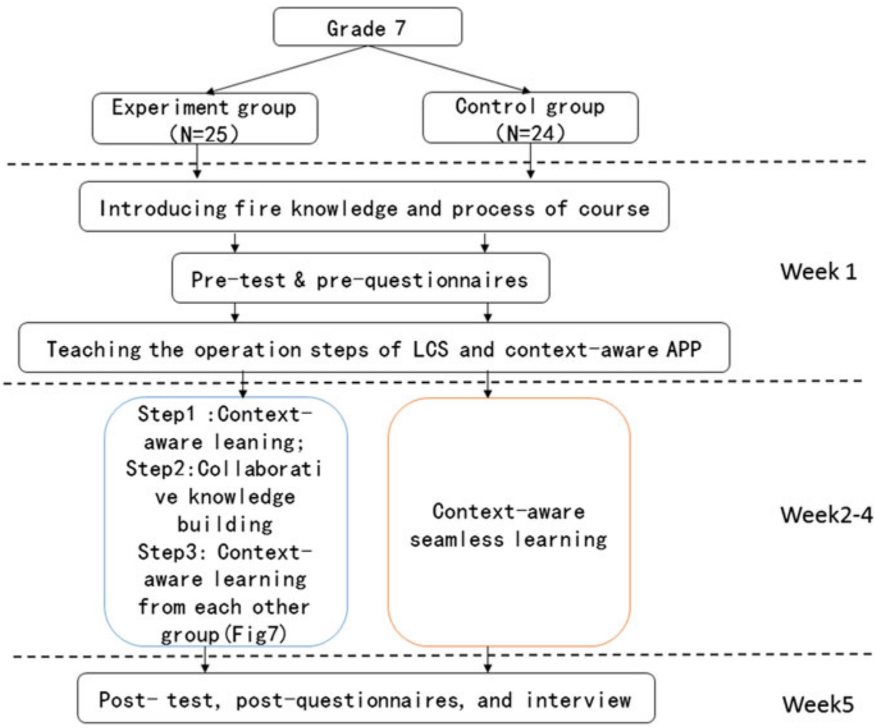

Fig. 13.2 Experiment procedure

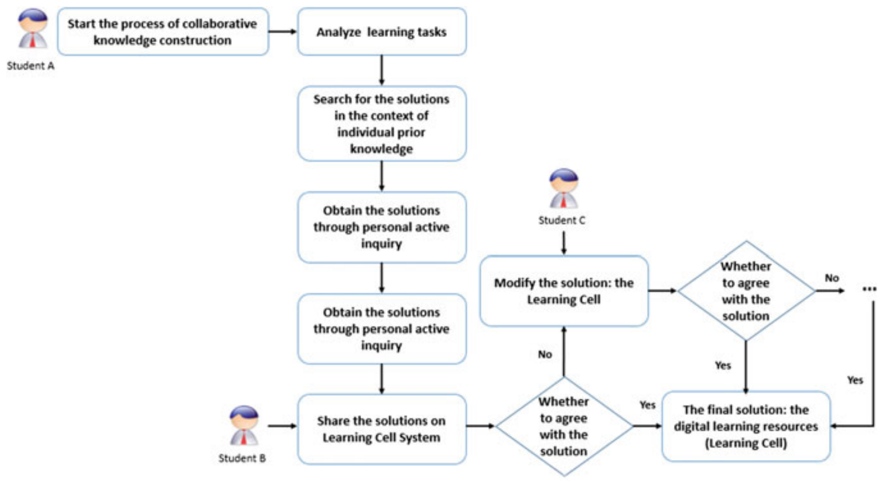

Fig. 13.3 Collaborative knowledge building process

Table 13.2 Descriptive data and t-test results of pre-test scores of the two groups

	N	Mean	S.D.	*t*
Experimental group	25	36.8	8.63	−28
Control group	24	37.1	5.31	

13.4 Results

13.4.1 Learning Achievement

Prior to the experiment, two groups took the pre-test to ensure that they had equal abilities in this subject before doing the authentic learning activity. The mean and standard deviation of the pre-test were 36.78 and 8.63 for the experiment group and 37.1 and 5.31 for the control group. The t-test result showed that the students in two groups did not differ significantly ($t = -2.8$, $p > 0.05$). The two groups of students had statistically equivalent abilities before learning fire control facilities (Table 13.2).

After students participating in the learning activity, the two groups of students took a post-test. The t-test result shows that the average learning achievement of the experimental group is significantly better than that of the control group ($t = 6.56$, $p = 0.005 < 0.01$), according to Table 13.3. The mean score of the experimental group is 87.5, higher than that of the control group 73.2.

As a social practice class, fire safety focuses on improving students' fire control skills. In the fire safety learning activity, the two groups observe the learning object and learn the content step-by-step under the guidance of the seamless learning system. Therefore, they obtained high scores; the post-test average score is more than 70 after taking part in the authentic learning activity. Moreover, the performance of the experimental group in the post-test was better than that of the control

Table 13.3 Descriptive data and t-test result of post-test of the two groups

	N	Mean	S.D.	*t*	*p*
Experiment group	25	87.5	6.81	6.56**	0.005
Control group	24	73.2	4.31		

**< .01

Fig. 13.4 Students doing collaborative editing

group. Better performance benefited from students building their knowledge structure through collaboration and interaction with each other.

13.4.2 Learning Performance

Table 13.3 shows that collaborative knowledge building in context-aware seamless learning has an important role in improving students' learning performance. In order to explain the relationship between collaborative knowledge building and learning performance, this study analyzed the data recorded in the LCS during the process of collaborative knowledge building. In the process of collaborative knowledge building demonstrated on the LCS, students in small groups need to edit the same Learning Cell according to their knowledge structure. When students were reading content modified by others, they could express their agreements or disagreements (shown in Figs. 13.4, 13.5 and 13.6).

Therefore, the experimental group was divided into a high score group and a low score group according to the post-test scores, and then their number of editions and the acceptance of modified content were analyzed. Table 13.4 shows the t-test results of the frequency of participating in the collaborative knowledge building process between the high score group and low score group. It found that students in the high score group edited content and accepted the content modified by others more frequently than the low score group ($t = 11.18$, $p = 0.002 < 0.01$).

Fig. 13.5 The content of collaborative editing

Fig. 13.6 Context-aware learning

Table 13.4 The frequency and quality of the collaborative knowledge building process in the experimental group

	Experiment group					
	N	Mean	Frequency	Acc	*t*	*p*
High achievement	7	92.14	3.81	95.6%	11.18**	0.002 < 0.01
Low achievement	7	75	1.09	33.3%		

**< .01

Table 13.5 Satisfaction survey

	N	Mean	S.D.	*t*
Experiment group	25	4.39	0.78	2.32*
Control group	24	3.5	0.89	

*< .05

Therefore, it is easy to find that collaborative knowledge building can improve the students' performance in context-aware seamless learning. In this process, students' skill of resolving problems and knowledge level had been improved. The learning performance of students who actively participated in collaborative knowledge building showed high achievement, and this result is consistent with other research (Hong, Chai, & Tsai, 2015).

13.4.3 Learning Satisfaction

After the experiment, students in the experimental group and control group were asked to take a learning satisfaction survey. The questionnaires adopted a 5-point Likert scale in which 1 represents "strongly disagree" and 5 represents "strongly agree". According to the t-test result shown in Table 13.5, we found that students in the experimental group had higher satisfaction than students in the control group. In other words, compared with the context-aware seamless learning model, students preferred to learn using the model of seamless learning of collaborative knowledge building.

In order to understand students' learning satisfaction with the learning method, this study analyzed the satisfaction of two groups in the model of collaborative knowledge building and in the model of context-aware seamless learning. The results indicate that 95.8% of the students in experimental group prefer to use the model to learn, and 33% of students in control group agreed to use the context-aware seamless learning to learn. In the constructive point of view, 100% students in the experimental group believed that the learning model has a significant role in improving learning achievements. However, only 66% students in the control group agreed that context-aware seamless learning is able to improve their learning achievements.

Table 13.6 Descriptive data and t-test result of cognitive load

Items	Experimental group			Control group			
	N	Mean	S.D.	*N*	Mean	S.D.	*t*
Q9	25	4.19	0.68	24	3.91	0.94	0.97
Q10	25	4.48	0.60	24	4.45	0.69	0.09
Q11	25	4.43	0.68	24	3.91	0.70	2.04*
Q12	25	4.57	0.59	24	2.91	1.14	4.53**

*< .05
**< .01

13.4.4 Cognitive Load

Cognitive load is concerned with the way in which students' cognitive architecture deals with learning objects during the learning process (Hwang & Chang, 2011). In this study, students in the experimental group need to build knowledge space through collaborative knowledge construction. Therefore, the cognitive load of the experimental group of students may be higher than that of the control group. In order words, theoretically, the cognitive load of the experimental group could be higher than that of the control group.

To analyze the difference of mental effort and mental load between the experimental group and control group, a t-test was employed; the result is shown in Table 13.6. It found no significant difference between the two groups of students in terms of mental effort. Although students in the experimental group need to build knowledge space by themselves, they did not make more effort than the control group in the learning process. Moreover, Table 13.6 shows significant difference in the level of mental load between the experimental group and control group. The experimental group presented a lower level of mental load than the control group. In order words, in the process of collaborative knowledge building, students' mental load did not increase because of heavy learning tasks, but it increased because of the collaborative learning approach. To summarize, the students in experimental group had low cognitive load and high achievement.

13.4.5 Interview

After the experiment, this study randomly selected 5 students to attend an interview. The interview mainly investigated the learning attitudes and learning satisfaction of the students in the two groups. In the interview, the experimental group generally agreed that collaborative knowledge construction seamless learning is a very interesting learning model. In this learning process, they learned as if they were playing a game. Furthermore, with this learning model, students learned more effectively and they could master the knowledge more firmly. Moreover, the control group also agreed that context-aware seamless learning is an intriguing way to learn, and it improved the students' learning attitudes. However, in this learning process, students generally said that context-aware seamless learning was short of appropriate learning activities facilitating the deep interaction between themselves and the learning content. Therefore, they hoped that teachers could add some meaningful learning activities for context-aware seamless learning to help them improve their learning.

13.5 Discussion and Conclusions

In this study, we propose an innovative approach of seamless learning, collaborative knowledge space construction in seamless learning. In this seamless learning model, the seamless learning space is no longer created by teachers or researchers, but by students based on the theory of collaborative knowledge construction.

Moreover, compared with traditional seamless learning in which the knowledge space was preset by teachers, collaborative knowledge building in seamless learning can significantly enhance learner's academic performance. This result is consistent with Coll, Rochera, and Gispert's (2014) study; it showed that knowledge construction in an online collaborative learning environment has an important role in learning achievements. In the process of collaborative knowledge space construction in seamless learning, students acquire learning resources not only from a teacher; they can obtain resources from peers, networks etc. Therefore, it is found that students could have deeper interaction with learning content and authentic learning environment in this learning process.

In context-aware seamless learning, technology can facilitate the association between learning objects and the authentic learning environment, but the learning process is still a simple process of knowledge transfer. In this process, the knowledge space was preset by teachers, and students had no in-depth interaction with learning objects and the learning situation.

Collaborative knowledge construction is a learning method that requires students to deeply engage in the study. In this process, students need to follow formal learning contexts to build the knowledge space in seamless learning based on the theory of collaborative knowledge construction. Because members in small groups have different background knowledge and skills for solving problems, students actively participate in the group discussion under the guidance of teachers' preset questions, and share their learning experiences with each other in small groups. Therefore, in this learning process, collaborative knowledge building enhances the in-depth interaction between the students with the learning environment and learning content, and improvdes learning efficiency.

Compared with traditional seamless learning, this study found that collaborative knowledge construction seamless learning has a positive effect on students' learning attitude. In the process of context-aware seamless learning, students had interest in knowledge obtained through the context-aware device at first. When students mastered skills to use mobile devices and technology, their enthusiasm about and interest in seamless learning gradually reduced. In this process, students' new knowledge is created through experience sharing, exchange, discussion within a small group, and the construction of students' new and background knowledge. Therefore, this learning process allows students to interact with the learning content. Furthermore, other research has proposed the same idea that participation in learning activities will promote students' in-depth learning in seamless learning as our study did.

On the other hand, our study found that students in the experimental group had good learning performance and low cognitive load. In the process of collaborative knowledge building, the knowledge space was built by students, so that they could get more learning tasks compared with the control group. However, this study achieves a contrary result. The experimental group had lower cognitive load than the control group (shown in Table 13.6). Thus, it is found that when students are interested in one learning model, even if learning activities are too heavy, the individual cognitive load for students does not increase.

In summary, collaborative knowledge construction seamless learning positively affects students' learning performance and learning attitudes. We hope that collaborative knowledge construction seamless learning can be applied to more subjects in future to help students learn effectively and efficiently with happiness.

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Chapter 14
Mobile Applications for Encyclopedias

Paul Neuhold, Martin Ebner and Hermann Maurer

Abstract In this research work a survey of tested mobile applications will be summarized, which were selected by a few defined prerequisites, and a brief overview is given of what is available in the corresponding stores. It will also be shown how the individual mobile applications for encyclopedias are presenting and providing information to users. This covers its visual representation and the manner in how information is retrieved. Additionally a new smart way will be introduced in which we can deal with information with a special focus to encyclopedias and mobile devices. The prototyped application carries out special features, which makes usage of mobile device capabilities. The presented approach follows a slightly more aggressive way on how to bring information to users. For example it requires the permission of user and tells him/her actively that there is an interesting piece of information close by his/her location. Communication between the device and users is done using the notification system. To satisfy the needs of users a set of options will be presented so that they can customize time and number of notifications. Those settings shall also prevent the battery from draining too fast and give the user control about it. The outcome is a prototype with a set of features which allows users to retrieve information based on their mood and their willingness of spending effort. If he/she is eager to learn, the application provides ways to support that. If he/she just wants some quick information, there are ways to get it. And if he/she wants a new way of information retrieval via mobile applications for encyclopedias, the prototype offers the above-mentioned possibility to do so.

Keywords Mobile applications · iOS · Android · Enceyclopedia · Austria forum

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_14

14.1 Introduction

Known trademarks like “Brockhaus” and “Encyclopedia Britannica” announced that they have stopped producing and publishing printed editions of their encyclopedias (Kramer, 2014; McCarthy, 2012).

Struggling with the appearance and the spreading of free knowledge which became more in quantity and quality and much easier with accessing it they decided to discontinue the printed version. This circumstance was triggered by the fact that Wikipedia, as huge representative of Web 2.0 technologies, and mobile device are part of everyday life. They give us great opportunities to retrieve knowledge and information about anything, anywhere (Ebner, Kickmeier-Rust, & Holzinger, 2008).

To satisfy the demand and the needs of users to get information very fast and easy in consequence, a lot of mobile applications were designed, built and published till now, as shown later on. Those differ not only in design and functionality but also in the way how information is presented and offered. The main aspect which will be discussed in this research work is the research question *what features for information retrieval should a mobile application for encyclopedias at least offer to satisfy users and their urge for knowledge, especially when an additional responsive website of that encyclopedia is available.*

First there will be a brief introduction about the state of the art of multiple available mobile applications for encyclopedias. After that a slightly more aggressive way on how to bring information to users will be presented. This approach requires the permission of the user and tells him/her actively that there is an interesting piece of information close by his/her location. Daily observations show that nowadays people react fast if their mobile device is receiving a notification or seeks for attention of the user. Precisely because of that reason a feature will be described which pushes notifications based on the current position of the user with a hint about an article concerning a point of interest, which is nearby. There will also be further possibilities described which will be provided in order to customize the settings to prevent battery drain and user displeasure at a minimum. Finally, this chapter on the research work will end with a conclusion.

14.2 State of the Art

At first a brief overview about a few selected applications is taken from Apple’s App Store and Google’s Play Store to see what they are able to do for the users. Secondly assumptions will be made about which technical methods and functionality were used in order to use and retrieve information. Sadly there is no access to the source code of these applications so as already said only assumptions can be made based on what could be experienced and how an experienced developer would implement those functions in order to make it work like it was observed.

For searching applications a set of keywords were used for both android and iOS applications. Furthermore, after receiving search results the selection was based on deeper investigation of the provided screenshots and descriptions. Another limitation was the rank of the search result. As for this work only around the top 20 search results were taken into account. Because observations showed that all results beyond the first 20 could no be used for categorization as an application which was suitable for the survey. The decision was also based on the fact that most users, who use the search engine Google, do not go to the second page of the search result. Even 50% do only take the first three results into account for considerations (Sweeny, 2011).

Additionally given that humans stick to their habits as Lenzen (2012) mentioned in her article in the relation to the book of Charles Duhigg. Provided with the information from Lenzen it was decided that what Sweeny wrote can be applied to search results from Apple's App Store and Google's Play Store. Furthermore, only those applications were analyzed which could be downloaded without having the users to pay for it and also could be used for free at least at some basic level. For this reason In-App purchases were ignored.

Since this work is interested in applications for encyclopedias, following keywords were used for selection: "Enzyklopedia," "encyclopedia," "Wikipedia," "Wiki," "Brockhaus," "Encyclopedia Britannica." Furthermore, it was decided to focus on the DACH[1] region. That is why most of the applications are in German language.

Investigations showed that there are a handful of interesting features which are distributed and shared between the applications. But before going into detail about the found features a general overview of what was observed will be done.

The research shows (Tables 14.1 and 14.2) that there are different approaches and techniques in how the information is presented to the user. The majority of applications (1–12, 16) are using the information base of Wikipedia, which was on the one hand verified by comparing some example articles on both, the application and Wikipedia's website, and on the other hand some of the applications wrote or mentioned it somewhere in the description, give a hint about it or just load Wikipedia's website in a web view. An example for a hint can be found in the application 8 for iOS which has the term "Wikipedia" as placeholder in the search bar. The visual presentation differs in some of the surveyed applications. Applications 1–3, 5–7, 12 are just presenting the rendered website of Wikipedia with a lightweight interface on top of it. Those will be called Wikipedia-Container. And then there are also applications which only use the content provided by Wikipedia but not its visual representation; this description is true for the ones with the numbers 4, 8–11, 14, 16. The interface on top of it does not only provide shortcuts to features but also present text in a customized rendering. This is possible because Wikipedia provides an API which can be accessed through various

[1]https://de.wikipedia.org/wiki/D-A-CH last access 25.08.2016 at 7:37 AM.

Table 14.1 Surveyed applications, part I

	Name of the application	Description	Store	URL
1.	Wiki Encyclopedia gold	It is a Wikipedia-Reader which supports also other projects from the Wikimedia Foundation. It also provides possibilities for random articles, article of the day or nearby articles. The nearby feature does not provide distances	Android	https://play.google.com/store/apps/details?id=uk.co.appsunlimited.wikiapp
2.	Encyclopedia + 1800 eBook	This is a Wikipedia-Container which also provides a generated collection of ebooks and a random article functionality	Android	https://play.google.com/store/apps/details?id=com.hoons.wikipedia.free
3.	GWiki-Wikipedia for Android	GWiki is a Wikipedia-Container which embedded Wikipedia's mobile website; therefore, the nearby function is possible. The interface of the app itself does support receiving random articles or daily articles	Android	https://play.google.com/store/apps/details?id=org.strive.wikipedia
4.	Everywiki: Wikipedia ++	As the name suggests, it is a wiki-reader. Not only information from Wikipedia but also from multiple wiki's is available and browsable. There is also a random functionality which is a bit cumbersome to use because backnavigation is needed in order to use it again	Android	https://play.google.com/store/apps/details?id=net.nebulium.wiki
5.	Random Wiki—learn new things	This application is mainly designed for presenting random knowledge and is yet another Wikipedia-Container. Although the mobile website of Wikipedia is presented, not all features of it are working correctly.	Android	https://play.google.com/store/apps/details?id=co.sharan.random2wiki

(continued)

Table 14.1 (continued)

	Name of the application	Description	Store	URL
6.	NearbyWikipedia	NearbyWikipedia is designed to display nearby articles on a map. Further information of selected articles is then displayed through Wikipedia's mobile website. Therefore, it is also a Wikipedia-Container	Android	https://play.google.com/store/apps/details?id=pkg.NearbyWikipedia
7.	Wiki Around Me	Wiki Around Me primary focuses on nearby articles which are displayed on a map through markers. If the user seeks for more information, a click on such a marker will load the corresponding article. This article is then shown on Wikipedia's website which is embedded into this container	iOS	https://itunes.apple.com/at/app/wiki-around-me/id452992419?mt=8
8.	Articles	This application is categorized as a Wikipedia-Reader. Articles can be read via browsing or searching. It is also possible to open multiple tabs with different articles	iOS	https://itunes.apple.com/us/app/articles/id364881979?mt=8
9.	WikiExplorer for Wikipedia	WikiExplorer is a Wikipedia-Reader which mainly supports articles with a correlation to a specific selected location. On location selection nearby articles will be presented on a map highlighted with markers. The provided information is presented in a customized rendering	iOS	https://itunes.apple.com/at/app/wikiexplorer-for-wikipedia/id1023141634?mt=8
10.	Wikipanion	Wikipanion is a Wikipedia-Reader which also supports random articles, nearby articles and a customized search bar. It is not only possible to browse or search the Wikipedia itself, but there is also a way to add other wikis	iOS	https://itunes.apple.com/at/app/wikipanion/id288349436?mt=8

Table 14.2 Surveyed applications, part II

	Name of the application	Description	Store	Url
11.	Minipedia Offline Wiki	Minipedia is again a Wikipedia-Reader which offers offline access of previous downloaded packages of articles. Once downloaded a random and a nearby functionality is provided. Only small packages are for free and do not create additional costs	iOS	https://itunes.apple.com/de/app/minipedia-offline-wiki-wikipedia/id473512078?mt=8
12.	Wiki Plus Free: Neue mobile Lesen und browser tool	Wiki Plus Free is not only a Wikipedia-Container for the known Wikipedia but also for multiple projects of the Wikimedia foundation. But only the random article functionality of Wikipedias mobile site is supported. The container itself does only support random articles and switching to different Wikimedia Foundation projects	iOS	https://itunes.apple.com/at/app/wiki-plus-kostenlos-ihr-neues/id670522549?mt=8
13.	Encyclopedia Britannica	It is the official app of the encyclopedia with the same name. It supports features like random article or article of the day. Furthermore, it is possible to search the knowledge base of it or learn facts via a quiz	iOS	https://itunes.apple.com/us/app/encyclop-dia-britannica/id447919187?mt=8
14.	Kiwix	Kiwix is more or less an offline Wikipedia-Reader. This works by importing files in ZIM format. Besides Wikipedia, more sources provide content in ZIM format. Getting a random article out of the imported knowledge base is limited to the android version of the application	iOS Android	https://itunes.apple.com/at/app/kiwix/id997079563?mt=8 https://play.google.com/store/apps/details?id=org.kiwix.kiwixmobile&hl=de

(continued)

Table 14.2 (continued)

	Name of the application	Description	Store	Url
15.	Encyclopedia	This application acts like an encyclopedia for terms, expressions or words. After entering a term, the application will present search results from multiple sources. Only one result of each source will be visible then	iOS Android	https://play.google.com/store/apps/details?id=nl.dirkslot.encyclo.uk https://itunes.apple.com/de/app/encyclopedia-en/id964502197?mt=8
16.	Wikipedia	Wikipedia is the official mobile application of the Wikipedia itself and is by our definition a Wikipedia-Reader. Besides random articles, nearby articles or picture of the day, it offers all the information and features which Wikipedia provides	iOS Android	https://play.google.com/store/apps/details?id=org.wikipediahttps://itunes.apple.com/us/app/wikipedia/id324715238?mt=8
17.	Brockhaus	It is the official mobile application from the encyclopedia of the same name. But in order to use it a VPN tunnel to an institution which is supported by the application must be created. So no further analysis of this application was done because not every user has access to it	iOS Android	https://play.google.com/store/apps/details?id=de.brockhaus.wissenhttps://itunes.apple.com/de/app/brockhaus/id1126027419?mt=8

requests. It is possible to just get the content[2] of an article for example instead of rendering the whole URL. Furthermore, it is possible to create customized skins[3] for presenting an article. Applications which have that much degree of self made layout of content will be called Wikipedia-Reader. There are also applications which offer possibilities to not only get information from Wikipedia's knowledge base but also retrieve information from other sources; those are 4, 10, 14, 15.

Besides the appearance of the application and the way how they visualize information to users it can furthermore be distinguished between them on how they work or what is needed for displaying the information. On the one hand there are applications which does not work without a valid connection to the Internet (2–10, 12, 13, 15–17), because they retrieve data and content on the fly. On the other hand

[2]https://www.mediawiki.org/wiki/Extension:TextExtracts last access 13.09.2016 at 10:17.

[3]https://de.wikipedia.org/wiki/Hilfe:Skin last access 13.09.2016 at 13:02.

there are applications (1, 11, 14) which enables offline access for the users. So they can access all of it even without or a bad connection. The downside of the second solution is that users have to download a large amount of data at the initial startup. And sadly not all provided offline solutions are for free. To be more precise on this concern, number 1 only provides offline access if additional costs will be paid. Number 11 only supports packages with up to 180 mb for free. However, number 14 supports offline access without any additional costs. Here multiple different sources are available and provide downloadable content.

Multiple features were analyzed and discussed. This arises following questions: Which of the features are important for information retrieval and should be included in a mobile application for encyclopedias? And is there even a need of a native mobile application considering that a responsive website already exists? Those questions will be discussed in the next section.

14.3 Research Design

The approach of this research work follows the principle of prototyping and that is the process of creating a prototype. With such a prototype it is possible to identify critical aspects of the resulting software. It implements all tricky parts of it and proofs if the elaborated features are feasible in a realistic environment. If not, it reports all upcoming problems which will occur. Requirements can then be reconsidered, and the prototype can easily be adapted (Kuhrmann, 2012; Steinbauer & Thomas, 2003).

Before creating the prototype a literature study of what is available in the corresponding stores was done. In this process multiple interesting features were discovered and sorted. The features are described in the enumeration below, starting with the most important ones at 1–3. To not only provide a mobile view of an encyclopedia, the results of those observations were discussed and additionally complemented by a heuristic evaluation done by a round of experts. While complementing, the technical capabilities of a mobile device were taken into considerations. The findings of those discussions result in the following listed key features. After that the topic native application versus responsive website will be covered.

1. ***Nearby Article***
   The most important feature which got frequently discussed and evaluated by a round of experts is the so-called nearby articles function. Because of the way how it got planned and designed it perfectly suits to the possibilities of a mobile device. It works with the current position of the user. In detail it takes latitude and longitude of the mobile device and provides related articles or information about something in the surroundings of the user. This feature aims for users which are willing to learn new things but cannot decide what to look up or search for but at least want to know what is going on in their immediate

environment. An important difference to the previous mentioned methods is that the user will not only receive some random piece of information or an article which is new this month but also she/he will in some case influence the result of what will be presented to him/her. The importance of this feature becomes even more clear when applications in the corresponding stores are discovered which are solely designed and developed only because for this way of working. For example, WikiExplorer for iOS and NearbyWiki for Android are two of those mentioned applications. But for this work it was not only decided to show nearby articles actively on request but also implement a way so that users can passively get informed about nearby articles via the notification system of a mobile device. Communication between the device and the user is then done via the notification system of the mobile device. To give users more control over what the application is doing it was decided by a group of experts to let them alter the configuration which is used for recognition of a location change and for triggering a notification. So every individual user is able to customize the way of how he/she will be informed about nearby locations.

2. ***Random Article***
   One key feature which should be available is the possibility to obtain random articles from the whole information base. As discussed by a round of experts, this is interesting for people who are eager to learn but does not really know what to look up. With this approach the urge of knowledge will be satisfied without much interaction of the user. Minimal effort is another important fact; therefore, it is necessary not only to present the user information and quench his/her thirst for knowledge but also to do this in a fast and uncomplicated manner without any hindrances. In addition to that the decision was made that users should also have the chance to decrease the amount of randomness. Therefore, the group of experts came to the conclusion that users should be able to restrict the result of a random article to a specific category.
3. ***Article of the Month***
   A second important feature which was decided to get implemented from the prototype is the so-called article of the month. For the sake of this research work the decision was made that the article of the month is not limited to only one article. To be more precise there is a list of new articles which got added to the knowledge base in the current month. If the user activates this functionality one article will be selected at random from this list. For the user this feature acts like the one which delivers random articles but reduces the experienced amount of randomness drastically. Because the result of it is not just some random or old piece of information, which remains unrecognized within the base of knowledge but rather delivers new interesting information.
4. ***Full-Text Search***
   To cover also the case of active targeted information retrieval, searching based on a given input from the user was also registered into the list of features for this prototype. If the user wants to know more about a specific topic he/she can then look it up with the implemented search possibility.

5. ***License information of a particular piece of information***
   Retrieving information about the license was also reviewed by the group of experts. The conclusion of those discussions was that this should be more or less a passive information retrieval approach. The user should not have to search for it. If he/she wants to know about it, the information should be present and instantly available. Therefore, a realization of this concern will also be described in the next section.
6. ***Data persistence***
   Additionally to the above-mentioned features about data retrieval also discussions about the data persistency were held by a round of experts. One outcome of those was that the resulting prototype will require a valid Internet connection in order to work properly. This decision is primary based on two facts. The first is that users should not be confronted with additional waiting time after they installed the application. The second one is that the knowledge base keeps growing. New information and articles are consequently added and updated. To keep users up to date and keep required data traffic at a minimum it was decided to follow the online approach. Another functionality discussed on this concern was that the prototype should allow users to bookmark articles or pages, so that they can later finish their readings.
7. ***Home navigation***
   This feature seems to be rather trivial, but it is a functionality which should not be underestimated. Observation showed that getting back to the starting point was not always that easy. Because of that and to provide a solution for explorative users to go back to the start it was decided to provide an easy way to do so.
8. ***Mobile app versus responsive website***
   Nowadays people use their smartphone more than ever. According to a released study from Deloitte people of all age groups check their phones 46 times per day on an average. In fact those numbers relate to people of the USA (Eadicicco, 2015).
   But not only in the USA people are using their phone a very long time over the day. In Japan for example people from the age of 14 up to 25 use their phone two hours per day. Taking a look to South Korea, people there even spend four and a half hour per day using their smartphone (Neidhart, 2015).
   Also worth mentioning is the JIM study where teenager in Germany from the age of 12 to 19 were asked about how they interact with media. Ninety-two percent of the surveyed persons own a smartphone, and even 97 of them are using it multiple times a week. Seventy-five percent also have an Internet flat rate which means that they are always on (Feierabend, Plankenhorn, & Rathgeb, 2015).
   Furthermore, a research conducted by British psychologists states that young adults use their phones an average of five hours a day (Gregoire, 2015).
   Overall, the time which people spend on their mobile device distributed over the day is still increasing. A significant part of that growth comes from the time which is used within applications. Although the growth itself flattened, time spend within applications is still increasing (eMarketer, 2015a).

The slowdown of that rate could be interpreted with the time limitation given by a natural day. Because only 24 h is available it is logical that the growth must decrease and stop at some point. Besides the normal usage of mobile devices, also a significant number of users allow applications to send push notifications. An average of 71% of all users gives applications permissions to send them push notifications. Not all of them who give the allowance actually react to an incoming notification. Only 8.7% tapped on a push notification after receiving one (Shaul, 2016).

Taking a look at the global distribution of smartphones, which is forecasted to be 2.2925 millions in 2017, this little percent is still a huge amount (eMarketer, 2015b).

Given all those facts of how much time users spend on mobile devices and with applications on it, it is important to produce and develop applications which are an additional benefit for users. Since the interests of users or the decision they make while thinking about what application they should download cannot be influenced, it is at least necessary to offer applications such as the ones for encyclopedias, so if the desire is present an application like that is available. Reconsider all of this, some assumptions arise which will be discussed later on. At first there is a need to provide knowledge via notification. On the one hand there is a market for a notification-based functionality, but on the other hand such a functionality was not found in the survey of applications about encyclopedias. But creating such a functionality should be done with much caution because "over 50% of App Users Find Push Notifications Annoying" (O'Connell, 2016).

Secondly providing random information should be delivered without much effort because users are lazy and choose the way with the least effort. Tétard and Collan (2009) discussed this behavior in their work about the "Lazy User Theory." Lastly everything nowadays must happen really fast. One can say that the motto of today's society is Faster! Faster! Faster! (Hammelehle, 2013).

Further studies have shown that one-second delay in loading a website can decrease users satisfaction by 16% (Weatherhead, 2014).

Therefore, it was decided to build the user interface of the prototype in a way so that minimum effort is needed to trigger an action, simultaneously providing information as fast as possible and therefore implementing a solution where the users need to be online.

14.4 Prototype

Supported by the provided facts and the evaluated features the conception of the prototype was done. For the sake of user experience the behavior of contemporary users, which was described in the previous section, was also kept in mind while making user interface decisions. Therefore, it looks rather plain but as shown in

Fig. 14.1 Prototype main screen

Fig. 14.1 the prototype allows easy and fast access to every functionality which is offered by it.

Thinking about features, in particular the idea of nearby articles, was from high importance for the emerging prototype. It got implemented for targeting two different use cases. The first one covers the situation where a user wants to know what is currently from importance at his/her current location. At this point he/she can then press on location icon (1) which opens the nearby article list. Once the request succeeded users will see all articles which are currently nearby. The second use case which covers the idea of passively notifying users of nearby articles was actually not discovered while researching existing mobile applications for encyclopedias. But as decided by a round of experts, this is a feature which should be provided by mobile applications for encyclopedias. Because it covers the idea of passive information retrieval. Therefore, it got implemented by the resulting prototype. If the user wants to get passively informed about nearby articles he must actively activate it at least once. After that the localization service will start to work in the background and do its job. But one should not forget that such an implementation brings a little downside with it. The disadvantage which will be noticed is that active localization has a slight impact on the battery life of mobile devices. In fact it will consume a little more power than normal execution because the localization service keeps running in the background. Although localization itself is managed by the operating system of a device, it must be used with much caution in order to keep the needed energy at a minimum. There are a few settings which can be customized so that localization of the device will work in the most efficient way relating to battery life. With this in mind the calibration of the localization service was done with much caution. The accuracy which is best for the scenario was therefore selected. Secondly another important value which has to be defined is the distance which needs to be traveled so that the localization service informs the application about a new location change. The art of the configuration of the location service influences the amount of energy which will be drained, and therefore, the possibly best solution was discussed and created. One problem which can occur here is that users have different ideas of the best configuration. Therefore, it was decided that only the accuracy will be defined and set from the application. For the critical value of traveled distance the decision was made that users can change it to adapt localization to their needs. The corresponding settings can be seen in Fig. 14.2, marked with (a). In addition to alter settings for the localization service the possibility of turning it completely on and off is given within the settings screen of the prototype (Fig. 14.2 b0, b1). To use its full potential, the passive nearby article feature is supported by the local notification system of the corresponding operating systems. First of all users must agree to receive notifications from the application. Given the facts which were discussed in the previous section and for the sake of users comfort it was decided that it should be possible for the user not only to turn notifications on and off (c) but also to alter the frequency of appearance. Therefore, as shown in Fig. 14.2, the prototype implemented a setting (d) to change the time which needs to be passed in order to trigger a new notification. To reduce battery drain to a minimum further processing of new registered locations from the system will only be done if the given time interval of the notification setting has been passed. Once all preconditions are met, the application will trigger a notification with information about the nearest article. For the implementation of the nearby feature and the corresponding notifications a service[4] was designed for the android version of the prototype. The service creates a connection to Google Play services location APIs[5] and therefore is responsible for the location awareness of the

[4]https://developer.android.com/reference/android/app/Service.html last access 12.09.2016 at 08:39.

[5]https://developers.google.com/android/reference/com/google/android/gms/location/package-summary last access 12.09.2016 at 08:45.

application. While creating this connection, settings like accuracy or the given distance which needs to be traveled are taken into considerations. Once the service is started it continues to run for an indefinite amount of time until the user stops it.

In the iOS version a facade got implemented for the prototypes sake which simplified and adapted the access to the underlying CLLocationManager.[6] Fundamentally the manager supports two kinds of localization. Both are implemented by this prototype. The first is similar to Android's location service. Before starting it, settings like accuracy or the provided minimum distance for triggering location changes need to be provided. For the second way of working (b1) it is not possible to provide these configurations. The system will automatically notify the application when there is a significant location change and that is if at least 500 m is traveled. In such cases the system even starts the application when it is terminated.[7] Once all the requirements are set and the manager runs in background mode, location changes will be registered as long as the user is in motion. If the user stops moving and the location manager does not recognize any location changes for about 15 min it will get stopped by the operating system. This mechanism prevents the location manager from doing unnecessary work and is a feature of the CLLocationManager itself.

As shown in Fig. 14.1 also the feature of retrieving a random article (5) is available without much effort of the user. Besides requesting any random piece of information a solution was determined to let users also modify the result of it. To actually realize this, the prototype provides the possibility to alter one part of the request which is responsible for retrieving a random article. More precisely a user can define a category which will be submitted additionally. The corresponding logic on the server will then take the provided information into account and will return an article associated with a given category. By default the requested random article will be one out of all existing categories.

For the feature of monthly article (3) and the possibility of a full-text search (4) the discussed principles of providing it fast and uncomplicated got realized. For the sake of providing good search results a real-time search got implemented, so that on every input of the user he/she will receive updated results.

After providing multiple ways to actively retrieve information fast and uncomplicated also the need to let users know how the article is licensed got worked out. Inspired by Hammelehle (2013) and Weatherhead (2014) who say that nowadays everything must be happen more less in time and that for modern Internet users slow experience bores, it was decided that users must be able to instantly recognize the license under which the article is published. Therefore, a floating view (5) was created which resides at the bottom-right corner of the screen which tells the users the license of the current loaded article. Information of the license

[6]https://developer.apple.com/library/ios/documentation/CoreLocation/Reference/CLLocationManagerClass/ last access 12.09.2016 at 08:53.

[7]https://developer.apple.com/library/content/documentation/UserExperience/Conceptual/LocationAwarenessPG/CoreLocation/CoreLocation.html last access 13.10.2016 at 20:41.

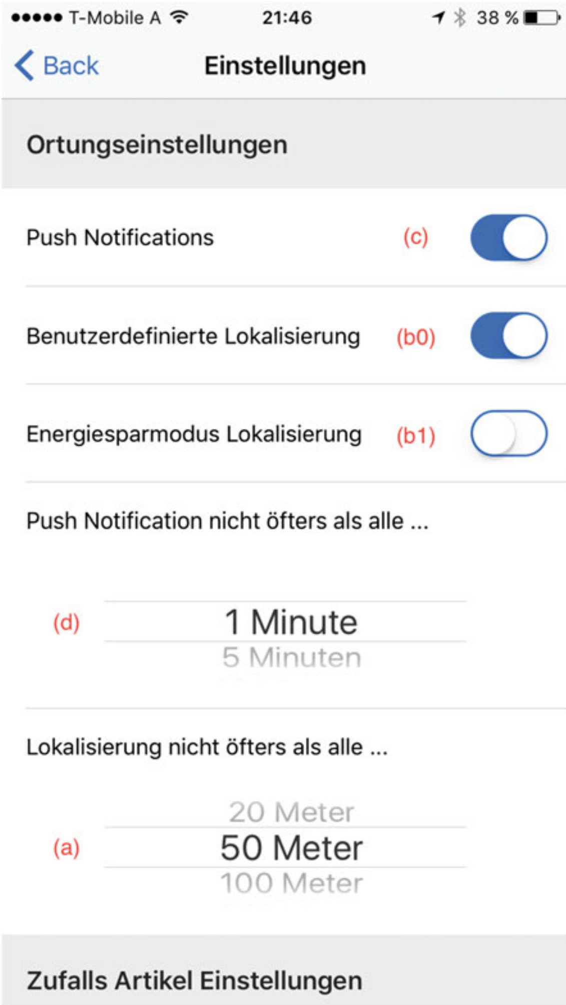

Fig. 14.2 Prototype preference screen

will be directly transmitted within the responses of the provided features of information retrieval. If the user is just browsing within the content the license of the newly loaded article will be passively requested in the background. The user can then receive more information about it if she/he touches on the floating button. On touch more of the licensing will be loaded within a browser.

For the often referenced sake of speed and fast access the prototype fully it was designed and built to work with a valid Internet connection. Therefore, the decision to not function while offline was taken by a group of experts. The only data persistency is required to store bookmarks from users.

The developed prototype gets all its content from the knowledge base of austria-forum.org. In order to make the described features work as intended and to ensure that the web service delivers appropriate data, the existing API had to be extended to fit the needs of our client. Austria-Forum itself is based on a JSPWiki and provides the possibility to handle JSON Remote Procedure Calls (JSON-RPC). Given that opportunity the client was designed to create and parse JSON-RPCs for communication with the server.

14.5 Limitations

The developed prototype provides multiple ways of information retrieval while taking advantages of the capabilities of a mobile device. After offering these features a discussion about possible limitations will be done. This research work makes the assumption that a random article is a good way to deliver information to the user which is completely new to him/her and transmit knowledge which he/she never would have looked up in the first place. But somebody could claim that this is just some random piece of information which is not in the interest of the user and will be forgotten anyway by him/her soon. At this point the prototype offers the possibility to specify a category which will be taken into account when delivering the next random article. This way the absolute randomness will be gone and the user will receive new and interesting information which is in his/her concern.

As good as passive notification of an article could be, it is important to not forget that such a feature uses the current location of users permanently and continuously sharing it to the server if active. Therefore, one could state that this violates the individual privacy of each user. Exactly because of that reason it is crucial that this information is only used in order to calculate distance to relevant articles. Location information should not be saved or used for other purposes. Secondly, it is important that they are only used for reasons which are described in the shown message when an application is asking for location permissions. Once a user allows the application to use his/her current location he/she is then able to retrieve information about his/her immediate environment. Those can be facts which he/she might never would have known and perhaps surprise him/her about what is going on in his/her surroundings. But providing all nearby articles can somehow deceive the user. The reason for that assumption is that the results are limited because not every article which is located close by is actually tagged with coordinates. If an article does not provide information about longitude and latitude the distance cannot be calculated and therefore not all of what is nearby can be delivered to the user. That is why they could mislead and think that there are not that much interesting things around him/her. As for now there is still a huge need of complementing more articles with a corresponding position.

Another point which should be brought up here is the fact that intensive usage of this feature will have a negative effect on the battery runtime. If background localization is running, more power will be consumed. This is a trade-off which a user must make in order to use it over a longer period of time.

It is known that some decisions, while designing the user interface, do not completely conform to the suggested guidelines of the corresponding platforms. But the objective of this prototype was to provide easy and especially fast access to all features of the application. This is also a reason why there is a need for a native mobile application. Otherwise user have to search the route through the browser and then set a specific bookmark or enters the URL of a responsive website manually.

All in all there are a few limitations which were discussed above. But in order to make it as valuable as possible and provide a new way of information retrieval those tradeoffs were decided to implement directly in the app.

14.6 Conclusion

To sum it up one could say that based on the facts that nowadays users spend a tremendous amount of time on their mobile devices it is important that there are proper solutions if a user seeks for information. Furthermore, it is critical that the provided applications are fitting the behavior of today's society. In a digital world where everything must happen immediately and has to be available as fast as possible also the offered product has to work in the same manner. Therefore, the desired result must be achieved with minimal effort. Given the results of the survey of mobile applications for encyclopedias it is also necessary to create a basic approach to deliver information and knowledge via notifications. Since this feature was not observed there was a need to implement it for those kinds of applications. Following the outcome of the usability tests it is advisable to offer possibilities in order to give the user full control over what the application is doing so that she/he can decide when and how often interaction with the application occurs. After an intensive literature study and a heuristic evaluation done by experts this research work identified a number of features for mobile applications which are designed to work with encyclopedias. The discovered features were implemented and fiercely tested, and it is proposed to use them in the future for applications of this kind. In addition to that as a prospective thought, user experience and design decisions can be optimized and reconsidered in order to make users even more comfortable. Although the prototype followed the principle of least effort usability tests can be made to identify the pros and cons of the used approach versus using typical android and iOS user interface elements. Is it actually better to minimize the needed actions or to make the users feel at "home."

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Chapter 15
Use of Social Media and Social Network Analysis for Mobile Learning

Helmi Norman, Mohamed Ally and Norazah Nordin

Abstract Social media has currently become a ubiquitous communication tool in all facets of the society. It enables networks of communication channels to become available—linking us to networks of people, organizations, and information. The education sector is also benefiting from the growth of social media in areas such as mobile learning. Yet, despite its' rapid growth and integration in mobile learning, research in this field is still relatively new, particularly in areas relating to investigation of social network analysis in mobile learning. Thus, the chapter focuses the discussion on the approaches of integrating social media for mobile learning and links it to appropriate learning theories and strategies. The chapter then taps into a case study of social network analysis and explains how it can be used to discover the dynamics of social roles in learning as well as participation levels in mobile learning. The chapter ends with a discussion on conclusions and future directions for future educators and researchers interested in the use of social media for mobile learning.

Keywords Mobile learning · Social media · Instructional design
Social network analysis · Egocentric network diagrams
Assessment in mobile learning

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_15

15.1 Introduction

Social media has become an essential medium for communication in various fields, including the education sector (Chin & Zhang, 2014; Siemens & Weller, 2011). This has lead to the emergence of numerous studies in social media for teaching and learning (Kimmerle, Moskaliuk, Oeberst, & Cress, 2015; Norman, Nordin, Din, Ally, & Dogan, 2015). Learners are constantly learning on the move, and the use of social media for learning allows them be connected to their peer in socio-learning spaces via mobile devices (Ally & Samaka, 2016; Crompton, 2014; Lewis, Pea, & Rosen, 2010). The connectivity of mobile learners on social media is changing how we understand the roles, patterns, and patterns in a learning community (Chin & Zhang, 2014; Lewis et al., 2010).

Social media is associated with online social platforms such as social network sites, blogs, microblogs, and location-based services. The platforms allow its' users to interact and communicate with other users and enable them to create and share content among one another using digital devices (Bechmann & Lomborg, 2013). Tapping into social media for mobile learning, it can be linked to Crompton's (2013) definition of mobile learning, which states that: it involves "*learning across multiple context, through social and content interactions, using personal electronic devices.*" Here, social media allows users to experience learning across multiple context—in their classes on campus, while on a train going home, or while sitting in park—they can personalize the experiences according to their context. Furthermore, social media via mobile learning allows for social and content interaction in which they experience social interactions with their peers online and interact with content as they consume and create them via their mobile devices (Atzmueller, 2014).

In the context of social media for mobile learning research, past literature suggests that research in the field is relatively new (Bechmann & Lomborg, 2013; Cochrane & Narayan, 2016). Studies in this field include studies by Cochrane and Narayan (2016) and Gikas and Grant (2013). In Cochrane and Narayan's (2016) study, they investigated the use of social media for mobile learning in a transdisciplinary course of journalism and law. They discovered that by using the mobile social media for learning and assessment, learner engagement levels were increased and assessments were more authentic. An example of a mobile learning activity and assessment that was carried out is using the Storify.com software with their mobile devices and assessment based on the stories/learning materials created using the software. With regard to Gikas and Grant's (2013) study, they investigated on perception of learners toward social media for mobile learning. The study discovered that learners perceived that learning via social media in mobile learning settings could facilitate in terms of information access, communication between peers and instructors, and enable contextualized and situated learning. The study also found out that social media also caused distractions in learning—as they were sometimes distracted by activities that were not related to learning such as chatting with other peers during learning. Although there have been recent studies that have been carried out in social media for mobile learning and assessment such as

Cochrane and Narayan's (2016) and Gikas and Grants' (2013) studies, there is still a lack of research that focus on assessments in terms of social participation in social media for mobile learning settings. As such, the chapter presents a case study of how social media can be used for learning and how social network analysis can be used for assessment in these learning settings.

15.2 Social Network Analysis

Social network analysis refers to a quantitative analysis of social network and elements that populate these networks. The analysis allows researchers to understand and systematically analyze the social world in terms of network comparison, network pattern changes over time and investigate relative positions of individual users and cluster within a social network. The analysis is measured by concepts such as density, centrality, structural holes, balance, and transitivity. Network density measures the percentage of all possible connections in a network. Centrality measures capture the importance or centrality a vertex (e.g., actor, user, learner, teacher) is within a network against a set of criteria. With centrality analysis, we can indicate whether a person is active or inactive within a network by looking at their position in a network—as a more central position indicates that the person is important and highly connected with other people, while a less central position indicates that they are not important in the network. In a large network, some people are not connected to each other. Yet, the person who is central allows for all the people in the network to be connected to each other and can be regarded as a "connector." However, when the connector is removed from the network, it creates a structural hole in which there is a gap in the connections (Hansen, Shneiderman, & Smith, 2011; Lee & Bonk, 2014; Ni, Sugimoto, & Jiang, 2011).

There are various types of analysis that can be conducted on social networks. In this chapter, we focus on two types of analysis, which are: aggregate network metrics and vertex-specific network metrics. The former metric refers to measures that explain the interconnectedness level of vertices. The density is calculated by the number of relationships currently present in a network divided by the relationships that could be present. The latter metric (vertex-specific network) refers to an individual position within the network. As discussed before, this analysis explains the "centrality" or how "central" a person is in a network indicating the importance of that person in the network interactions. The vertex-specific metric measures centrality in terms of degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality. Degree centrality is a vertex's total numbers of connections while betweenness centrality refers to how often a vertex lies on the shortest path of two other vertices, termed geodesic distance. Meanwhile, closeness centrality refers to the average distance between a vertex and every other vertex in a network while eigenvector centrality refers to the influence score for strategically connected vertices. (Hansen et al., 2011; Lee & Bonk, 2014; Ni et al., 2011).

15.3 A Case Study of Social Media for Mobile Learning and Use of Social Network Analysis for Mobile Learning Assessment

To illustrate how social network analysis can be applied to investigate the dynamic of social roles in mobile learning settings, a case study conducted in a course applying mobile learning settings is presented.

(i) ***Overview of Case Study***

The social media platform used in the case study was Facebook Groups, where the learning platform allowed learners to share their learning activities, conduct discussion with other learners, and consult instructors over issues related to learning. The case study was conducted in an ethnic relations course from a period of two months (March to April 2016) in Universiti Kebangsaan Malaysia. The course is an undergraduate course, which is compulsory course on providing exposure about social cohesion in Malaysia. The course was conducted in blended learning format, where 40% of the course was carried out via face-to-face learning, and 60% was carried out online—in mobile learning settings.

(ii) ***Instructional Design Applied in the Case Study***

The instructional design applied was the Park's (2014) framework of mobile learning and Ryberg, Glud, Buus, and Georgsen (2010) work on problem-based learning. The framework is based on the transactional distance theory by Moore (2007) that posits that the transactional distance is controlled and managed by three aspects, which are: the learning program's structure, the dialog (or communication) between instructors and learners, and autonomy of learners. Park's (2014) framework extends this theory in the context of mobile learning settings in which mobile learning activities are categorized into four types, which are as follows.

The first type is categorized as *high transactional distance and socialized mobile activity*. This occurs when (Park, 2014): learners have more space (psychology and communication) with instructors; learners are involved in group learning; learning materials are delivered from pre-determined programs via mobile devices; and transactions are mainly controlled by learners; and instructors have minimal control in facilitation. The second type is *high transactional distance and individualized mobile activity*. Here, individual learners have more space with instructors; individual learners are provided with tightly-structured learning materials; individual learners have a higher control over their learning in order to master it; and interaction mainly involve the individual learner and the content. With regard to the third type, *low transactional distance and socialized mobile learning activity*, individual learners interact with both their peers and instructors using mobile devices; the communication and psychological space is less with instructors and instruction is loosely structured; the learners are involved in group learning and collaboratively work toward a common goal; and they frequently communicate, social interact and negotiate naturally during learning. The last type is *low* *transactional distance and individualized mobile learning*. In this category, individual learners interact directly with instructors; instructors have more control over learning while maintaining learner independence.

As for Ryberg et al.'s (2010) work on problem-based learning, the approach emphasizes on the control distributed between instructors and learners in terms of three aspects, which are: problem, work process, and solution. Here, several aspects have to be considered in designing problem-based learning with regard to: (i) do instructors design the problems or learners define the learning problem on their own; (ii) do learners or instructors define the work process as well as theories and methods to apply; and (iii) is the learning solution fixed (the solution is pre-defined) or open-ended (learners are expected to produce new insights and knowledge) (Ryberg et al., 2010).

The case study applied the third type of mobile learning activity, which was *low transactional distance and socialized mobile learning activity*. As discussed before, this involved learners, their peers, and instructors using mobile devices where communication is more focused among peers, the instruction is loosely structured, and learners work in groups to reach a common goal. In terms of problem-based learning, the course was designed as follows. First, for the implementation of problem-based learning, the control of the learning problem was distributed among the instructors and learners. Here, the instructors provided the context of the learning problem, which was to identify any problems related to the teachers' subject domain (in this case, primary education mathematics) and propose a solution to solve the issue. For the learners, they assumed control of the learning problem as they identified the problems related to the subject that they were teaching in schools, and defined it according to their context. With regard to work processes, theories and methods to apply, the learners assumed full control—in which they designed their own work processes, applied learning theories that they perceived was appropriate, and applied methods that were suitable for working toward a solution of their problems. As for the learning solutions, it was defined as open-ended. Here, the learners were expected to produce educational technological solutions to solve the problems that they defined.

(iii) ***Social Network Analysis for Interaction and Participation Analysis of Learning***

Social network analysis was used in the case study to assess learners' interaction during learning. Two measures were used for assessment, which were: aggregate network metrics and vertex-specific network metrics. Aggregate matrix can be used as measures to explain the interconnectedness level of vertices, where in the study, the density measure was used to measure the aggregate matrix. Meanwhile, the vertex-specific network metrics refer to an individual position within the network. The vertex-specific metric was used to measure degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality.

An example of aggregate network metrics measured related to aspects such as number of vertices, unique edges, edges with duplicates, and total edges. Tables 15.1 and 15.2 summarize the metrics for two periods, the initial and latter stages of the course. From the tables, it can be seen that the numbers of all aspects (vertices, unique edges, edges with duplicates, and total edges) increased as the course reached the latter stages. Here, we can use the network metrics to identify the number of vertices present—which refer to the number of learners and instructors active in the online interactions. Interestingly, only 123 of a total 154 vertices were present indicating that 31 learners were non-active in the initial stages of the course. Yet, as the course progressed, we can see that the total number of vertices increased to 154, indicating that all learners and instructors were active in online discussions during that specific period of time.

With regard to vertex-specific metrics, it can be seen that Student 1 has the highest level of betweenness centrality (value of 812.490), indicating that the learner is "central" to interactions, hence considered a very important person in the social network. If Student 1 were to be removed from the learning network, the learning network would be disrupted, as many of the interactions in the network are dependent on him/her. This could suggest that the learner is a discussion initiator and he/she highly contributes toward learning discussions. With regard to closeness centrality, Student 1 has also a high value of closeness centrality (value of 0.010), which is also another indication that this learner has an essential social role in learning. As discussed before, this type of centrality shows that the distance of information distribution is shorter if the information is passed via this particular learner, hence inferring that the learning discussions could be quicker and easier if he/she is involved in the discussion. Meanwhile, as for eigenvector centrality, Student 1 has the lowest value indicating that he/she is placed strategically in the network to be involved in learning interactions (Table 15.3).

As for egocentric sub-graphs, the social network maps assist instructors in visualizing learners' participation level during learning. Here, the location in the graph indicates the level of participation in learning during a period of time. When a learner's sub-graph is more toward the central of the egocentric graph, it indicates the participation level of the learner is high, showing that the learner is active (Fig. 15.1). When a learner's graph is off the center, it indicates the participation level is low and less active in learning (Fig. 15.2). In addition, the density of the sub-graph is another indication of a learner's participation levels in learning. In

Table 15.1 Aggregate network metrics for the initial stage of course

Element	Total
Vertices	123
Unique edges	1236
Edges with duplicates	640
Total edges	1876

Table 15.2 Aggregate network metrics for the latter stage of course

Element	Total
Vertices	154
Unique edges	1541
Edges with duplicates	1317
Total edges	2858

Table 15.3 An example of vertex-specific metrics in social network analysis

Student	In-degree	Out-degree	Betweenness centrality	Closeness centrality	Eigenvector centrality	Clustering coefficient
Student 1	41	55	595.198	0.009	0.025	0.212
Student 2	35	27	372.425	0.007	0.017	0.294
Student 3	20	28	132.925	0.007	0.016	0.328
Student 4	8	1	0.000	0.006	0.003	0.786
Student 5–147	…	…	…	…	…	…
Student 149	10	1	0.000	0.006	0.004	0.708
Student 150	5	4	0.000	0.006	0.003	0.708

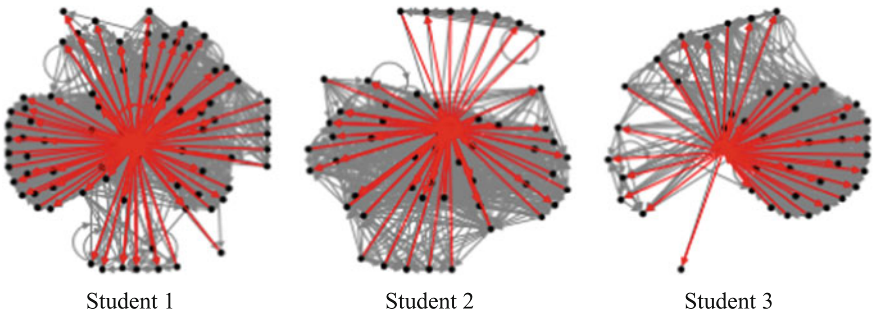

Fig. 15.1 Egocentric sub-graphs of active learners

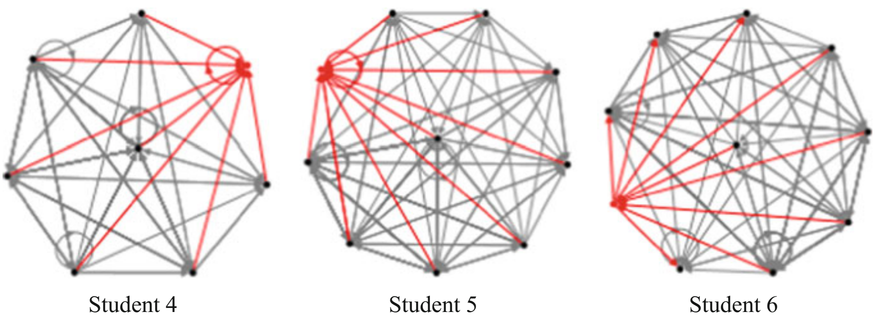

Fig. 15.2 Egocentric sub-graphs of passive learners

Figures 1–3, the graphs are denser as compared to Figures 4–5. This infers that active learners have more dense sub-graphs as compared to passive learners due to the fact that they communicate more with their peers in learning. Furthermore, sub-graphs also indicate the direction of the communication in an outwards direction (i.e., out-degree) shown as red-colored arrows in Figures 1–6. A higher numbers of arrows moving outwards indicate a higher communication level of the learner. In other words, when a learner is observed to have a higher number of arrows pointing outwards, he/she creates more communications with his/her peers, hence can be termed as a "conversation initiator" (Hansen et al., 2011).

15.4 Conclusion and Future Directions

The chapter has presented how social media can be used in mobile learning settings and how social network analysis can be used for mobile learning assessment. In carrying out mobile learning, it is recommended that learning be designed and developed with instructional design to identify the types of learning activities appropriate for learning. In the chapter, the design of mobile learning activities was linked to a Park's (2014) framework for mobile learning in which learning activities are classified into high and low transactional distance, as well as social and individualized mobile learning activities. The design was then merged with problem-based learning, where the learning problem, process, and solutions are further designed to identify the control over learning of both learners and instructors. After that, the chapter continued with a discussion on how social network analysis can be used for learning assessments of social media for mobile learning.

Some suggestions for future directions in the field are as follows. First, it would be interesting to investigate the impact of a particular instructional design or mobile learning framework on egocentric sociographs. Different instructional designs for mobile learning would elicit different learning patterns—and visualizations via social diagrams would assist in understanding learners' as well as instructors' profiles. By understanding the patterns and profiles, we would then be able to understand more on appropriate learning interventions and levels of control—whether to provide more learner autonomy or to intervene more in increasing learning engagements. Second, it would be interesting to see how other social media platforms have an effect on mobile learning and social network analysis. As the case study presented the use of Facebook Groups for social media in mobile learning settings, use of other platforms such as Instagram or Snapchat could yield different social network diagrams. Comparison across different social networks could assist us in identifying which platform would be appropriate for different types of mobile learning activities. Third, the case study presented in the chapter focused on higher education settings (i.e., undergraduate education). It would be interesting to study how social media and social network analysis could impact other types of learners including primary and secondary learners as well as lifelong learners or special needs learners (Nordin, Embi, Norman & Panah, 2017). Finally, only aspects such as betweenness centrality, closeness centrality, and egocentric diagrams were utilized to assess social media for mobile learning. Future research could tap into other aspects such as geodesic distance and graph density for further understanding learners/instructors profile, and learning patterns (Hansen et al., 2011). In sum, it is hoped that the chapter could assist future educators and researchers interested on investigations of social media for mobile learning.

Glossary

Mobile learning Learning that is carried out across multiple context, through social and content interactions, using personal electronic devices

Social media Social media is associated with online social platforms such as social network sites, blogs, microblogs, and location-based services. The platforms allow its' users to interact and communicate with other users and enables them to create and share content among one another using digital devices

Instructional design The design of pedagogy and learning

Social network analysis The analysis of social media for mobile learning to assess learners' interaction during learning

Egocentric network diagrams Diagram that visualizes the participation level of social media users

Betweeness centrality A value that indicates the importance of a learner toward a network of learners in social network analysis

Closeness centrality A value that indicates the distance of the learner from another learner (in terms of communication) in social network analysis

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Chapter 16
Large-Scale Deployment of Tablet Computers in Brazilian Public Schools: Decisive Factors and an Implementation Model

Giovanni Farias, Mohamed Ally and Fernando José Spanhol

Abstract Since the beginning of this decade, there have been some government-supported initiatives towards the large-scale deployment of tablet computers in public schools districts around the world, such as Thailand, Turkey, India, Singapore, USA, and Brazil. They mostly aim at improving teaching processes and boosting their student's learning outcomes. However, they have reported problems in the deployment processes, such as disinterest in the device use, and implementation delays or suspensions. In the Brazilian deployment, involving 600,000 tablet computers, there was even refusal among teachers to use the devices. This chapter describes a study focused on the identification of the most important factors that influence a large-scale deployment of tablet computers in the Brazilian public schools, as well as the relationships between them. The study involved the participation of stakeholders in the Brazilian deployment, such as teachers, principals, managers, technicians, and education policymakers, who externalized their respective standpoints on the deployment process. The study employed the Grounded Theory approach, and the result of the study was a list of factors to be considered in a large-scale deployment of tablet computers in a public school district system as the Brazilian one. The chapter presents the success factors and the implementation model for introducing tablet computers in large scale in Brazilian public schools. It can lead to mitigating problems and improving a type of a deployment process barely studied since there are few studies focused on large-scale deployment of tablet computers.

Keywords Tablet computer · Public school · Brazil · Deployment
Large scale · Model

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_16

16.1 Introduction

In 2012, the Brazilian Government announced the launch of an ambitious project to improve the quality of the educational level of high school students. It aimed at deploying 600,000 tablet computers in public schools dedicated to basic education across the country. The tablet computers were supposed to be distributed among K12 teachers in order to use them in their classes to search for information and make presentations using 3700 interactive whiteboards (Lima, 2013; Santana, 2012). It was an initiative from the Brazilian Government towards to the improvement in the quality of public education.

The Programme for International Student Assessment (PISA), an international assessment managed by the Organisation for Economic Co-operation and Development (OECD, 2012), demonstrated the lack of quality of the Brazilian high school education. Brazil occupied the 55th position in a group of 65 countries whose students were assessed by the PISA in 2012.

To address this bad educational scenario, the Brazilian Government implemented several changes. The tablet computer deployment initiative was just one of many changes to try to improve the public educational sector. The idea defended by the government was based on the fact that providing tablet computers would allow them to improve their classes. As a result, it would boost the student learning process by presenting the materials in a more attractive way with the use of resources such as videos, audios, illustrations, and animations. Then, it was expected that it would stimulate the students to study more, enhancing the student's learning outcomes (Mercadante, 2013).

Nonetheless there is a logical reasoning supporting the arguments of the then Ministry of Education, there was a lot of criticism from different segments of the Brazilian society. For instance, Cardoso (2012) stated that the government enthusiasm at the beginning of the deployment results in no or little significant result from the use of the technology. She pointed out that "introducing tablet computers in the classroom means more of the same". She goes further, naming this phenomenon "politician technophile". Teles (2012) reinforced the Cardoso's criticism listing some factors, such as the absence of a broader curriculum planning to support the use of tablet computers and the lack of well-defined standards for the digital content to be used by the teachers in their classes supported by tablet computers. Ferreira (2013) was still more pragmatic in his criticism, stating that some schools did not count on a good Internet connectivity and the teachers were not trained to master the use of such devices for teaching. Even the training provided for the teacher to make them able to use the tablet computers suffers criticism because it was a fast-track process (Lima, 2013).

The lack of good expectations from the Brazilian scholars contrasts with the positive impressions on the use of tablet computers in a classroom, as it is indicated in the next section.

16.1.1 Tablet Computers in Education

The use of tablet computers in education is not new. Bort (2013) indicates that the scholars do research on this topic since the decade of 2000, although these mobile devices have been available on the market since 1987. Some of the publications on the use of tablet computer for education demonstrate the use of mobile devices is feasible and fruitful in an educational environment. Mango (2015) states that the use of the tablet computer increased learning engagement resulting in active learning in the classroom and leading the student to success. Furthermore, the learners can use the device in other places than the classroom, allowing for field-based nature learning, due to the device's flexibility and multimedia.

Tront (2007, p. 64) stresses that the tablet computers permit a more natural use than the notebook, with a more comprehensive and easy-to-use note taking and sketching capabilities, either for face-to-face or distance learning. He goes further and points out that the students have a more flexible way to submit their homework than using desktops or even notebooks. In another publication, Moore et al. (2008) declare that those students that used tablet computers for education expressed better results regarding lecture delivery, interaction with their instructor, more engaged in the learning process, and following up the lecture.

Nevertheless, there is a significant limitation regarding the focus of the publications above in what regard to the Brazilian tablet computer deployment. All the studies are focused on user adoption, teaching methods, or learning outcomes with the use of mobile devices for educational purposes. In fact, the scholars have avoided focusing their attention on the implementation of such devices in the educational scenario, especially when dealing with a large-scale deployment. As highlighted by Farias (2016), practically all the studies that investigate the implementation of tablet computers in schools involve a few thousands of devices, at most. McGee and VanderNoor (2013, p. 12) agree with this standpoint and state that the studies on tablet computer deployment processes have been based only on few schools, with a limited number of involved devices.

However, this lack of global view on the large-scale deployment processes occurs not by chance. Before 2010, tablet computers were not popular and had their use restricted to some very special niches, such as high-profile schools or scholar-supported initiatives. The high price, lack of integration between hardware and software, heavy weight for long periods of use on hands, and the short-life and overheating battery were some of the factors that impeded the tablet to become popular (Spillers, 2009).

Only after the launch of the Apple's tablet computer, the iPad, in 2010, this kind of mobile device assumed an outstanding position in the information technology market (Neves & Cardoso, 2013). The light weight, the integration between hardware and specialized software that resulted in the simplicity of use, the more sensitive and sophisticated touch screen and battery technologies, headed by an affordable price, made the iPad conquest an important position in a market that was dominated by notebooks (Tanous, 2013).

This market shift modified some established paradigms from studies before 2010. Moore et al. (2008) state that the modern tablet computer is more than a notebook with touch screen and e-ink software, as the old ones were considered. They clarify that the modern tablet computers count on software specifically designed for them and a seamless integration with the hardware, which optimizes the information processing and the battery life, besides making the use of the device more comfortable.

16.1.2 Large-Scale Deployment of Tablet Computers

This new generation of tablet computers made the paradigm to mobile device for educational purposes a reality at home and school environments (Clarke & Svanaes, 2012, p. 5), in particular with the emergence of the Android devices. The tablet computers with the Google's operational system started some important government initiatives to use tablet computers for educational purposes. Large-scale deployment of educational tablet computers started being announced around the world, most of them with Android technology. Table 16.1 shows some of these announcements that involved at least 100,000 devices, including the year of the announcement for the initial implementation and the respective references.

In fact, all of the above deployments faced serious problems that resulted in significant delays, suspensions, or cancellation of the project. The Singapore deployment had to face delays of more than 18 months in the project schedule (Kwang, 2012). In mid-2014, the Turkish operation distributed only 732,000 devices out of 15 million units that were supposed to be deployed between 2013 and 2017 (Faas, 2013).

In Thailand, the tablet computer deployment had serious issues regarding hardware quality. In 2013, an audit found out that 30% of the Android devices provided by the manufacturer in the previous year presented some hardware defect (Sakawee, 2014). The contract ended up being cancelled. The India's government almost cancelled its tablet computer deployment because of performance issues of the mobile devices (Nanda & Agarwal, 2013). Even the large-scale deployment that used Apple's iPads had to halt the implementation just one year after they launched

Table 16.1 Large-scale deployment of tablet computer initiatives around the world

Country	Number of devices	Announcement year	Reference
Singapore	120,000	2010	Kwang (2012)
Brazil	600,000	2011	Savarese (2012)
Thailand	860,000	2012	Garun (2012)
India	100,000	2013	Nanda and Agarwal (2013)
Turkey	15,000,000	2013	Faas (2013)
USA	640,000	2013	Kastrenakes (2014)

Source Farias (2016)

it. Kastrenakes (2014) listed the main reasons for the suspension: the lack of adequate content and curriculum for using mobile devices, the resistance of students and teachers to adopt the mobile devices, the misuse of the tablet computers, and problems with infrastructure, especially regarding the Internet connectivity.

Neves and Cardoso (2013) listed some problems found in the Brazilian deployment: low device adoption by the teachers since the adherence to the project was not mandatory, hardware defects of all kind, high dropout rate among teachers that attended the online training to learn how to use the devices, and the lack of adequate Internet connectivity.

The Federal District, a wealthy Brazilian region where is located the Brazil's capital, is an excellent example of the Brazilian deployment problems. From the 3000 devices available for distribution, the teachers only took 1900 out, from which 100 devices were returned due to technical issues and 140 devices without any justification (Neves & Cardoso, 2013).

In short, serious problems surrounded the largest tablet computer deployments for education purposes around the world. Some of them resulted in numbers far away from what was planned. Even so, relatively very few researchers have published studies focused on these phenomena if compared to those concerned with what happens in small scale and within the classroom routine, after the deployment has been done (Clarke & Svanaes, 2012). This fact was one of the main motivations to develop this research, whose details are presented in the next section.

16.2 The Research

The initiative for developing this research emerged from a scenario in which there is little concern to the large-scale deployment of tablet computers in an educational context. It aims to attempt to reveal relevant information about what educational leaders must consider when deploying a huge number of mobile devices in a school district or even in a nationwide educational system. It is important to understand that the teacher acceptance of using the tablet delimits the scope of this research. What happens after the teacher get engaged in the deployment project, such as pedagogical strategies, students' adherence, or learning outcomes, is not the focus of this investigation. Especially because if the teacher does not adhere to the deployment, there will be no future subject to be investigated on this topic and the deployment has been failed. Thus, the elements needed for this research are those between the initial planning until the teacher becomes engaged.

The primary objective of this research was to identify, in a systematic manner, the factors that influence the large-scale tablet computer deployment in the Brazilian public school districts. Furthermore, it also had the objective of establishing the existing relationship between these factors with each other, making possible to reach a model that describes these elements and their relationships. By doing so, this research not only aimed to have a big picture of what happens in a deployment process like the one described in this article, but also it could generate a model to be used by future similar deployment initiatives to mitigate risks and increase the chances of success.

Despite previous similar scale technology deployment in schools, such as those involving computer laboratories and interactive whiteboards, the use of tablet computers for education presents an important difference because it involves hardware similar to a smartphone, which most students are familiar with. Teleco (2016) indicates that 84.2% of the mobile phones sold in Brazil between October 2013 and September 2014 were smartphones. It demonstrates that once the use of mobile devices for educational purposes becomes a reality, a significant number of the students will be able to take advantage of it using the BYOD (Bring Your Own Device) policy. Then, the results of this research can contribute to accelerating the adoption of mobile devices in public education districts in Brazil, improving the pedagogic strategies and boosting learning outcomes for the students.

16.2.1 Research Design

There was awareness that the small number of previous studies on the subject of this research would lead it to unexpected results from the data. After all, there were a lot of unpredictable variables related to a complex process of deploying a huge number of mobile devices, involving another huge number of schools and people. Moreover, as the phenomenon was very recent and unprecedented, there were few clues that could underpin the creation of a hypothesis.

Facing this research scenario, the researchers took some important decisions regarding research design. The research epistemology was interpretivist because of this complex and unpredictable variable involved in the phenomenon. The research methodology was Grounded Theory, due to the fact it allows to describe the phenomenon but also to comprehend what underpins it (Corbin & Strauss, 2008). The research methods were semi-structured interviews and on-site observation performed during the visits to a sample of schools.

As research tools, the researchers used an online survey, to reach participants located across a whole vast country as Brazil, and a qualitative data analysis software, to obtain the adequate productivity to process all of the qualitative data collected.

16.2.2 Research Implementation

Mewborn (2005, p. 45) states “Grounded Theory is a method that emphasizes understanding the voice of the participant to build a theory about phenomena”. In fact, instead of deducing conclusions just based on a proposed hypothesis, the use of Grounded Theory implies taking an initial inductive approach, underpinned by the data collected from participants and other sources of information, such as papers, reports, and videos.

For this initial step of the methodology, the researchers could count on the ABED, the initials in Portuguese for Brazilian Association for Distance Education. ABED is an important Brazilian organization in the distance education field, counting on members from all over Brazil. The researchers had the support from ABED to send invitation emails to its e-mailing list, to reach teachers, educational leaders, policy makers, scholars, and service providers involved directly or indirectly in the Brazilian deployment of educational tablet computers. Based on this initial setting, the initial inductive approach of Grounded Theory took place, as indicated in Fig. 16.1.

An online survey was used to get the responder profile data, their respective roles in the deployment, and open responses from the participants on the tablet computer implementation they had been involved. The profile data analysis aimed to check whether there was some bias regarding the responders' characteristics. Furthermore, the profile information allowed stratifying the analysis based on the type of participant role in the deployment.

The open coding resulted in tagging important concepts, ideas, and events identified during the analysis (Corbin & Strauss, 2008, p. 89). After that, the analysis performed the axial coding, "which consisted of reorganizing the data with the identification of relationships between codes via a combination of inductive and deductive thinking" (Farias, 2016). It resulted in categories with names and properties, combining concepts or themes that shared similar characteristics.

Then, as shown in Fig. 16.2, it started an iterative process. Based on the initial data analysis, the researchers did a theoretical sampling, which aimed "to collect data from places, people, and events that will maximize the opportunities to develop concepts regarding their properties and dimensions, uncover variables, and identify relationships between concepts" (Corbin & Strauss, 2008, p. 143). As the initial analysis brought unpredictable finding, generating new questions about the phenomenon, the researchers needed to contact new participants. That is, theoretical sampling means "choosing the new participant sample to respond to the new questions" (Farias, 2016).

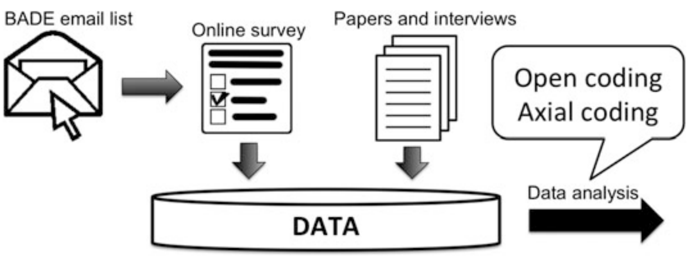

Fig. 16.1 Initial data collection process. *Source* Farias (2016)

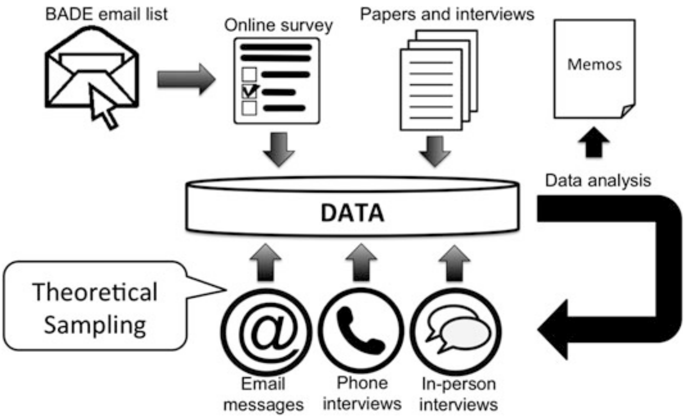

Fig. 16.2 Theoretical sampling done after the initial analysis. *Source* Farias (2016)

Meanwhile, the researcher wrote memos to record his impressions and register aspects, observed during the investigation that were not explicit in the responses from the participants. The researcher repeated this process until no new significant information emerged from the collected data. At this point, the research had reached the theoretical saturation, and the theoretical construction could start with the selective coding, which consisted of establishing the most important category found during the analysis, followed by the work of creating relationships between it and the other categories (Corbin & Strauss, 2008).

In fact, as the reader can observe later in this chapter, the model proposed in this study is the storyline resulted from this selective coding. In this model, the categories are the factors that influence the tablet computer deployments, and the tablet computer adoption by the teacher is the main category or factor for the deployment.

16.3 Results and Discussions

The researcher performed the data collection by the end of 2015, making its analysis by the beginning of 2016. The deployment, at that time, had been taking place since the end of 2012. Then, there was enough time to obtain results from the tablet computer distribution to have a good picture of the phenomenon. The online survey collected 82 responses, but the analysis discarded 17 of them because they had either incomplete profile answers, meaningless answers to the open-ended questions, or the respective participants did not meet the requirements to take part of the research. The participants should demonstrate that they had been involved directly or indirectly with the studied deployment, and most of these discarded responders declared they did not have any contact with the deployment; they just wanted to give their opinion about the studied topic. Thus, 65 online survey responses from all over Brazil were used in the initial analysis.

The participant profile, the first data analysed by the researcher, was composed of data about age, gender, home state, highest education level, professional experience, roles in the deployment, and subject matter (only for those that declared themselves as being teachers). The profile results demonstrated that no data were a source of any bias, and then, the collected data were not compromised.

After the first open and axial coding, as the result of the initial analysis, the researcher contacted fifteen new participants as the theoretical sampling, spread out in schools across different cities in Brazil. The researcher visited these schools and interviewed the new participants in person. Moreover, the researcher had the opportunity to observe the reality in schools, confirming the information provided by the answers of the open-ended questions through the online survey and obtaining new impressions to feed the memos.

16.3.1 Main Factors Considered Important for the Deployment Process

The survey responses and the interviews performed during the visits to the schools where tablet computers had been deployed, plus some published papers and videos with interviews with prominent Brazilian educational specialist, underpinned the identification of the most important factors that influence the studied deployment. The first round of coding, according to Grounded Theory techniques, generated 50 different categories. After cycles of constant comparison, theoretical sampling, and memo analysis, the analysis reduced this number to 16 categories, each of them corresponding to a different factor. Figure 16.3 presents the factors accordingly to the number of times the respective code was identified during the data analysis, followed by their respective explanation.

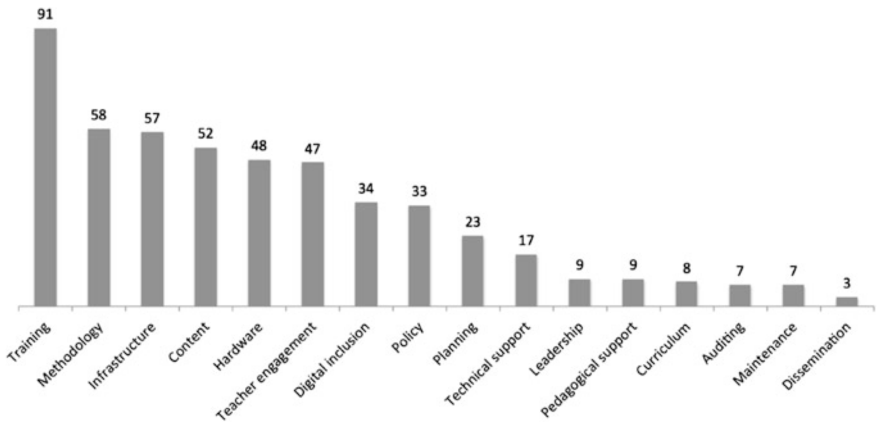

Fig. 16.3 Resulting categories from the Grounded Theory analysis. *Source* Farias (2016)

Planning. The factor related to any action to organize the resources and procedures towards its success, especially for a project with this scope. There were planning problems regarding policies, which were not standardized. Each Brazilian state could specify its policies for deployment, which contributes to operational problems, especially related to training. There was complaining about the fact of having just one public hearing on such a huge project. There was not enough time to run adequate pilot projects to adjust the deployment details. Farias (2016) stated that “this planning decentralization, coupled with the relatively fast pace with which the project was implemented, generated some of the problems narrated by the participants regarding other factors”.

Auditing. This factor involves mechanisms of monitoring and controlling the use of the distributed mobile devices. The participants explained that the teachers are not obligated to use the tablet computers. If a teacher adheres to the project, he/she has the freedom to do anything with the device, including doing nothing. Then, some participants stressed that there must be rules, audit tools, and procedures to follow up on the use of the received devices to foster the expected pedagogical results and to avoid misuse of the equipment.

Dissemination. This factor regards the communication and relationship strategies with the stakeholders, such as teachers, school staff, students, and the student’s parents, to introduce the deployment project in a way that everybody is aware of its goals, can get involved and/or monitor the deployment properly. There was at least one very positive declaration about the good results obtained from an organized dissemination process in Espírito Santo state, which was considered a reason for facilitating the deployment in its school districts.

Policy. The planning must specify the rules and protocols that must be followed by the stakeholders to deploy and use the tablet computers in schools. In fact, it is an element of planning that was separated because its focus on the operational level of the deployment, which involves mostly the final destination of the tablet computer, in other words the school. The poor policy planning, for instance, allowed serious problems with equipment maintenance since the users spent months waiting for the return of broken devices without any fast-track replacement procedure.

Curriculum. This research uses the definition of curriculum as being a set of documents, subject curricula/syllabuses, and relevant supportive learning materials, such as textbooks, teacher guides, and assessment guides. The deployment of tablet computers in large scale in schools has a high impact on the requirements for curricula and methodologies. Then, the curriculum must give the directions on how to design the classes to achieve the best learning outcomes with the use of mobile devices. Nevertheless, all of the participant’s responses on this factor stated that the devices were deployed without any integration between technology and curriculum.

Methodology. This factor “is the know-how needed to use the tablet computer in the educational context” (Farias, 2016). It may be the educators’ theoretical knowledge or the lesson plans for using mobile devices to achieve an enhanced learning outcome. The responses pointed out it is necessary that teachers master not only the use of the mobile devices pedagogically but also to develop their teaching methodologies to contextualize this use in the classroom.

Maintenance. This factor also includes the device replacement, and it is critical when the deployment involves a large number of devices because there is a percentage of equipment breakage that varies between 5 and 30%, depending on the situation (Clarke & Svanaes, 2012; Sakawee, 2013). There must be a well-defined policy for fixing or replacing not only broken tablet computers but also stolen or lost equipment. Farias (2016) described "how impactful the issue of hardware failure is for the effectiveness of the education paradigm regarding learning outcome improvement". This study revealed that several problems were identified with the long wait for maintenance and the lack of replacement devices, which compromised the teacher engagement with the project.

Hardware. This factor is related to the tablet computer as a product, including its performance, battery life, durability, resistance, cost, and facility of use. Many of the participants gave up participating in the project because of the low equipment quality. There were complaints about low performance, short-life or broken battery, small memory capacity (it prevented to use the device where there was not Wi-fi signal), and small screen (a significant part of the devices had 7″ screen).

Infrastructure. Infrastructure refers to the physical support for the use of the mobile devices in the schools. There were a lot of criticisms regarding this factor: non-existence of Wi-fi connection in all school classrooms, an insufficient number of projectors or interactive whiteboards, narrow bandwidth connection to the Internet, lack of power outlets in classrooms, and lack of computers and software for content authoring. There was a surprising declaration from a school technical support employee, who said that the principal did not care if most of the teachers did not engage with the deployment. It happened because if a large number of teachers would adhere to the project, there was not infrastructure enough to support their activities using the devices (Farias, 2016, p. 95).

Content. This factor is related to any published content available on the Internet for teachers to use legally, any repository of Open Education Resources (OER) appropriated for the teachers use within the tablet computer deployment context, or any content designed by teachers and available to be used by their colleagues. The participants mentioned the teachers need to have local content and with no risk of violating any copyright. They also expressed the desire of having specific training to use the content available in their pedagogical scenario. There is a perception that the teacher cannot embrace an additional task of developing a vast amount of content they need to use the tablet computer. Having this content ready to use is a great incentive for the teacher to engage with the project.

Digital inclusion. This factor regards the ability of teachers to use efficiently and relevantly the available hardware, software, infrastructure (including the Internet), time, and skills to engage with the tablet computer deployment. The lack of this factor is indicated as being an important reason to prevent the teachers from engaging with the project successfully. Moreover, without digital inclusion "the teachers feel embarrassed due to the gap between their performances compared to the student flippancy in the use of mobile devices" (Farias, 2016).

Leadership. It implies in the emergence of formal and informal leaders, and their engagement with the deployment, resulting in an easier way to overcome the difficulties inherent to the process. The formal leaders can create the proper conditions and require active attitude from the teachers, whereas the informal leaders can foster their engagement with the project. Some responses from the participants revealed that some teachers assumed an informal leadership in their respective schools helping their colleagues to overcome the difficulties related to the devices deployment, especially in what regards to training issues. On the other hand, it was stated that some principals were not so engaged with the deployment, at least as they should to, creating a barrier to the success of the project.

Training. This factor refers to the knowledge to be learned by teachers, involving the technical and pedagogical skills, to enable them for the proper use of the devices and the available content, and foster the full deployment engagement. By far, it was the most cited factor that influences the deployment results. There were a lot of complaints related to brief and superficial training, mostly or totally focused on the operational use of the device and without any pedagogical approach. The researcher visited a school that had received twenty devices, and just one was being used for pedagogical purposes. It was said that the main reason for that low level of engagement was simply the lack of training.

Technical support. This factor regards any action, resource, or structure element that fosters the teachers to use the deployed mobile devices or that solves the problems concerning technological aspects of their use. It regards mostly to staff dedicated to helping teachers to overcome their difficulties to deal with the technology involved, such as the mobile devices, the Wi-fi connectivity, and the peripheral equipment. In some of the visited schools, the teachers stated that there was little or no technical support, which is composed of contractor staff with a high turnover. Then, they ended up giving up of engaging with the deployment since they did not have who they could count on quickly to solve their technical issues with the use of the mobile devices.

Pedagogical support. This is related to any action, resource, or structure element that fosters the teachers to use the deployed mobile devices or that could solve the problems concerning pedagogical aspects of their use. It includes, but not limited to, class planning, methodology design, and content creation or adaptation for their classes. The school districts had teams spread out in each state territory with this role. However, in some cases, even these staff did not have the skills needed to provide pedagogical support for the teachers. Moreover, in general, the schools could not count on their own pedagogical support teams. On the other hand, they visited the school in which the technical and pedagogical support teams were provided by regular staff, the teacher engagement was a case of success since they had who they could ask for help, not only for pedagogical support but also for technical support as well.

Teacher engagement. This is related to the teacher engagement or resistance against the use of tablet computers in their classes. Those engaged teachers used the mobile devices for presenting classes, although the set of difficulties presented so far. However, some teachers had no reason for not using the devices, whether they did not want to get out from their comfort zone, they did not agree that the use of tablet computers could improve their classes, or simply they were not interested in adhering to the project. Because of it, the teacher engagement is a factor by itself; at the same time, it is the final objective of the deployment, as interpreted in this research. In fact, it is the most important element, when considering it as a factor of influence. It is because regardless the fulfilment of requirements related to all other factors, if the teacher is not keen to engage the deployment will not happen. If the teacher is willing to engage, then the other factors must be considered. This study demonstrated that when most of other factors were properly offered for teachers willing to use the mobile device in their classes, the deployment was a success.

Based on these factors presented above, the researcher could develop a model that describes the phenomenon and allows the understanding what happened in the Brazilian deployment of tablet computers, presented in the next section.

16.4 The Large-Scale Mobile Device Deployment Model

The Large-Scale Mobile Device Deployment (LSMDD) model, presented in Fig. 16.4, is the result of the analysis of studied phenomenon. It presents the factors that were identified as the leading influencers on the large-scale tablet computer deployment in Brazilian public schools, detailing how they related to each other.

The design allows comprehension of the model just by reading the factors (rectangular elements) and the relations between them (arrows for one-direction influence and double arrows for mutual influences). The Planning factor is differentiated because it is considered the original factor for the deployment as a whole, as well as the Teacher Engagement, which is the final objective of the implementation; at the same time, it is a factor by itself. The remaining factors were separated into three classes according to their nature:

- The method factors are those related to mastering the way of doing some procedure towards the implementation of the mobile devices in the educational structure. They can be know-how elements as well as the result of the application of this know-how in the form of plans and scripts.
- The structure factors are those that involve physical, human, or digital resources needed to implement successfully the use of mobile devices in a school. It includes Internet connectivity, staff, and logistics to replace information technology components, as well as non-concrete elements such as software and digital content.
- The personnel factors are those more directly related to the human resources and their traces involved in the deployment.

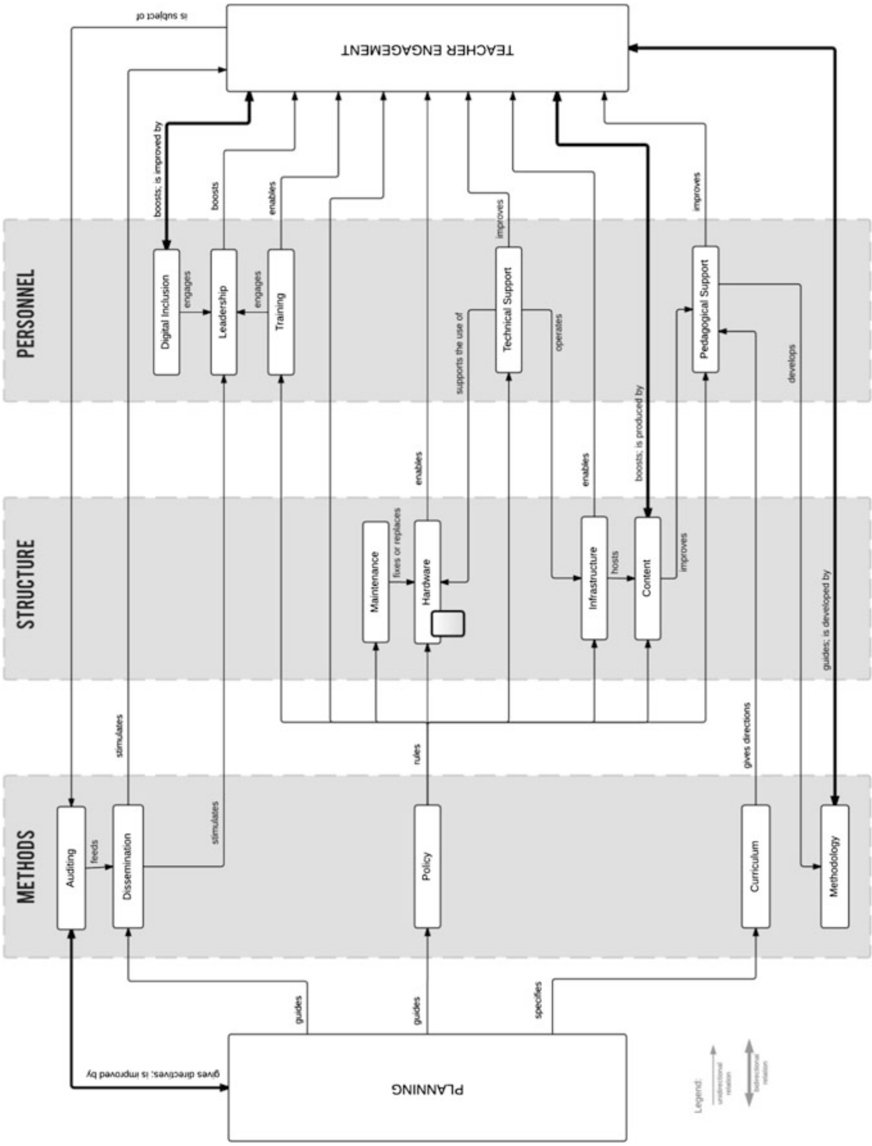

Fig. 16.4 Large-scale mobile device deployment model. *Source* Farias (2016)

16.5 Conclusion

After reading the description of the presented factors, the reader can conclude that poor planning was the reason for most of the problems related to the deployment described here. Because of that, unfortunately, the identification of the factors was mostly based on complaints than on examples of the best practices. Nevertheless, the failure in providing the conditions to attend the listed factors has been shown effective to make clear what must be observed for a successful deployment with the use of the LSMDD model.

In fact, the LSMDD model was designed in a way to avoid the particularities related to the scale of the Brazilian deployment, in order to make it fit in contexts other than the Brazilian one. Thus, the model can be used in a school district with thousands of tablet computers to be deployed. Hopefully, this model can help policy makers and deployment managers to predict problems, mitigate risks, and optimize the large-scale implementation of such mobile devices in school districts.

Glossary

ABED Brazilian Association for Distance Education

IDEB Basic Education Development Index

bps Bits per second

BYOD Bring Your Own Device

CIA Central of Intelligence of America

DL Distributed Learning

GDP Gross Domestic Product

IT Information Technology

ICT Information and Communication Technology

IWB Interactive Whiteboard

LSMDD Large-Scale Mobile Device Deployment

OECD Organization for Economic Co-operation and Development

OER Open Educational Resources

PDF Postscript Document Format

PISA Programme for International Student Assessment

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Author Biographies

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Chapter 17
Successful Delivery of a MOOC Via Basic Mobile Phones: A Case Study of Mobile Learning in India for Increasing Awareness of Science-Based Production Practices Among Semiskilled Horticultural Farmers

Raj Kishen Moloo, T.V. Prabhakar, Venkataraman Balaji and Kavi Khedo

Abstract Increased concerns about food security in the context of increasing climate variability and globalized trade in agricultural commodities have led to a realization that scalable and technology-enabled methods of learning are necessary to help farmers access new science-based information. We have proposed an innovative Mobile Learning System based on simple (dumb) phone technology, which enables learning through voice calls. In Hindi, the word Mali refers to a semiskilled horticultural worker. A series of *Mobile for Malis* (MfM) Audio MOOCs were developed and delivered to open up access to learning materials and processes to the unreached usually hindered by limitations such as data connectivity, distance from experts and limited literacy. We conducted two large-scale trials, the objectives being threefold: to test our system to see if all the different components behaved as expected in a live situation. Second, we wanted to observe the human response and behavior to such an innovative learning system. Third, we wanted to confirm some of the pedagogical hypotheses we had assumed during the design of our audio lessons. A total of 1900 learners were involved. Audio materials were in Hindi language as spoken in the State of Uttar Pradesh, which is the largest province of India. The results proved that the innovative arrangement involving basic cell phones, telephony infrastructure, Interactive Voice Response (IVR) systems, Hindi speech recognition and a web-based course management

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_17

system was highly effective. Our trials have also opened up to some major research avenues in Mobile Learning which need to be further investigated.

Keywords Audio/voice MOOCs · IVR · Audio Learning · Mobile Learning VoIP · Education for low literate population

17.1 Introduction

The advent of mobile phones has radically changed the lives of people, from mere communication via phone calls to Mobile Learning and mobile transactions. UNESCO (2014) remarked that the world is *book poor but mobile device rich*. Decreasing cost of mobile communications has fueled the proliferation of mobile phones, increasing mobile ownership even in areas where most of the population is poor or ultra-poor. In India, there are around 616 million unique mobile subscribers (GSM Association, 2016) with an overall tele-density of 83.14%, while rural tele-density accounts for 51.75% (TRAI, 2016). Still expanding their vast reach and simplicity of use at affordable cost, mobile devices are now in a position to extend public services to rural people all over the country (Kokate & Singh, 2012). Hence, using mobile as a means to reach and educate the poor and the have-nots is within the possible domain.

In India, the public sector extension services for farmers have been important and there are ongoing efforts to utilize the advantages of ICT-based approaches, including Mobile Learning. Yet, for these solutions to be effective, there is a need to overcome several challenges inherent to extension for Indian farming, such as limited literacy, diversity in agroecologies and lack of access to data communication. Internationally, a number of trials in Mobile Learning systems are based on internet access, meant for higher-end phones and tablets.

In Hindi, the word *Mali* refers to a semiskilled horticultural worker. The Mobile for Malis (MfM) initiative arose from the idea of bringing knowledge to the poor and the unreachable farmers of India through the use of mobile technology. At the same time, it was also a trial to revitalize the functioning of Krishi Vidyan Kendras (KVK), i.e., local Farm Science centers, with the aim of educating and passing on new agricultural technologies to them. Prior studies (Balaji, 2006; Government of India, 2003) identified the diminishing use of KVKs by farmers for information access, who were favouring other sources of information like relatives, friends and local market dealers.

We have proposed an innovative Audio MOOC Mobile Learning System based on simple (dumb) phone technology, which enables learning through voice calls by leveraging the existing telephony infrastructure instead of using the internet. Spoken language interface has been argued to be the most logical, acceptable and natural way to interact with low-literacy population since it provides intuitive interaction that can be meaningful to all users irrespective of literacy levels, cultural and technology exposure. The Audio MOOC system consists of functionalities like management of Audio Learning materials, setting up of on-air quizzes, tests, exams and surveys as well as students' performance monitoring and learning management.

The system takes advantage of voice technology and Interactive Voice Response (IVR) system over existing telecommunication infrastructure as a medium to enable access to Audio Learning materials via phone calls as an alternative to Internet access. A series of Mobile for Malis (MfM) Audio MOOCs were developed and delivered to learners usually hindered by limitations such as data connectivity, distance from experts and limited literacy. This also helped offset the serious limitation faced in India where very large proportion of cell phones are not designed to display characters of Indian languages with consistency.

Our larger research question is the viability of using audio telephony as a medium for sustained engagement between experts and farmers in order to help increase awareness among the latter about science-based production practices. As a major component of our effort to address this research, we have conceived of using a highly scalable learning platform that can offer learning materials and mentoring exclusively in the audio mode. Our interest in the present effort is on sustaining the engagement of the learners. In this paper we propose to demonstrate the feasibility of such system in dispensing interactive on-air MOOC to semiskilled horticultural farmers on science-based production practices via mere phone calls. We conducted two large-scale trials, the objectives being threefold: to test our system to see if all the different components behaved as expected in a live situation. Second, we wanted to observe the human response and behavior to such an innovative learning system. Third, we wanted to confirm some of the pedagogical hypotheses we had assumed during the design of our audio lessons. A total of 1900 learners were involved.

17.2 Literature Review

Our work brings together three strands of independent research and practice, namely: (i) applying mobile communication for empowerment of farmers, (ii) mobile user interfaces for low-literacy population and (iii) pedagogy and instructional design for Audio Learning. In this section we identify relevant advances in those three strands. However, to place things in perspective, we start by giving an overview of the Indian agriculture and the information needs of farmers.

17.2.1 Agriculture Knowledge Dissemination in India

Agriculture has always been the prime concern of governments in India since it plays a pivotal role in ensuring food security, sustainable development and the alleviation of poverty (ICAR, 2011). Around 90 million households depend on agriculture for employment and livelihood in India (Government of India, 2013b) with 22% of the Indian population being agricultural workers (Government of India, 2013a, p. 17). The Agriculture sector accounts for 13.7% of India's GDP (Government of India, 2013a, p. 4) even though the population engaged in it is almost 67% of the total population. India achieved spectacular agricultural growth since 1960s due to its green, blue, yellow and white revolutions responsible for substantial quantitative increases in food production (ICAR, 2012). A major factor in this success has been the investment in agricultural research and higher education, instrumental to generating new technologies which trickled down to the farmer community via state-run agricultural extension services.

Traditionally, education, training and technology transfer for farmers all over India were done by thousands of extension services workers, a part of whom were placed in the Farm Science centers called Krishi Vigyan Kendra which were established by the federal government in India. However, the extension system and farmer-outreach programmes are facing major challenges in the area of dynamic information and advice. New cost-effective, farmer-friendly solutions tailored to their educational needs are to be sought. Mobile technology can be the response in providing a low-cost personalized alternative to the traditional extension services (Ramamritham, Bahuman, Duttagupta, Bahuman, & Balasundaram, 2006).

17.2.2 Information Needs of Farmers

Information needs of farmers have been subject to lots of literature work based on which many applications have been derived. There are many different ways that ICT for agriculture mobile applications could be classified and several researchers namely Mittal, Gandhi and Tripathi (2010), Parikh, Patel and Schwartzman (2007), Hellström (2010), have coined it in their own terms. World Bank (2012) summarizes all of the above and describes four types of mobile agriculture-specific applications in use, namely (i) improving access to financial services, (ii) providing agricultural information including prices, weather and information on agricultural techniques (iii) improving data visibility in the supply chain, including logistics, traceability and tracking systems, and supplier and distribution management support and (iv) enhancing access to markets such as platforms for trading, tendering and bartering.

17.2.3 Existing Mobile Learning Applications

Over the years, several initiatives have mushroomed to cater for the information needs of farmers. Emergence of different types of applications over different range of mobile phones (from simple to smart phones) has been noticed. However, most of the emerging mobile applications targets higher-end market based on internet connectivity, SMS and tech-savvy users such as mKisan, Reuters Market Lite, Nokia life tools, mKrishi and Esoko. Nevertheless, there have been initiatives especially for the developing world to empower the farmers plagued by literacy, language and connectivity barriers. Gakuru, Winters and Stepman (2009) provide an inventory of innovative ICT advisory services to farmers mostly based on audio services. For the purpose of this research we categorized these initiatives under

(i) radio programs (ii) call center approach and (iii) knowledge-/forum-based approach using IVR system.

(i) **Radio** has been a mass communication tool par excellence for Governments, nonprofits and commercial bodies for sharing knowledge with low-literacy groups. Thereon variations in radio delivery have been observed from broadcast radio to interactive radio instructions and phone-in programmes. Farm Radio International (2015) pioneers in farmer education over radio and provides support for over 400 radio broadcasters in 38 different African countries. Examples are Farmer Voice Radio of Uganda, Dzimwe Community Radio of Malawi, Radio Ada of Ghana.

(ii) In recent years, the service centric **call center model** has been extended and adapted to provide agricultural information on a wide variety of agricultural information and advisory services based on local demand to farmers. This model has the advantage of being accessible from anywhere and at anytime with a maximum outreach as compared to traditional extension services. Yet, call center agents who are usually agronomists need to be at the back-end ready to response to any queries. Examples abound like Kisan call center (KCC), Kisan Sanchar, IFFCO Kisan Sanchar (IKSL) in India, m-Kilimo of Kenya, Jigyasha in Bangladesh and Farmer call center from Uganda (USAID, 2012).

(iii) **Knowledge-/Forum-based approach** caters for the empowerment of farmers through education. Likewise there have been some innovative platforms based on IVR system to connect farmers to audio knowledge repositories. Agropedia and vKVK (agropedia phase 2) projects, developed by IIT Kanpur, provides a wiki-type platform (IIT Kanpur, 2008; Venkataraman & Prabhakar, 2014), providing a digital ecosystem connecting KVKs with farmers through internet, mobile and IVR technology. Learning through Interactive Voice Educational Systems (LIVES) is a voice based Learning System using the existing cellular infrastructure, VoIP and IVR. It is a push-based system developed at the University of British Columbia and has been used in a limited set of trials (Vuong et al., 2010). Avaaj Otalo is a forum-based system developed in collaboration with IBM for farmers to access relevant and timely agricultural information over the phone (Patel et al., 2009). By dialing a phone number and navigating through simple audio prompts, farmers can record questions, review and respond to others or access content published by agricultural experts and institutions. It has been a major success since its launch.

17.3 The MfM Audio MOOC System

17.3.1 MfM System at a Glance

The system is architected on a three tier layer, namely the *Application*, the *SoftSwitch to Application* and the *Hardware* layer. The *Application layer* hosts the

Audio Learning Management System which provides features like User Registration, Audio Course Administration, Audio Quiz/Test/Survey Management, Call Management and Learner Analytics. The *SoftSwitch to Application* layer relies on an open-source PBX system bringing the power of Voice and Internet-telephony to the Application layer. The *Hardware layer* allows all the interfacing with a physical telephone line.

The system has been designed for scalability and robustness allowing the system to scale and service a maximum number of simultaneous users without loss of performance. Besides, the system is portable and can be replicated on other platforms and sites without much difficulty. Having a modular design, the system provides LMS support with easy integration capabilities since it can be packaged as plug-ins. Learner controlling the pace of their learning using navigation capabilities is a major strength of the system. Besides the ease with which courses and tests can be created and deployed, on-air assessment, proper feedback and learner analytics make this system an ideal Audio Learning platform.

The cost of development and popularizing the system amounted to less than USD 20,000 in operational costs. It included the amount paid to design and develop the delivery platform, the audio horticulture courses lessons, money spent for conducting trainings, call charges for the delivery of lessons to all learners over mobiles and certificate distribution. Besides the development of the system involved eleven human resources from IIT Kanpur, consisting of four agricultural scientists, four technology experts, two language and two recording experts (Yadav, 2015).

17.3.2 Audio Lessons Design and Preparation

Audio content creation was the most tedious and challenging part of this project. Unlike traditional classes, learning over a phone is through the auditory medium only. Audio lessons had to be designed in such a way to captivate listeners' attention for smooth and enhanced learning experience; else the learners will very quickly lose focus leading to no learning at all. Due pedagogical consideration has been given in audio course design in terms of (a) human attention span, (b) learner cognitive capacity (c) content and (d) audio recording and voice quality.

Accordingly, we designed our audio course to be short (Sherwani et al., 2009a, b) having an average time duration of 7 min based on literature in attention span. However, we considered that listening to a single audio file at a go can be very difficult to assimilate and memorize. Hence, each course is split into nine (9) smaller audio chapters, according to Miller's Law (1956) stating that people can retain 7 ± 2 objects in working memory. Besides, these chapters were of a maximum of 60-s duration based on Pew Research (2012) and confirmed by Guo, Kim and Rubin (2014) stating that students are much more engaged within the first three minutes of video lectures.

Voice and speed of delivery plays a vital role in affecting learner experience. Bellis (2003) advocates proper pacing and appropriate pauses between key pieces of information help the learner remember each piece presented. It gives time to the working memory to register and digest information which has been presented and allows auditory processing to schematize the information in long-term memory before the next segment (Mayer & Moreno, 2003). Harmer (2007) recommends three issues when considering the use of the voice in the management of teaching, namely audibility, variety and conservation. To avoid monotony, voice needs to be varied in terms of pace, pitch, volume and modulation. Voice which projects well and appropriately in all these circumstances is also pleasant to listen, and this enhances learning experience, creating a conducive environment to learn and draw student attention. To this effect we asked a voice artist from the public service broadcast agency, *All India Radio*, to lend his voice for creating the audio lessons in conversational style according to Reeves and Nass (1996) who claims that people learn better this way.

Agricultural domain experts based in a laboratory at IIT Kanpur provided the course content through extensive research. Content started with clearly defined objectives since students are much likely to succeed if they understand what is expected from them at the very outset of the educational experience and if they perceive the expectations to be realistic (Keller, 1987). Also contents were devised according to the targeted audience and aligned according to Bloom's Taxonomy (Bloom 1956) for higher level thinking and Laaser (1986) audio design recommendations. Content was designed to be relevant, concise and to the point, so that they can be delivered within the human attention span. Navigation capabilities were provided so that users can listen to the same lesson again whenever required before going to the next lesson. This design was meant to cater for individual learning pace and also to reinforce learning through repetition/playback. End-of-segment questions were included at the end of each chapters to promote discrimination of new concepts (Gronlund, 1998). At the end of each course, a formal test was conducted to assess the effectiveness of the learning.

17.3.3 IVR and Navigation Design Consideration

Designing an easy to use interface with an enjoyable user experience is a challenge on voice telephony since the telecommunication infrastructure provides the IVR as the only interface for interaction over the telephone network. Spoken language interface or IVR has been argued to be the most logical, acceptable and natural way to interact with low-literacy population (Agarwal, Kumar, Nanavati, & Rajput, 2010; Chaudry, Connelly, Siek, & Welch, 2012; Huenerfauth, 2002; Sherwani et al., 2009a, 2009b) since it does not require literacy, and relies on existing telephony infrastructure (Plauche, Nallasamy, Pal, Wooters, & Ramachandran, 2006). It provides intuitive interaction that cuts across all users irrespective of literacy level and cultural background or familiarity with technological sophistication (Edim, Muyingi, & Sibanda, 2013).

The IVR technology allows a computer to interact with humans either through the use of voice via Automatic Speech Recognition (ASR) and Dual Tone Multiple

Frequency (DTMF) tones input via phone keypad. As an input mechanism, DTMF has the advantage of being both instantaneous and 100% accurate as compared to speech recognition. ASR causes delays for a caller, and the variability of spoken inputs prevents speech from being accurate. However, DTMF is limited to only twelve (12) keys for input and requires mapping between the specific choices (Sherwani et al., 2009a, b) which may lead to frustration. Hence, while determining the input modality for users of a telephone-based information, trade-off between (a) constrained but accurate DTMF input and (b) highly unconstrained yet often misrecognized speech input is important (Lee & Lai, 2005). Besides, the specifics of the interface (e.g., type of prompting), the cultural context, and the domain of use (health, agricultural, finance), operating environment (e.g., noisy) and privacy (degree of confidential information) need to be taken into account when choosing the modality type (Grover, Stewart, & Lubensky, 2009).

For our Learning System, the users can access the audio lessons by simply making a call. Once a call is received, the system plays out the IVR audio files, providing a menu and navigation options to the user. The user may select the options by pressing the respective numbers on their mobile handset keypad to navigate through the IVR and finally listen to the audio lesson of his choice. Trials 1 and 2 used DTMF, while Trials 3 and 4 used ASR for navigation only.

IVR interface design has been adapted from the best design practice guidelines of IVRa & IVRb (2016). Option menus have been restricted in the range of 5–9 choices at a time, based on the working memory span according to Miller's Law (1956), so that the user does not lose track of the options. Menu Options have been kept short at around 30 s for a more efficient IVR experience. Appropriate pauses between menu items have been respected to allow users time to press the correct key. The IVR navigation has been designed to guide the user into selecting courses and lessons files. Option to *repeat* the played lesson, *go to previous*, *go to next lesson* and revert back to main menu has been incorporated for a smooth and pleasant user experience. Options keys were used consistently throughout the course to avoid confusion. Language used was adapted to the local context with a friendly tone. Professional voice artists, with proper voice modulation, were hired for recording of audio prompts and lessons. No technical terms and jargons were used for a clearer understanding. Short and concise sentences with appropriate speech rate were used for menus and prompts and were done in a turn-taking manner to make it less formal and more conversational. No background music was used.

17.4 Delivery of Audio MOOC Courses on Air—A Case Study

17.4.1 Course Details

Since the system has been deployed in 2014, a total of four free courses have been conducted as shown in Table 17.1. Courses C1 and C2 were trial courses with

Table 17.1 Audio MOOC courses delivered

#	Course name	Duration	Registered users	Successful users	Start and end date
C1	Cultivation of vegetable crops in kitchen gardens (trial course)	1 week	12	11	July 10–July 19, 2014
C2	Cultivation of flower and vegetable crops (trial course)	2 + 1 weeks	111	58	Aug 25–Sep 19, 2014
C3	MOOC on horticulture	4 + 2 weeks	1055	296	Nov 20–Dec 30, 2014
C4	Mobi-MOOC on agriculture	4 weeks	702	201	July 2–July 30, 2015

Table 17.2 Audio clips (min:sec)

Vegetable crops	Duration	Flowers	Duration
Tomato	5:56	Gladiolus	4:55
Vegetable pea	5:38	Chrysanthemum	5:53
Brinjal	5:38	Rose	7:01
Cauliflower	5:23	Marigold	5:41
Radish	4:04	Jasmine	5:15
Carrot	4:11		
Potato	6:21		
Fruit crops	**Duration**	**Spice crop**	**Duration**
Mango	6:38	Fenugreek	5:31
Guava	5:25	Coriander	4:48
Banana	6:30	Chilly	4:25
Gooseberry	6:38	Garlic	4:51
Papaya	5:15	Onion	4:11
Total hours—2:00:13			

smaller number of learners. Trials C3 and C4 were courses conducted on a much larger scale with 1055 and 702 registered participants (farmers as well as students who were doing courses in biology or in agriculture).

C1 started on *Cultivation of Vegetable crops* with a small identified group of 12 gardeners to test the viability of our system in a live situation. To assess the effectiveness of the course, a small test and a survey with the gardeners were conducted over the mobile phone. Its instant success led us to conduct course C2 on *Vegetable crop and Flower cultivation* over a much larger scale with 111 gardeners from Kanpur with the aim of confirming the robustness and scalability of our system to support more users. Details of the different courses offered and their respective audio duration are as per Table 17.2. Twenty-two audio lessons of a total of 2 h have been created by the agricultural experts. Each audio lesson consists of 9 clips of 15–60 s duration.

17.4.2 User Registration

For the trial course C1, our team identified and registered a group of 12 gardeners in the campus of IIT Kanpur. For other courses onwards (C2–C4), an important feature was that users could self-register by calling and providing their details (name and age) to the IVR System. The courses were initially promoted through personal contacts by word of mouth. Besides, our team visited a number of schools and colleges to explain this new platform, which was a major challenge. Later, a massive promotional effort was done through mobile messages, resulting to a high number of admissions. Besides, leaflets were prepared and distributed, pictorially showing the mobile interface and the toll-free number to call to access the learning materials as per Fig. 17.1.

Fig. 17.1 Leaflet distributed to the gardeners

17.4.3 Delivering and Managing the Course

Figure 17.2 shows how such a course is conducted over the phone. Users can call a specified number at any time. The system, on getting their call, verifies their numbers and hangs up. It then calls back and presents the callers with an IVR audio interface allowing them to select the lesson they want to learn. On selecting a particular lesson, the audio is played over the mobile phone in the sequential order of the clips. The system provides navigation capabilities (pause, play, forward, backward) either through key presses or voice recognition. Learners can also be assessed over such medium through yes-no type of assessment. The system performs an automatic grading to provide the quiz results for each learner. During the course we regularly monitored the students via our *Tracking* module which provided detailed statistics on the number of audio files being viewed, the date and time these files were viewed and each farmer call duration. We could also monitor the learning progress for each student by checking the completion rate of each course. Those who lagged behind or were not accessing the system were sent reminders over the phone via a pre-recorded audio message.

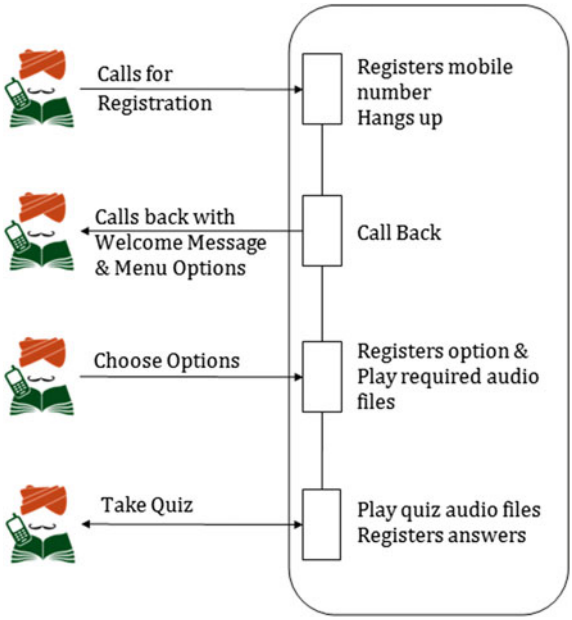

Fig. 17.2 Audio MOOC operations

17.5 Results and Discussion

This section is based on the observations made on trials C1–C4 totaling 1900 users. C1 and C2 were conducted with farmers only, while C3 and C4 had a mix of farmers and a number of college and university students.

17.5.1 System Accessibility

No system downtime was noted during the conduct of any of the four courses, the system being up and running 24 h a day. System performance was stable with some slight peaks, but this did not impact the accessibility or system lags. A peak of 154 users simultaneously accessing the system was noted. Learners could easily access the system and did not note any decrease in audio or communication quality.

17.5.2 Demographic Attributes of Learners and Their Technology Background

17.5.2.1 Age Distribution

The consolidated age distribution of learners in the different courses (C1–C4) was as per Fig. 17.3a. Trials C1 and C2 were conducted entirely with the farmer community having a mean age of 32 with a minimum of 20 years and a maximum of 45 years as in Fig. 17.3c. The standard deviation value of 6 infers a homogeneous group with respect to their age. On the other hand, Courses C3 and C4 were conducted mostly with college and university students as depicted by Fig. 17.3b.

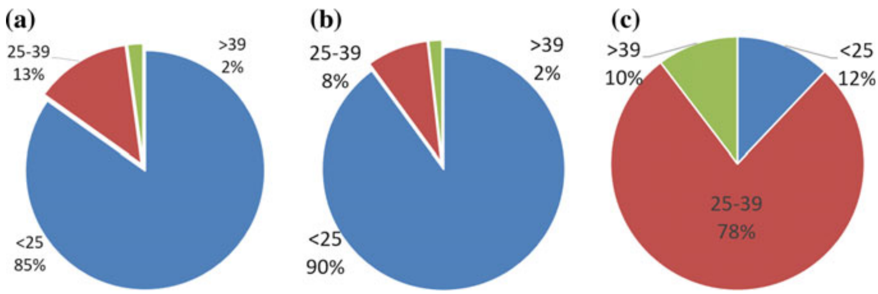

Fig. 17.3 **a** Age distribution C1–C4. Mean: 21. STD: 7. **b** Age distribution C3–C4. Mean: 20. STD: 6. **c** Age distribution C1–C2. Mean: 32. STD: 6

17.5.2.2 Gender

The courses were followed by a majority of the male population. Trials C1 and C2 had all male participants, while C3 and C4 had very few female (3%) participants as shown in Fig. 17.4a. This is because there are few women among semiskilled farmers, while in a typical agricultural college setting in India, the proportion of female students is below 30% (Government of India, 2014).

17.5.2.3 Learner Classification

While C1 and C2 courses were followed only farmers, C3 and C4 were taken mostly by College and University students. The consolidated classification of learners for all four (4) courses is as per Fig. 17.4b with 52% as University Students, 39% as College students and 9% as farmers.

17.5.2.4 Education and Mobile Literacy Classification

This section aims at demonstrating the extent to which education illiteracy affected the use of mobile phones, hence determining the success of our proposed system in dispensing courses over the phones to illiterate/semiliterate groups. While College and University students have been assumed to be literate and proficient in the use of mobile phones, a small survey on a farmer population of 58 was conducted to determine their literacy status. Fifteen percent were illiterate, while the rest studied up to middle school with one graduate student as shown in Fig. 17.4c.

Most of them considered themselves as average users (79%) as shown in Fig. 17.5a and claimed to possess a mobile phone since 6 years on average, minimum being 2 years and maximum 12 years. Few (12%) claimed to spend more than 1 h on call daily, while the rest (88%) was less than an hour as shown in Fig. 17.5b. Popular mobile features were music, game, alarm clock and camera (over 70%), while only 30% claimed to use Texting/SMS. This gives an insight on

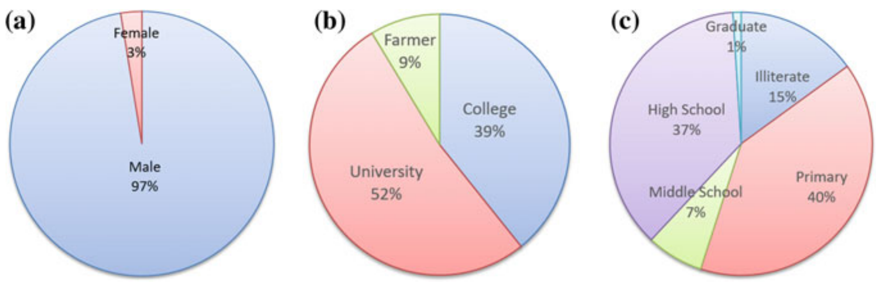

Fig. 17.4 **a** Gender classification. **b** Learner classification. **c** Literacy classification

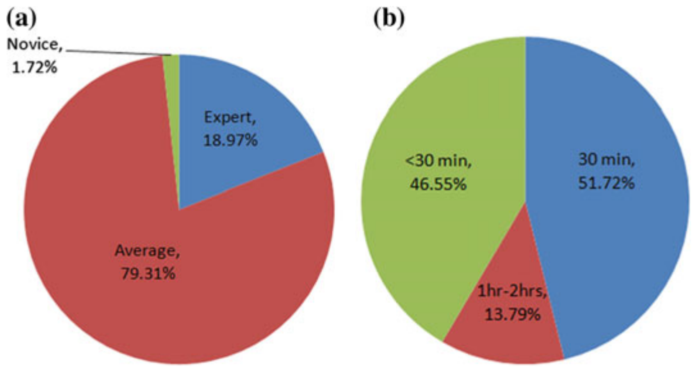

Fig. 17.5 **a** Mobile knowledge rating. **b** Daily mobile usage

Table 17.3 Survey questions

A. Knowledge of planting vegetables and flowers prior to course	B. Was the course easy to understand
C. Was the mobile interface easy to use	D. While on the phone, were you doing other things at the same time
E. Was the course useful	F. Would you recommend this training course to other colleagues
G. Would you do this training, if you were to use your own mobile credit	H. Are you willing to pay for this course if it is not free

their mobile literacy with the ability to use phone features. Hence, irrespective of their literacy status, all of them knew how to operate a phone, the least being making calls.

17.5.3 User Feedback

Our system allows the collection of feedback from the learners after each course. We got a total response of 311 students and 58 gardeners, respectively, from the four (4) courses conducted. Most of them (96%) had prior general knowledge of planting. Seventy-eight percent claimed that the audio course were of good quality. The interface was easy to use, and the course was easy to understand and useful. It was interesting to note that the majority (94%) claimed to be doing other things at the same time to listening to the audio course. Most of them would recommend such training to their friends and would not mind using their mobile credit to access the system. They were also willing to pay for such kind of course if it was not free. Tables 17.3 and 17.4 show the survey questions asked and their answers.

Table 17.4 Survey answers

	A%	B%	C%	D%	E%	F%	G%	H%
Very much	51.7	53.4	45.6	56.1	67.2	43.1	35.1	33.3
Somewhat	44.8	46.6	54.4	38.6	32.7	51.7	59.6	61.4
Not at all	3.5	0.0	0.0	5.2	0.0	1.7	1.7	0.0

17.5.4 Course Content

As per the survey conducted in Table 17.3, the users were satisfied with the courses offered and did not find any difficulty in following the audio lessons, held in their native language, Hindi. Hence no literacy barriers were noted. Seventy-eight percent of the respondents found the content good and relevant to them, while the rest suggested improvement. This is also confirmed in Sect. 17.5.8, whereby those who followed the course, passed the exam, depicting a high correlation between the course content and success rate. This concludes that our audio design assumptions for voice quality, audibility and duration were good. The lesson contents were of value to them since it was presented in a more formalized and professional way for growing vegetables. They even requested more courses on this medium and did not mind to pay for the air time and the course if these were charged.

17.5.5 Usability of System

All of them unanimously claimed that the system interface was very simple and easy to use without any difficulty as shown in Tables 17.3 and 17.4. This inferred that our navigation design was properly done and they had no problem in choosing a course from the menu options and in navigating through the different lessons. This can be correlated with the audio files accessed pattern (Sect. 17.5.7) and completion rate (Sect. 17.5.8) of our system. Same can be deduced for quiz/exam and survey module. Besides the system was accessible anywhere and anytime, at their convenience which made it a very suitable medium for learning. Indeed, these can be correlated to the usage statistics in Sect. 17.5.6, whereby the system was being accessed at their convenient time. Audio files were re-listened for better understanding, denoting the familiarity of the system to the users. It was interesting to note from their feedback that such medium allowed them to do other things in addition to listening to a course denoting the flexibility of such system. They found the system good as it is and no improvements were suggested.

17.5.6 Usage Statistics

We analyzed the audio files within intervals of 2 h to have an insight of the access pattern of the both farmers and students as shown in Fig. 17.6b. It was interesting to note that there was a good spread of the system usage and learning was done at the convenience of the learners. Audio access pattern for both set of learners followed the same trend except that the 10:00–14:00 h time intervals registered access peak for farmers, while for students it was 16:00–20:00. Learners engaged more actively in their learning during lunch breaks and after working/school hours.

17.5.7 Audio Files Access Pattern

Even though a course had 9 audio clips with each audio file having duration around 60 s, it was interesting to observe the learner behavior in accessing the files. For trials C3 and C4 it was observed that most of the learners did complete the 9 audio lessons at a go as shown in Fig. 17.7b with an average file access of 10.6 audio files. This was different for trials C1 and C2 whereby average audio files listened stood around 6 as shown in Fig. 17.7a and average files accessed were 19.8. This can be explained by the fact that students had a much better attention and retention span than gardeners. Students were younger, more literate than the gardeners. Those who did not complete all the audio lessons at a go, did it afterward at their convenience and pace. It is also to be pointed out that some audio lessons were listened more than once as denoted by the file access average. This was mostly more observed among farmers than students who re-listened to audio chapters. Besides, audio lessons were listened consecutively without skipping the chapters with a minimum of 2 and a maximum of 30 files listened at a go.

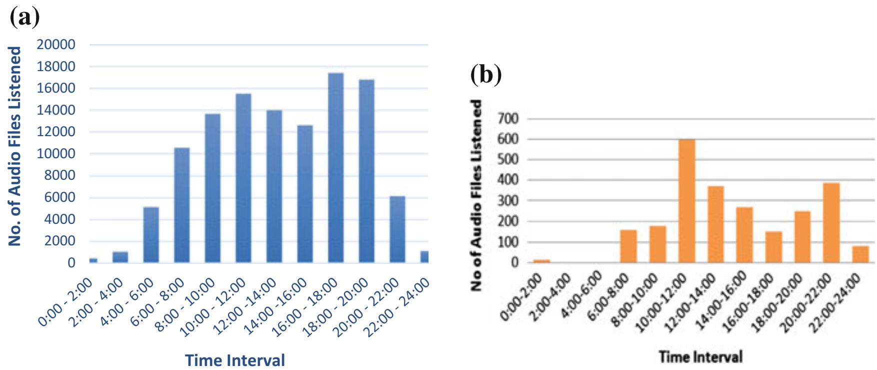

Fig. 17.6 **a** Audio access pattern—C3/C4 farmers. **b** Audio access pattern—C1/C2 farmers

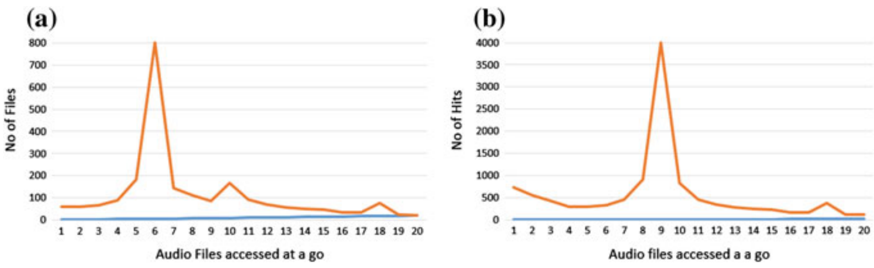

Fig. 17.7 **a** Audio files accessed at a go C1–C2. **b** Audio files accessed at a go C3–C4

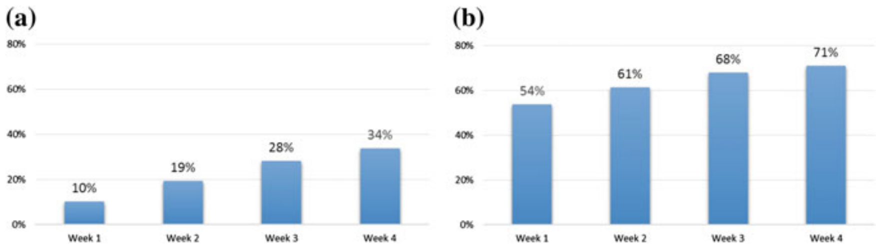

Fig. 17.8 **a** Student who completed all the audio lessons. **b** % of course completion by active students

17.5.8 Completion Rate and Active Participation

Completion rate is referred to as the percentage of enrolled students who successfully completed the course. Active participation refers to the percentage of enrolled students who regularly listened to the audio lessons. For trials C1 and C2, based on a small dataset (N = 122), the course successful completion rate was 55% with a 70% active participation. On the other hand, Courses C3 and C4 with a larger dataset (N = 1746), course successful completion rate dropped significantly to 28%, while active participation stood at 61%. Although, these figures are higher as compared to completion rates of online and MOOC courses which turns around 6% (Breslow et al., 2013; Jordan, 2014; Reich, 2014), it should be noted that our dataset was relatively small as compared to well-known MOOCs which have thousands of participants. To improve participation, we constantly monitored the learners, whereby they were sent reminders in case of low participation.

It is interesting to note that most of the participants did not listen to the complete set of lessons per course. Only 21% of learners completed all the lessons, while the others listened partly to the audio sets. Figure 17.8a shows only a small percentage of students who completed the whole series of audio lessons, while Fig. 17.8b shows the weekly completion rate of audio lessons by active students. This denotes that a majority of students deemed not important to follow all the lessons, while a significant proportion of active learners were not successful in completing the lessons through the assessment, hence correlating to participation and success rate of normal MOOCs.

17.5.9 Correlation Between Completion Rate and Test Results

At the end of each trials (C1–C4), we conducted an exam consisting of 10 random yes-no questions with the gardeners over the mobile to assess the effectiveness of our learning medium. The criteria to allow a gardener to take the online exam were that they should have listened to a minimum of 50% of the audio lessons. It was interesting to note that those who did not follow at least 40% of the lessons could not answer the test questions. Those who followed up to 60% of the lessons managed to attempt 50% of the questions, while regular participants who followed most of the courses did very well for the test scoring above 60% as shown in Fig. 17.9. This is confirmed by the strong Pearson correlation coefficient ($r = 0.8$, $N = 7455$) showing a positive relationship between listening to courses and exam results. This denotes the effectiveness of the learning medium whereby it was imperative to follow the course to pass. The course dispensed was of value added and allowed the participants to answer the exam questions successfully.

17.5.10 Constraints

A sample of 42 learners was interviewed on constraints they encountered while using the system and adoption of the recommendations of the course.

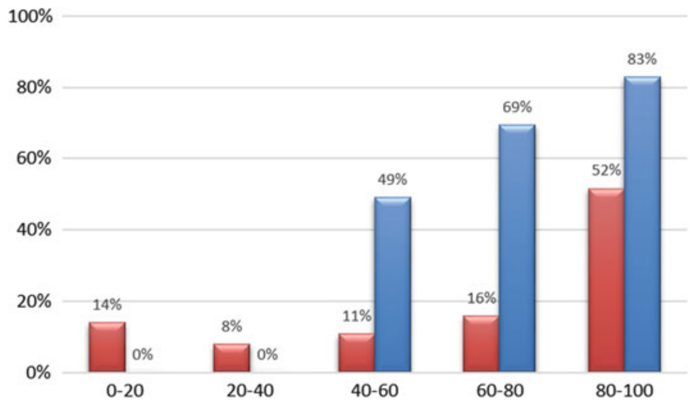

Fig. 17.9 Correlation between completion rate and exam result. Pearson correlation coefficient $r = 0.8$

Table 17.5 Constraints

Constraints	Gardeners		Students	
	Mean	Rank	Mean	Rank
Encountered technical issues while taking the lessons	2.2	1	1.9	1
Recommendations were no ready to use	1.88	2	1.78	2
Involves too many steps to fetch information	1.59	3	1.1	3

The constraints faced are as per Table 17.5. They encountered some technical issues especially with the IVR prompts for key presses. Many a times, the system was not accepting the key pressed. Besides, some perceived that it involved too many steps to get information (mean 1.59 and 1.1 for gardeners and students, respectively). Also, the courses dispensed made recommendations in standard terms without considering the agricultural specificity of some regions, hence making adoption of some of the prescribed practices irrelevant (Yadav, 2015).

17.5.11 Types of Learning Addressed

Based on Laaser (1986) work, MfM courses had clear didactic/teaching objectives, providing close interaction with the participants via navigation and quiz features for better stimuli. The intention was to maximize interest and appeal to the learners. Due to the literacy level of the learners, the MfM courses intervened at the first two levels in the cognitive domain of Bloom's Taxonomy (1956), namely *Knowledge* and *Comprehension* level. Gardeners were presented with agriculture learning materials which ultimately they can recall and understand so that they can put these into practice in their every day job. This was demonstrated by the exam success rate which shows that such medium of learning is effective in addressing relevant cognitive aspects of learning.

17.6 Conclusion

While the world is moving toward educating the masses through learning over latest communication technologies, smart phones and the internet, our research aims at keeping the communication medium simple over dumb phones. Mobile for Malis (MfM) mainly targets the poor and the unreachable by allowing them to access education through their simple mobile phones. Its aim is to reduce the digital divide by delivering Audio Learning contents on low-cost simple dumb phone technology, hence overcoming distance and literacy barriers. An Audio MOOC system has been implemented using IVR and open-source software *SoftSwitch*. We conducted four trials with 1900 students as a proof of concept. The results proved to be very conclusive in ways that related to (1) system architecture and implementation,

(2) bridging the digital, remoteness and literacy divides and finally (3) from an audio pedagogical point of view.

First, the results discussed showed that our framework is viable, robust and scalable and thereon can support this new and innovative method of learning using dumb phone technology. It exploits the existing voice calling telecom infrastructure and IVR (both DTMF and voice recognition) to access audio contents at low cost of operation without the need of expensive hardware. Airtime cost is the only cost of using such a system. Our experiments proved that it was possible to host an Audio Learning Management System on the framework. Besides, the successful implementation of our quiz module demonstrated that tests, quizzes, surveys and exams can effectively be carried out using the proposed framework, proving that it can be an ideal and full fledge learning platforms to deliver content but also to assess students. The proposed system, if exploited, can become a Voice MOOC for the "have-nots," an alternative to MOOCs which mostly target the "haves" via the internet.

Second, the proposed system proves to effectively bridge the digital, literacy and remoteness divide. Access to learning has long been hindered due to connectivity issues whether physical or digital (internet). Those who could afford and overcome such barrier empowered themselves through education. Learning is costly if we consider setting up schools, employing teachers, teacher to student ratio, traveling and variation in content quality and delivery. With our system, same quality content can be delivered to massive number of remote students anywhere and at anytime. This has been confirmed through our audio courses whereby users accessed learning content at their convenience. Possessing a simple mobile handset opens up to an infinite repository of Audio Learning materials via a mere phone call, same as the internet analogy. Onwards, remoteness and internet connectivity will no longer be an issue to access education. Literacy has been another issue while accessing educational content over the internet. One needs to know how to read and write besides being technology savvy. With our system, audio content is delivered in the native language hence overcoming the literacy issue. And this has been confirmed by the good results obtained from the assessment we conducted with the gardeners.

Finally from a pedagogical point of view, the experiments carried out in this research work explored a number of issues pertaining to Audio Learning. Contrary to traditional learning methods characterized by their multimodality and interactivity, Audio Learning through mobile is only via a single medium. Since there has been few prior works and literature on Audio Learning, we made a few assumptions in the creation of the Audio Learning materials as discussed in the design. This experiment somewhat confirmed that our audio lesson design was in the right direction. An audio lesson should be short and equate to the human attention span which we assumed to be around 60-s-based ideal video duration literature. However, this attribute should be investigated further since Audio Learning and video learning are not the same. Splitting a course into smaller lessons/chapters of smaller duration with navigation capabilities proved to be a good strategy in Audio Learning since we observed that the navigation features have been used extensively. This infers that such feature catered for individual pace of learning and preferences. It is to be noted that some audio lessons were viewed more than once, denoting that the repeat feature was used to re-listen to audio files hence promoting memorization and better understanding. Besides, quality content and delivery were also important factors in captivating attention of listeners. Concise contents recorded by an experienced voice artist were widely accepted and appreciated by the learners as confirmed by their feedback.

We proposed to assess whether an on-air, audio-only mode of expert-farmer interaction can lead to sustained engagement with farmers when it comes to provision of detailed information on science-based crop production practices. The results presented and discussed above show that sustainment of engagement with farmers is feasible. Results reported on active participation and completion rates (Sect. 17.5.8) clearly show that sustainment of engagement was achieved as proposed.

It can be concluded that this research has been highly beneficial and ground breaking in terms of opening access to education to the have-nots, eliminating barriers of language, culture, literacy and distance. If nurtured and promoted, it can indeed be a factor of change and help in bridging the digital divide. Yet this new learning medium is still at its infancy, and our research has opened up to some major research avenues which have to be probed into, namely (a) what is the ideal time length for an audio lesson; (b) what is human attention span for Audio Learning (c) is content preparation and content delivery same for an audio lesson as compared to a normal online course (d) best-fit pedagogical and technology acceptance model (e) learning behavior over such medium (f) how other cognitive levels from Bloom's taxonomy can be targeted by our Learning System. To address these research questions, we intend to carry out more experiments on larger number of learners to increase our dataset based on which we can confirm these hypotheses.

Acknowledgements We would like to thank our colleagues from the Media Lab at IIT Kanpur for their support and collaboration that made this project a success. They are: Prof. J.R. Yadav, Dr. Sharwan Kumar Shukla, Dr. Vinod Kumar, Mrs. Sughatha Chaturvedi, Mr. Krishna Kumar Dubay, Mrs. K.T. Revathy, Mr. Gaurav Shukla, Mr. Deepak Kumar, Mr. Prashant Gautam and Ms. Akanksha Rastogi. We would also like to acknowledge help received from Ms. Jennifer Lam (COL).

Sponsors

This research is sponsored by the Commonwealth of Learning (COL), Research-I Foundation and the Department of Computer Science and Engineering, IIT Kanpur.

Award

This research project won the eUttara: Manthan Award for Uttar Pradesh, India in the category of e-Agriculture and Environment.

http://www.euttara.org/voice-package-of-practices-and-mobile-for-malis-information-for-farmers-over-mobile431/

Glossary

ASR Automatic Speech Recognition (ASR) allows real-life speech interaction between humans and machine

DTMF Dual Tone Multi-Frequency (DTMF) is a signaling system allowing digits to be represented and recognized as tones over the phone lines

IVR Interactive Voice Response (IVR) allows human computer interaction over the phone either via voice or DTMF/mobile keys over the phone

LMS Learning Management System (LMS) is a software tools that allow the management of learners, courses and assessment

MOOC Massive Open Online Courses (MOOC) is an online course aimed at unlimited participant with open access contents

PBX Private Branch eXchange (PBX) is a telephony system within an organization allowing the routing calls for intercommunication to both internal and external parties

SOFTSWITCH A software switch (SoftSwitch) is software that allows the routing and management of calls over IP network and allows intercommunication with other networks such as landlines and cellular phones

VOIP Voice over IP(VoIP) is a standard for the delivery of voice and Multimedia content over the IP infrastructure

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Chapter 18
Student Learner Characteristics and Adoption of M-learning: Are We Effectively Supporting Students?

Alice Schmidt Hanbidge, Tony Tin and Nicole Sanderson

Abstract In this chapter, m-learning is identified as a social as well as a technological phenomenon. Several studies (Cheon et al. in Computers & Education 59:1054–1064, 2012; Navarro et al. in IEEE Revista Iberoamericana de Tecnologias del Aprendizaje 11(1):33–40, 2016; Wang et al. in Computers and Education 59(2):817–827, 2009) contend that numerous factors must be considered when examining the adoption of m-learning by students. Data collected from 309 post-secondary students at a Canadian university who participated in a Mobile Information Literacy (MIL) research study were analyzed to identify specific student adoption factors for m-learning. The student adoption factors that emerged from the data included personal innovativeness of students, ICT literacy, self-management of learning, previous computer experience, ICT anxiety, and confirmation and satisfaction. These factors substantiate the student adoption factors identified by Navarro et al. (IEEE Revista Iberoamericana de Tecnologias del Aprendizaje 11(1):33–40, 2016) and Wang et al. (Computers and Education 59 (2):817–827, (2009). Recent studies of m-learning (Abu-Al-Aisb & Love in The International Review of Research in Open and Distance Education 14(5):82–107, 2013; Ally and Prieto-Blázquez in Revista de Universidad y Socierdad del Conocimiento (RUSC) 11(1):142–155, 2014) suggest that student learners need to be supported in their adoption of m-learning. The findings of the MIL research study, as well as the academic literature, describe the characteristics needed for adopters of mobile learning and led the authors of this chapter to ask what

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_18

post-secondary institutions and instructors are doing to support students and whether it is effective. Included are practical tips, strategies, and implications for post-secondary educators using mobile technologies that enhance student learning.

Keywords M-learning · Higher education · Adoption factors
Learner support · Usability · Technology adoption

18.1 Introduction

18.1.1 Definition of Mobile Learning

M-learning involves the use of mobile devices to deliver electronic learning materials with built-in learning strategies to allow access to knowledge from anywhere and at any time. M-learning or "education on-the-go" utilizing mobile devices, such as mobile phones and tablets, expands the boundaries of anytime, anywhere learning and will play an important and exciting role in the future of learning in the curriculum (Saunders, 2012; Wu et al., 2012). It is important to recognize that mobile learning is not about the technology; rather it is about the learner who is mobile and at the center of the learning, and thus the technology allows the learner to learn in any context (Ally & Prieto-Blázquez, 2014; Sharples et al. 2005; Vavoula & Sharples, 2009). Essentially, m-learning could be defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices" (Crompton, 2013, p. 4). This paper provides a brief overview of the literature about m-learning, user adoption conditions, and a Canadian research study case example viewed through the lens of the student adoption factors. Finally, keeping best practices in mind, we recommended educator guidelines that facilitate uptake of m-learning.

18.1.2 Mobile Learning in Education

Advances in digital technologies offer educators opportunities to design authentic learning materials directly suited to students' learning needs (Monahan, McArdle, & Bertolotto, 2008). It has been suggested that mobile devices may be tomorrow's textbook as the learning tool of choice in the future (Abachi & Muhammad, 2014). M-learning is described as having the possibility of expanding and broadening the enrollment of students from different age groups in higher education (Lowenthal, 2010). Ally and Prieto-Blázquez (2014) contend that m-learning makes the notion that education only occurs during certain periods of time and in certain spaces irrelevant, as students now have access to formal and informal learning across time and space. He also suggests that communication between students, peers, professor, and professional in the workplace will also improve.

Situated, contextual m-learning driven by user interactions is moving learning into spaces leading to authentic, ubiquitous learning (Ally & Prieto-Blázquez, 2014). Al-Fahad (2009) studied perceptions of higher education students toward the effectiveness of mobile learning and established that mobile learning could improve retention among higher education students. Cheon, Sango, Crooks, and Song (2012) studied undergraduate students at a large, public research-intensive university located in the Southwest, USA, and contend that the usefulness of using mobile devices in courses highly influenced attitudes toward m-learning, and that the meaningful use of mobile devices in a course is a key means of persuading college students to utilize m-learning. They also suggest that higher education institutions should be aware of the importance of faculty members' role when initiating m-learning and assert the importance of training and support for such faculty members. Keengwe and Bhargava (2014) contend that m-learning can reach the different learning styles of learners and can make education available to anyone, anywhere, anytime and at an affordable cost across the globe.

Predicted trends in the development and implementation of technology for higher education in the next 10–20 years are in the areas of mobile devices, immersive and virtual environments, Web 2.0 technology, and learning analytics (Johnson, Smith, Willis, Levine, & Haywood, 2011). However, the adoption of web-based applications in higher education still encounters challenges (Macharia and Pelser, 2014). It is therefore crucial to understand what motivates or discourages learners and educators to use them. As Terras and Ramsay (2012, p. 827) have pointed out, "the individual can shape and be shaped by the context", therefore, ignoring the role of the social context and individuals is likely deficient. Karimi (2016) asserts that m-learning ought to examine the relationship between learners and their learning contexts. Keengwe and Bhargava (2014) contend that from a sociological perspective, sociocultural and gender factors need to be considered when designing and implementing as there are differences in the perceptions, attitudes, values, and assumptions held by individuals and groups of individuals toward the use of mobile technologies. They also suggest that a "one size fits all" or "one technology for all contexts" does not practically work in education.

To help guide our theoretical understanding of m-learning, our research team turned to the Framework for the Rational Analysis of Mobile Education (FRAME) model (Koole, 2009; Koole & Ally, 2006) in initial course development discussions of the information literacy project. Koole's FRAME model highlighted pedagogical considerations for us that intersected learning abilities and social interactions for mobile learning. In addition, the model identified significant factors of the design and implementation process that intersected the social aspects of learning, the educational platform, the pedagogy of developing content materials, and device usability aspects. Koole's model fits well with our pedagogical understanding of the adult learner and curriculum development, taking into consideration social and cultural views of learning and technical aspects.

Overall academic research on the educational use of mobile devices is a recent trend and includes limited case studies of different implementations (DaCosta, 2010; Kim & Shumaker, 2015; Hanbidge, Sanderson, & Tin, 2015); however, it is anticipated that m-learning will grow quickly in the next few years. Hence, the authors of this chapter feel that it is essential to examine students' adoption of m-learning and to learn from the benefits and challenges of such learning.

18.2 Adoption Models of Technology

Various adoption models of technology have been used by researchers to examine students' adoption of m-learning in higher education settings such as technological acceptance model (TAM), unified theory of acceptance and use of technology (UTAT), and taxonomy of adoption. Rogers Everett (2003) defines "adoption" as the process by which a person changes from the first consciousness of an innovation, to forming an attitude toward it and then deciding to adopt it or reject it. Peinado and Bolivar (2008) define "technological adoption" as the concept that expresses the acceptance and inclusion of new information and communication technologies to daily life.

TAM designed by Davis (1986, 1989) proposed that the intention to adopt an information system is based on the perceived ease of use and perceived usefulness. UTAT created by Venkatesh, Morris, Davis, & Davis (2003) considers the continuous use, not only the adoption phase of the technology, and outlines four aspects that are relevant to the users' acceptance and behaviors. These aspects include performance expectancy, effort expectancy, social influence, and facilitating condition. Building on TAM and UTAT, Wang, Wu, and Wang (2009) outline an additional five adoption factors including performance expectancy, effort expectancy, social influence, perceived playfulness, and self-management of learning.

Navarro, Molina, and Redondo (2016) created a taxonomy list of factors that originated from theories such as TAM and UTAUT, which they feel help to improve the possibilities of m-learning adoption. They divide these factors into three broad categories: pedagogical, technological, and students' aspects. In this chapter, the "student aspects" category that refer to students' characteristics in an m-learning context was used to analyze the students' experiences in the Information Literacy Mobile Micro-Course research study in a Canadian university outlined below. The six factors in this category taken from Navarro et al. (2016) and Wang et al. (2009) include self-management of learning, previous experience, personal innovativeness of students, information and communications technology (ICT) literacy, ICT anxiety, and confirmation and satisfaction. Adoption of mobile learning will be examined through the lens of the seven student factors in the next section.

18.3 Information Literacy Mobile Micro-Course

18.3.1 Research Study Methodology

Our study explored the adoption of mobile technology through a formal educational setting to understand user's adoption behavior. A collaboration between faculty and the library resulted in the development and implementation of thirteen mobile lessons application (http://bit.ly/milmodules) in the Mobile Information Literacy (MIL) course that was designed to demonstrate how to locate, evaluate, and use information effectively. Rationale for the development of the project emerged from the observation that students were frequently using academic material both on- and off-campus and there is a need to provide easily accessible tools to assist students to retrieve the needed information. Assumptions that ground this project are that osmosis does not work for development of such skills, but rather pedagogical collaborations between faculty and librarians can be encouraged and established to assist in incorporating information literacy into educational curriculums. Helping student learners improve their information literacy skills using mobile devices shaped the study's research framework. Project objectives were to develop best practices and strategies from a user perspective, for delivering and accessing information while enhancing information literacy skills through mobile technology.

There is an apparent gap between the information literacy skills that faculty want their students to have and those that they actively support and develop. It is a gap that faculty and librarians from various faculties are best placed to fill as collaborators and bridge builders. To fill the gap, we advocate for students' learning of these skills, and we contend that this innovative mini course project will enhance the future design of mobile digital learning to support and enhance m-learning pedagogy in higher education. Grafstein (2002) argues that librarians bring unique expertise to course development and that teaching of information literacy should be delivered throughout an institution rather than solely through the library. Middle States Commission on Higher Education (MSCHE, 2003), an educational organization in the USA, provides clear guidelines to integrate information literacy throughout the curriculum to develop progressive information literacy skills in university students. This project began this collaborative, bridge-building process.

Further testing of learning analytics and the MIL course aims to deepen student learning while enhancing information literacy skills. University undergraduate students participated in a non-experimental research design study to understand the frequency of access to the information literacy course and the change in fluency of information literacy skills using mobile devices. Study participants completed thirteen online mobile information literacy lessons, pre- and posttests and a questionnaire. In Fig. 18.1, several screenshots identify the MIL course homepage and types of quiz questions that study participants answered (Fig. 18.1. MIL home page and quiz examples) Collaborative efforts between faculty and library staff will enhance the opportunity to support anytime, anywhere m-learning.

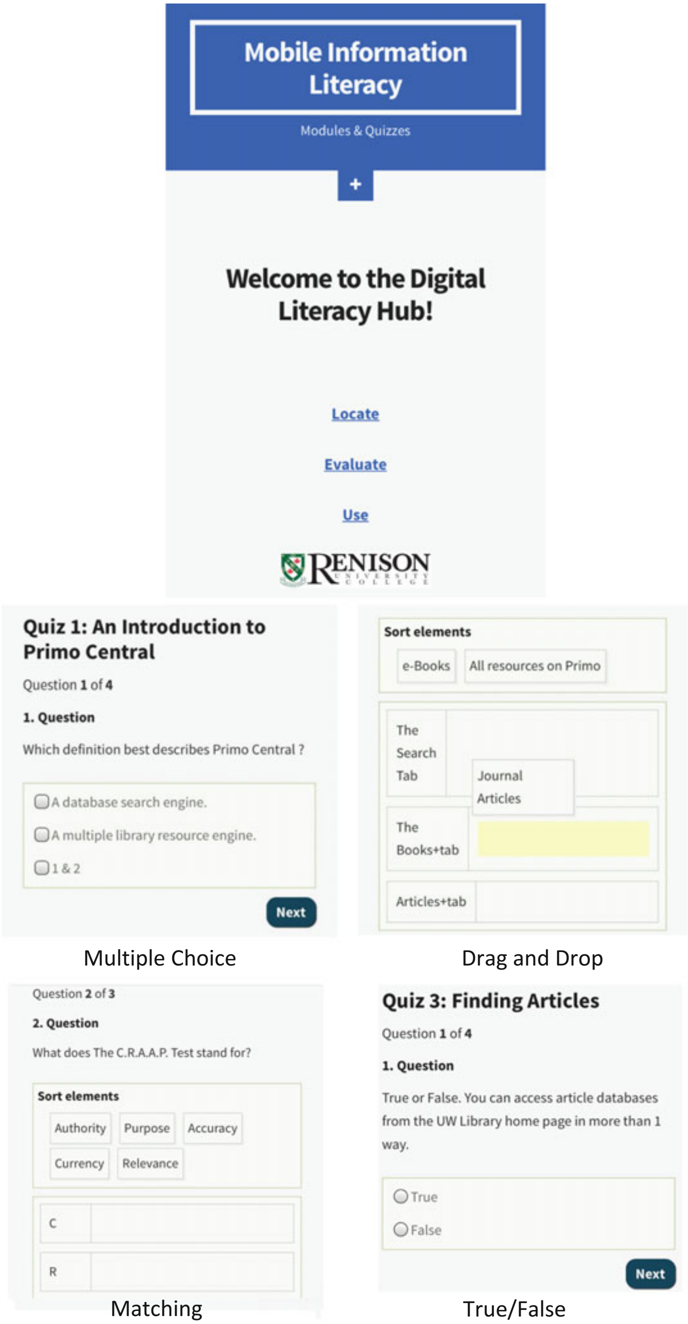

Fig. 18.1 MIL home page and quiz examples

Our study was a mixed-method (quantitative and qualitative) approach, including both pre- and post-digital literacy tests and student questionnaires. This project and the survey instruments were approved by the Research Ethics Board at the University of Waterloo, Ontario, Canada. All study participants received a 1.5% bonus mark in their courses at the end of the completion of the study. Three hundred and nine ($N = 309$) undergraduate arts and humanities students in twenty-two classes in psychology, social work, English, East Asian, or social development studies at the University of Waterloo participated in the research study to determine the effectiveness of mobile technology in enhancing students' information literacy skills and learning experiences. Ninety-two percent (91.9%) or two hundred eighty-four (284) study participants were female, while nine percent (9.4%) were male. The majority of participants (83.5%) were students between ages 18 and 25, while 43 (14.2%) were between the ages 26 and 49. The remainder were either 17 years or over 50 years of age (see Fig. 18.2. Age and Gender). The comparison group ($N = 32$) demographics closely matched with other participant groups, and they completed the pre- and post-digital literacy test, but they did not complete the thirteen online literacy lessons. Our research hypothesis was that information literacy skills will increase relative to the use of the information literacy m-learning.

As both quantitative and qualitative data were collected, statistical analysis of the completed surveys and questionnaires was done using Survey Monkey's Analyze tool, excel spreadsheets, and a systematic review of the raw data completed through Wordpress (https://wordpress.org/). Open-ended questions were coded, and the text was thematically analyzed. Usage of the MIL course was explored through Google Analytics. One hundred and ninety-two students reported frequently accessing Google (62.1%) rather than other online resources to search for academic information and resources on their mobile phones (see Fig. 18.3. User online search preferences). Sixteen students (5.2%) disclosed not accessing any research resources online.

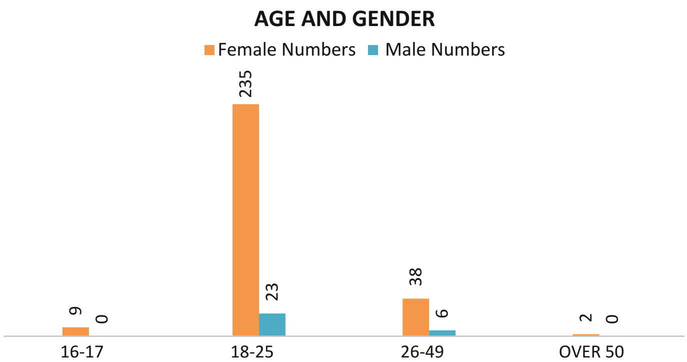

Fig. 18.2 Age and gender

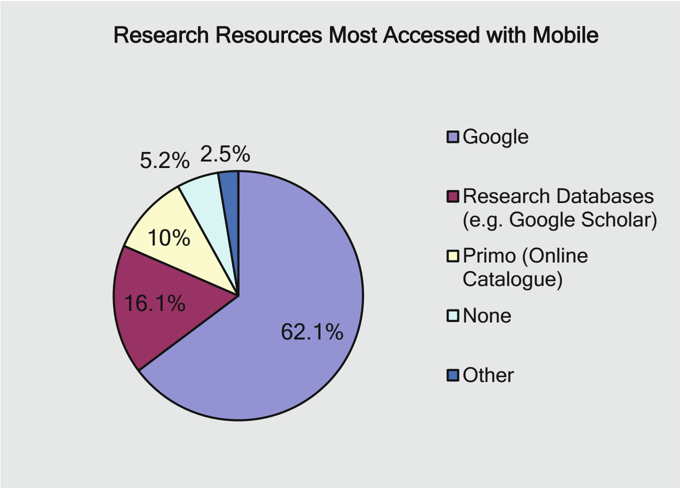

Fig. 18.3 User online search preferences

We asked learners to indicate their personal preferences for specific lessons in the MIL course based on knowledge and skills they wished to develop. Literacy lessons students found most helpful are listed in the table (see Table 18.1. Lesson use). From our data analysis, it was determined the most sought after online lesson for students was an orientation to *RefWorks* (Lesson 9), a web-based citation and bibliography tool. The second most popular lesson was *The Basics: How to Search* (Lesson 2), a resource on the search process and next was Finding Articles (Lesson 3), which helps narrow the search process.

Data analysis for program improvement, MIL lesson and quiz enhancement and expansion, and basic evaluation research in the emerging field of information literacy academic instruction were a focus for our research study. Initial exploratory, descriptive and statistical findings from our Phase 1 pilot project (Hanbidge et al., 2015) aimed to deepen student learning while enhancing information literacy skills.

This chapter explores the qualitative aspect of the data analysis, focused on the post-study user experience questionnaire that consisted of scaled ratings and open-ended questions. Questions asked of users targeted the seven adoption factors as identified by Navarro et al. (2016) and Wang et al. (2009). The research team systematically color-coded the study questionnaire qualitative comments and sorted them into themes that corresponded with the seven m-learning adoption themes. These six factors, distilled from the literature, represent key factors relevant to student adoption of mobile learning (see Table 18.2). Student comments describing user's adoption experiences in this research study emerged from the data and substantiated the adoption factors from the academic literature. Study participants shared constructive feedback and suggestions to enhance mobile learning adoption.

Table 18.1 Lesson use

Which literacy lessons did you find most helpful?		
Answer options	Response percent (%)	Response count
Locate: Lesson 1: An Introduction to Primo Central	17.8	47
Locate: Lesson 2: The Basics: How to Search	42.2	111 (2)
Locate: Lesson 3: Finding Articles	39.1	103 (3)
Locate: Lesson 4: Finding Peer Reviewed Journals	32.7	86
Evaluate: Lesson 5: Evaluating Information Sources	22.8	60
Evaluate: Lesson 6: Peer Review Process	17.9	47
Evaluate: Lesson 7: Popular Vs. Scholarly Resources	25.8	68
Use: Lesson 8: Using the Web for Resources	16.0	42
Use: Lesson 9: RefWorks	42.5	112 (1)
Use: Lesson 10: When to Cite Your Articles	30.0	71
Use: Lesson 11: Types of Written Articles	15.2	40
Use: Lesson 12: How to Approach Assignments	30.0	79
Use: Lesson 13: What is a Paragraph?	9.5	25
All of the above	5.7	15
Answered question	263	
Skipped question	14	

Table 18.2 Adoption factors that benefit mobile learning

Student adoption aspects in m-learning Navarro et al. (2016) and Wang et al. (2009)	
Personal innovativeness of students	Student's willingness to try out any new information technology
ICT literacy	Measure of a student's ability to use digital technology, communication tools, and/or networks
Self-management of learning	Extent to which a student feels they are self-disciplined and can engage in autonomous learning
Previous experience	Number of years a user has with computers in general
ICT anxiety	Fear of computers when using one, or fearing the possibility of using a computer
Confirmation and satisfaction	Confirmation is student's perception of the congruence between expectation of e-learning systems and its actual performance.
	Satisfaction is an object or circumstance that satisfies an attitude regarding the learner's desire or specific situation

18.3.2 Analysis of the Data Using Student Adoption Factors

Eager adopters of the MIL course or individuals who demonstrated high "Personal Innovativeness" to m-learning and those who had higher levels of "Previous Experience" with computers and technology appeared to be those students who were most comfortable using new technology. As m-learning is often self-driven, personal learner characteristics may function as facilitators or barriers to use this type of learning environment (Liu et al. 2010). Students frequently provided comments such as *I found MIL to be very accessible to do. I thought it was enjoyable to be involved in. Learning by mobile is useful as it is going to increase in the future. I am already familiar with mobile technology … Online learning is the new future* [Student 126]. Many students expect to have technology tools with them to learn on a daily basis—*I like being able to learn while I'm out/away from the computer* [Student 248]. For students studying the arts, providing brief lessons about information literacy supported their learning—*Very informative and useful, especially for arts students expected to write a number of essays throughout the term. Overall very informative! I think it's important to educate students on these platforms prior to writing paper* [Student 24].

Other comments demonstrated the "personal innovativeness of students" having an open attitude to experimenting with new technology captures this aspect of mobile adoption—*Neat Idea. Good to see innovative ideas and different ways to access learning lessons* [Student 44]. Today's learners are adept at incorporating technology in their daily lives an educational settings: *Using mobile technology to learn information literacy skills is convenient, easy and appropriate for millennial students who are reliant on the internet* [Student 284].

"ICT anxiety" experienced when users perceive challenges with technology was seen to be negative influential factor in the study and appeared to create anxiety for some students—*To me technology isn't mobile. A book is much easier to read and navigate through when on bus, plane, or waiting for a bus (even people who use cell phones wouldn't want to take their gloves off in the cold). This wouldn't be a problem with a book!* [Student 72] and *Tech is not my thing* [Student 88]. Interestingly, this student perceives the technology to be the mobile aspect of m-learning, not the learner themselves. This would support Cheon et al. (2012) assertion of the importance of empowering students with confidence to adopt m-learning in higher education.

"Self-management of learning" addresses the extent that users feel they are able to be self-disciplined in autonomous learning. The data suggest that learners focused on the task may prefer mobile learning rather than those who are easily distracted. One student indicated—*I got distracted sometimes with calls and messages* [Student 63], while another commented, they *needed to be in a very quiet environment to really focus on what it was trying to teach* [Student 189]. Other students indicated that nugget-sized learning bites were a good match for mobile learning—*For short quizzes and basic lessons like the ones in the experiment, mobile technology can be helpful* [Student 301].

"Previous experience" suggests that access to technology and Wi-Fi proved to be options that learners frequently addressed about their adoption experiences—*Some people do not have data!!! Thus if no wifi is available it doesn't help them* [Student 37]. *Phones are awful for quality learning if the text is miniscule. I was very frustrated and did not enjoy the experience. What about older students?* [Student 59]. Alternatively, mobile technology may be viewed as one of the learning tools available they have access to—*I've had a phone for most of my life and expect to have it with me for everything* [Student 168].

The importance of "confirmation and satisfaction" factors had an impact on student learning, especially when learner's experiences are satisfying. *I like that it is easy to use, and can be used anywhere* [Student 18]. For this student, learning at home provided needed convenience. *It was nice to learn this information whenever I wanted and where ever I choose (i.e. laying in bed, waiting in line)* [Student 36]. Users identified the value of learning the content in an educational setting. *The information was very useful and no one had taught me most of it before attending here* [Student 118], and *I believe this has enhanced my research skills and it should done with every first student. These are important skills to have in university* [Student 293].

"ICT literacy" refers to user's ability to use technology. With advanced literacy technology abilities, our findings suggest that students can easily transition to learning with mobile tools. *As a student, I cannot walk with my laptop everywhere as it takes up a lot of space within my backpack, but my cell phone is always on me so I have transported everything from my laptop to my phone to work on* [Student 118]. Adaptability to using technology often means the tool needs to suit the purpose when using it—*Portability and accessibility = awesome!* [Student 306].

Additional factors emerged from this analysis indicating the importance users place on the technological aspects of the tool, such as their mobile devices and the course platform. Kukulska-Hulme (2007) described the value of technology that is visible and situated to the context of learning, such as screen size, size of text, and buttons on the phone. Feedback from users confirmed the importance of considering question types and maneuvering on a mobile device. *The "drag and drop" questions can be difficult to manoeuvre on a small screen* [Student 155]. Viewing device screen sizes proved to be an important feature to lesson users. *Personally, I find mobile devices to be difficult to use to access information and I prefer using a device with a large screen when doing my research* [Student 288], and it may deter users from using their phones. *I can't focus reading on a tiny screen which is why I used my laptop* [Student 8].

Another factor from the findings included the design consideration for learning materials for delivery on mobile devices. Students were quick to provide suggestions to enhance their learning experience and to indicate their personal design preferences. *Add a screen/button that shows you completed a lesson, and perhaps track how many lessons completed as a list* [Student 222]. *Reading long articles—NOT on phone, audio-visual aspects are good on phone* [Student 269]. *The videos that showed how to use the databases step-by-step were very helpful* [Student 139].

Karimi (2016) outlined the importance of playfulness in m-learning adoption and suggests it is equated with perceived degree of focused attention, curiosity, and enjoyment during interaction with m-learning environments, e.g., gaming. During recruitment for the study, students were curious to participate in a study where they could practice learning academic material with their mobile devices. *I really enjoyed the experience; it was a fun and new way to learn* [Student 308]. Gamification of lessons and concepts can be one way to enhance learner's experiences. Study participant's reports on the benefits and challenges of using mobile technology in higher education corresponded to and substantiated the concepts identified in the literature.

18.3.3 Implications for Educators

As our study focused on the introduction of mobile learning for a specific purpose of information literacy knowledge and skill development in a higher education context, our data position us to identify some trends in education that substantiate literature findings indicating adoption factors. As outlined in both the Koole's (2009) FRAME model of mobile learning and the Navarro et al.'s (2016) m-learning adoption studies, the student social context has a critical role to play in adoption of learning in the mobile environment.

Our study confirms the usability of mobile learning in educational settings with positive outcomes when accessibility to the necessary tools is given. Study participants described multiple positive experiences about their introduction to information literacy that included: access to a new opportunity to learn about an educational topic; an appreciation for the visual aspects of the mobile learning course; their support for mobile phones as superb tools for efficiency; accessibility of the lessons (in hand when on-the-go); connectivity to the internet (learners appreciated Wi-Fi access); and the speed with which the brief lessons and quizzes could be completed. Student participants reinforced the value of simple and straightforward mobile lessons and quizzes in easily digestible forms; *Lessons were very convenient and easy to understand* [Student 110]. Some students suggested that educators integrate course materials with technology; *I learn better when my learning is applied to a certain project, for example, learning to research using real keywords, for actual papers rather than just learning how to navigate the system in general* [Student 144]. As learners vary in their learning styles with unique preferences for particular learning strategies, it becomes essential for educators to understand the diverse needs of learners with differing abilities (Wang et al., 2009).

While mobile technology has great adoption potential for on-the-go learning, some specific considerations may encourage better user adoption of viewing mobile technology as learning tools. Study participants shared some concerns with the capability of mobile devices, including: eyestrain caused by small mobile screens and difficulty inputting data on small keyboards, or that the phone lacked a keyboard altogether. Phone screens are often small; however, smart phones with larger screen have greater potential for visual ability to view mobile learning lessons. One common barrier to m-learning as voiced by participants was the cost of accessing Internet data. Greater availability of Wi-Fi capable phones and no-cost Wi-Fi accessible spaces across school campuses and in shared community spaces, such as shopping malls, restaurants, and workspaces, should help address the issue of wireless connectivity access and decrease the cost of access. Learners suggested that uptake of new technology could be better supported with tools that have visually appealing multimedia activities with engaging interactive activities. Enhancing these features could increase the usability of mobile devices in learning environments.

Cheon et al. (2012) provided design suggestions for educators when developing new m-learning systems. Technical considerations and ease of use should be at the forefront in determining the delivery. For example, user interface and content designs must take into account the smaller screen size and the slower network speed. Given platform and screen choices, technology needs to develop intuitive and comparable interfaces for different mobile devices. Giving students the confidence to adopt m-learning must include the meaningful use of mobile devices related to course work. When faculty incorporates mobile activities that students are already familiar with, such as texting, voice recording, taking pictures, or shooting videos, educational goals can be accomplished (Shih & Mills, 2007).

Similarly, educational institutions should be aware of not only the student user implications, but the necessity of considering the role of faculty members when initiating m-learning initiatives. Robyler, McDaniel, Webb, Herman, and Witty (2010) found that college students were more likely to use Facebook or similar technologies, while faculty members were more likely to use more traditional tech methods, such as email. Institutional support is called for in terms of technical support and professional development and provision of m-learning for faculty members (Gülbahar, Ilkhan, Kilis, & Arslan, 2013; Schaffhauser, 2016). Therefore, the integration of mobile learning in instructional settings as an integrated learning tool is an achievable goal, taking into consideration the factors that enhance and inhibit adoption of m-learning. Effectively maximizing the use of technology fully into the curriculum requires integration of the learner characteristics, use of the technology to deliver a sound experience, sound pedagogical curriculum content, and instructional design that integrates these aspects. Key adoption considerations, reinforced by this study, to maximize learning opportunities in education include:

- Inspiring learner confidence, providing institutional technological support and guidance for individual students at various levels of mobile technology adoption levels, from first-time users to those with open attitudes of exploring new technologies
- Ensuring mobile learning activities are pedagogically sound and brief, focused, manageable for users
- Supporting institutional open internet access facilitating learning activities less constrained or those beyond the formal in-house learning management systems
- Providing unique and relevant individualized learning opportunities for students accessible through their current mobile technology.
- Considering a variety of technologies and making learning objects available through multiple formats, including cell, tablets, and laptops.

Students have a greater likelihood of adopting mobile technology as a part of their educational experience when consistently weaving these factors into their learning experience.

18.4 Conclusion

To ensure that mobile learning becomes an integral and valued part of educational experiences that enhance just-in-time learning, it is important to consider the role of context when developing meaningful adoption factors congruent with maximizing learning potential. In this chapter, we noted multiple benefits to adopting m-learning in educational settings. Key adoption factors include personal innovativeness of students, ICT literacy, self-management of learning, previous computer experience, ICT anxiety, and confirmation and satisfaction. We examined the social context of the learner through a Canadian case example reviewed through the lens of multiple adoption factors, while addressing challenges when introducing m-learning.

Study findings are congruent with those emerging from the educational literature. With the guided process of learning, students can enhance their information literacy knowledge and skills in meaningful ways. Consequently, we suggest that any new applications with educational mobile technologies correspond with the key learner adoption criteria outlined herein. As mobile technology improves and the social context of the learner changes, it is critical for educators to make use of the best practices available when integrating emerging mobile technologies in their educational settings.

Acknowledgements The authors wish to acknowledge funding support for this research study from the University of Waterloo Learning Innovation and Teaching Enhancement (LITE) grant.

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Chapter 19
Exploring Functions and Tenable Structures for Mobile Use as Support for School Tasks

Tiina Leino Lindell and Stefan Hrastinski

Abstract The objective of this chapter is to explore the function that students' mobile phone use can have, and how the use of mobile phones could be structured in a tenable way, related to school tasks. Hence, we have defined and examined the following research questions: (1) What functions related to school tasks do students and teachers express that mobile phone use can have? (2) How do they express that mobile phone use needs to be structured in school tasks? To explore these questions, we have adopted an activity theoretical perspective and used qualitative methods based on interviews. The results show that the use of mobile phones can offer both supporting functions and functions with considerable tensions related to school tasks. The expressed supportive functions have been categorized as supporting memory, communication, and understanding. Meanwhile, mobile use can be critical because of ethical issues, limited capacity, distraction risks, and cost for students. All teachers and students have agreed that mobile phone use at school must be structured to be used in supportive ways related to school assignments. However, they have expressed different strategies and disagreements about how rules could be applied in school practice.

Keywords Activity theory · Computer-aided design (CAD)
Learning management system (LMS)

19.1 Introduction

There is nothing new in that mobile phones are very popular among young people. In their spare time, their mobile use can assume meaningful functions for them (Pachler, Bachmair, & Cook, 2010). At the same time, the opportunities to use their mobiles at school are usually limited, due to teachers' fear of distraction and e-harassment (Dykes & Knight, 2012; O'Bannon & Thomas, 2014; Pachler et al., 2010).

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_19

Although many have described the potential of using mobile devices for learning activities (e.g., Danaher, Moriarty, & Danaher, 2009; Kinuthia & Marshall, 2012; Milrad & Spikol, 2007; Repetto & Trentin, 2013), our knowledge about how they might be used to provide supportive functions in schools is still insufficient (e.g., Beland & Murphy, 2016; Kiger & Herro, 2015; Kuznekoff, Munz, & Titsworth, 2015). In order to increase our understanding, Kearney, Burden, and Rai (2015) have recommended that we need to investigate teachers' beliefs about how students' mobile use can be structured into educational practice. Further, Pachler et al. (2010) have suggested that schools may possibly build their mobile implementations around students' experiences of everyday mobile use. In other words, we need to improve our knowledge by asking both teachers and students about their use of mobile phones. Then, the question to answer is how mobile use can contribute to supportive functions related to school tasks. Moreover, we need to know what functions with tensions the use may take, because, to advance a tenable mobile use in the future, we also need to highlight its critical points (Nouri & Cerratto-Pargman, 2015; Waycott, Jones, & Scanlon, 2005). Additionally, we need to know how they think mobile use needs to be structured in their educational setting. Similarly, Ally and Prieto-Blázquez (2014) have pointed out knowledge gaps in the field. They state that, even if mobile technology is widespread, we do not have enough understanding about how learning situations might be structured related to students' cultures, attitudes, and local contexts.

The objective of this chapter is to explore the function that students' mobile phone use can have, and how the use could be structured in a tenable way, related to school tasks. We have focused on students and teachers' descriptions and take their culture and local school context into consideration. For these purposes, the following research questions are defined and will be examined:

(1) What functions related to school tasks do students and teachers express that mobile phone use can have?
(2) How do they express how mobile phone use needs to be structured in school tasks?

19.2 Mobile Functions and Desirable Structures in School

When reviewing relevant literature, we focused on studies that highlight the functions that students and teachers state that mobile devices can play in an educational context. Another focus has been to highlight texts that describe teachers and students' descriptions of how mobile use should be structured. We have structured the section into two main subsections. In the first, we describe research that emphasizes functions, and in the second, we pay attention to these structures. In each paragraph, we start with the teachers' and then continue with the students' descriptions.

19.2.1 Mobile Functions

Starting with the teachers, O'Bannon and Thomas (2015) have seen that teachers think that Internet access is the most helpful function for students. Calculators and calendars are other examples of mobile features that can also be described as useful. The biggest advantage with mobile phones is that students can develop digital fluency, which, among other things, enables an "anywhere" and "anytime" type of learning. With the help of mobile phones, students can make instructions more personalized. The most negative functions are cheating, class disruptions, online bullying, and access to inappropriate information on the Internet. They have also identified texting, gaming, tweeting, and access to inappropriate information on the Internet as the primary disruptions. They found that the more experience one has of using mobiles for teaching, the more positive one is toward the usefulness of mobile phones in schools. Similarly, Şad and Göktaş (2014) highlighted the function of mobile use. They examined how mobiles are perceived compared to computers and reached the conclusion that mobiles can provide helpful functions for student learning. This is because they give quick access to information. Their limited capacity compared to computers could, however, limit their uses in teaching.

Turning our attention to students, it is also possible to see examples of where a mobile phone can assume memory-supporting functions. According to Gikas and Grant (2013), video and sound can be used to make students remember an activity. By uploading the material so everyone has access to it, the material can also be used for class-wide discussions. The fact that mobile devices offer the possibility of constant communication is mentioned as a key to success in a learning context. This is because it enables students to be "fully productive." Another advantageous and convenient function of mobiles is that students can quickly access information, especially with access to the Internet. Among the disadvantages, the capacity of mobile devices is mentioned. The limited size of the keyboard can, for example, limit the ability of students to write. Another challenge is that mobile phones can play distractive roles. It is primarily the allure of social networks not used for teaching that can impact concentration negatively. Hopkins, Tate, Sylvester, and Johnstone (2016) describe that the reason why students bring mobiles to school is because they find that they can utilize many supporting functions. Mobiles can, for example, simplify learning and help them achieve better marks. The students also felt that mobiles are easy to use and that it is easy to complete tasks using them. Although the study did not intend to examine disadvantageous roles of mobile use, it emerged that the screen size, user interface, and keyboard are often felt to be limiting compared to tablets and laptops. Another disadvantage mentioned in this study is students' limited capacity to access the school's wireless network with their own devices, as well as concerns about e-security. Students are not unaware that there are challenges and obstacles for using mobiles in teaching. Sarrab, Alzahrani, Alwan, and Alfarra (2014) studied students not used to having mobiles in teaching. In the study, traditional teaching has been turned into mobile learning. In this case, 41 out of 56 students had used the Internet when searching for the meaning of words. At the same time, more than half also used the Internet for surfing and chatting on social networks. It also emerged that many thought the mobile devices were useful for note taking and for translating sentences. For the future use, students wished for access to a learning management system (LMS) and the possibility of using calculators. The double functions of the Internet can both support and distract from school work. This is also mentioned in a study by Chan, Walker, and Gleaves (2015). They mention that learning with the help of mobile applications and mobile Internet is better compared to learning from a teacher or a friend. The reason for this, they say, is that individuals possess finite knowledge, whereas knowledge on the Internet is boundless. At the same time, they stated that the Internet can have insufficient functions since not everything on there is reliable. When it comes to supporting functions, self-made photograph and video presentations that are shared on the Internet can be used to encourage discussions. The students describe how they chose to share the images in different forums, depending on the objective of the activity.

19.2.2 Desirable Structures

Kearney et al. (2015) focused on the structure of mobile use. They saw that both primary and upper secondary school teachers have found that teaching with mobile devices should be structured in small groups. The reason for this, they discuss, could be that they are in a physical face-to-face environment, rather than a virtual. They describe a connection between tasks that are carried out at school, as well as outside of it. For example, students who work outside of formal school locations are more likely to engage in online conversations. Teachers also tend to use more online communication in cases where the students own their mobile devices. Only 19% of the teachers in the study stated that they had a structure where students can carry out their tasks in a way that gives them full control over their time, pace, and location. At the same time, they have observed that increased teaching with mobile devices gives students more responsibility about when and how they perform their tasks with mobile devices. They also mentioned that the use of photographs taken with mobiles can assume memory-supporting functions for the students.

If we focus on students' perspective, Gikas and Grant (2013) stated that mobile learning should be structured in such a way as to allow students to have access to information wherever they are, on a device they are used to, carry everywhere, and consider as friendly as well as personal. Also in the study by Chan et al. (2015), the students described that pedagogical structures with mobile devices can be very personal because mobile learning offers students the ability to control how and when they learn. They can also individually decide on learning methods based on their experience. When considering the structuring of mobile devices in the classroom, some students in Sarrab et al.'s (2014) study thought that the use of mobiles should be limited, in order to make sure concentration is not disrupted during teaching. One suggestion for the limitation of mobile use is to only allow it under teachers' control. Contrary to the above-mentioned study, the results of Hopkins et al. (2016) showed that students are highly confident in structuring their use of mobiles while at school. They describe that the use of mobiles created a division of labor when the students increased their control over their learning and efficiency. Their study was conducted on students that have experience of bringing their own mobiles to school. At the same time, the study underscores that efficient teaching and learning structures that incorporate students' mobile devices are still a work in progress.

19.3 A Perspective Based on Activity Theory

In this chapter, we adopt an activity theory (AT) perspective (Engeström, 1987, 1999). By that we think mobile use happens in a context. In other words, the mobile use of individuals does not take place independently of the individual's surroundings. How mobile phones are used, and what role their use plays, is affected by the context. In the field of mobile learning, much has been written about AT, and the theory has also been adopted in order to develop future mobile activities (e.g., Sharples, Taylor, & Vavoula, 2005; Uden, 2006). As the name suggests, AT focuses on activities and actions. By means of the theory, we understand how actions can be shaped by objectives. People's objectives of mobile actions are essential for our understanding of the meaning that mobile use may have during school tasks. To exemplify, if a group of students chooses to photograph an event in order to remember it later, it is very likely that the photograph will assume a memory-supporting function. In other words, it is by studying peoples' objectives that we can understand which functions mobile actions can have. Mobile actions are not limited to a single objective, however. If a group of students has a task where they are supposed to develop a new product, this also affects their mobile use. It affects the objective for which they intend to use the mobile phone and which function this use may have with regard to the task. It also affects how they choose to structure their mobile use.

By means of this theory, we can think that a context consists of components as division of labor, rules, and a community. The division of labor describes how different individuals structure and divide work between them. For example, who should work together, and who does what? Should all the group members take photographs, or should someone act as the photographer while the others take notes? The division of labor also describes hierarchies between people. Do they have a hierarchy where the teacher decides when the students are allowed to use their mobile phones while at school? If the teacher controls the students' mobile use, this regulation may arise from norms concerning what is viewed as an appropriate use. These norms are made visible in the rules for mobile use. These rules are also governed by a cultural context; that is, the community that these people share. In a community outside of school, totally different rules for how young people may use their mobile phones might be dominant. Additionally, the division of labor may be different. These three components affect each other, together with the existing people, their objectives, and available mobile features.

Moreover, mobile use might have functions with tensions. If you want to develop mobile actions, you can look at the challenges that an activity presents by highlighting tensions. These tensions, or contradictions, are the key to what needs to be changed in order to ensure a more tenable future mobile use. One example of functions with contradictions is if everyone finds it distracting if the mobile phone is used for private calls during school assignments. Additionally, contradictions may appear between people. Perhaps teachers and students in the community have different ideas of when and how mobiles can be used. Then it could be fruitful to unpack this tension and develop a shared agreement about when and how students may use their mobiles.

Further, we can think of the local mobile activities as a part of a larger context. They are not isolated events, but part of a greater landscape. By studying local cultures, we can gather knowledge for the greater map. That way, we achieve an increased understanding of how mobile phones can be used in our society.

19.4 Method and Sampling

In this study, we interviewed two teachers and seven students. All have experience of a school task where students were to develop a product and use a computer to visualize products, using visualization software (CAD). In this process, it was also necessary to calculate constructions. The school tasks were undertaken at a school different from the regular one. The overarching theme of the interviews was to discuss how students and teachers think that mobile devices can be used and structured during the process. Teachers and students were interviewed in two separate focus groups. The students, in turn, were divided into two different focus groups, where group 1 consisted of three students and group 2 was made up of four students. At the beginning of the talks, everyone wrote down their own suggestions on notes. Then the suggestions were discussed in the groups (cf. Fern, 2001; Stewart, Shamdasani, & Rook, 2007). The interviews were recorded and transcribed.

19.5 Analysis

We analyzed the interviews by using AT. In order to explore what function mobile phone use might have in their school tasks, we initially analyzed the expressed objectives for the mobile actions. If teachers and/or students expressed objectives for mobile phone use as support in the task, we categorized these expressed objectives. Additionally, we highlighted which mobile features were pointed out for

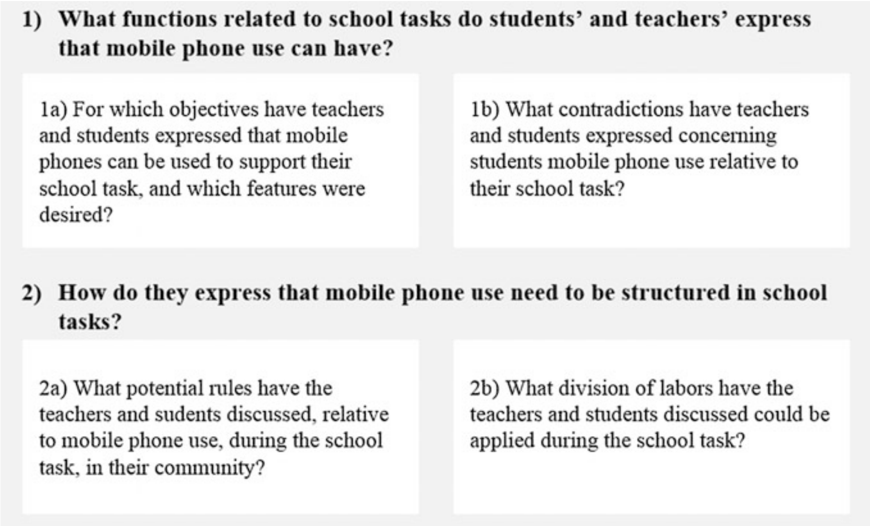

Fig. 19.1 Analysis

the desired use. Furthermore, we examined if mobile use might cause any tensions. This has been done by analyzing all expressed contradictions.

The next step was to explore the teachers and students' opinions about how mobile use needs to be structured during the task. Then, we investigated and discussed division of labor and rules in the community. Figure 19.1 shows the analysis schedule.

19.6 Findings

Students and teachers both stated that, in school, mobiles can have both supporting functions and functions with contradictions in relation to school tasks. The text has been structured according to these two categories and will conclude with a section describing how students and teachers want mobile use to be structured.

19.6.1 Supportive Functions

Mobile phones have the potential to support students' schoolwork. In this study, we can see that the ability to take photographs is a feature that everyone highlights as both useful and desirable. Several groups also point out that video recording and note taking also constitute helpful features. In addition, students have expressed that calculations, the search for information, calendars, translations, LMS, and presentation software can all assume supportive functions. When looking at Fig. 19.2, which gives an overview of the suggestions of supportive functions, it is evident that the student groups have offered many more suggestions than the teachers. In the overview, we can also see for what objective the mobile features can be used. Although all groups stated that mobile photography is useful, there are different ideas of what role that use can play. Based on the aggregate analysis, we were able to categorize three types of supportive mobile functions. We have sorted them under students' memory, communication, and understanding.

Support memory. Both student groups stated that the use of mobile phones can assume memory-supporting functions. According to them, it can support memory between time and places. The resources they describe as memory supporting are the use of video, photography, notes, and calendars. The students in group 1 stated that notes can be used at a later point to remember what teachers have said. Notes in a mobile calendar can be useful for remembering dates. In the other group, the students discussed how mobile photographs can make them remember what they have done. They also said that video can be used in similar ways, to get an idea of what a situation was like before. In contrast to the student groups, the teachers did not mention anything about the memory-supporting functions of mobile phones.

Support communication. All groups mentioned that mobile phones can be used to support student communication. Photographs can function as a support for students when they need to explain to others what they have done during activities. Teachers and students in group 2 found that video can be used in the same way. Students also said that it can be practical to communicate experiences with the help of video in case another student is absent. If this student has been ill, for example, they can still experience digitally what happened during the lessons. They mentioned that videos, photographs, and notes could be shared by students via a learning platform. With the help of presentation software, the experiences of the process could also be communicated to the rest of the class.

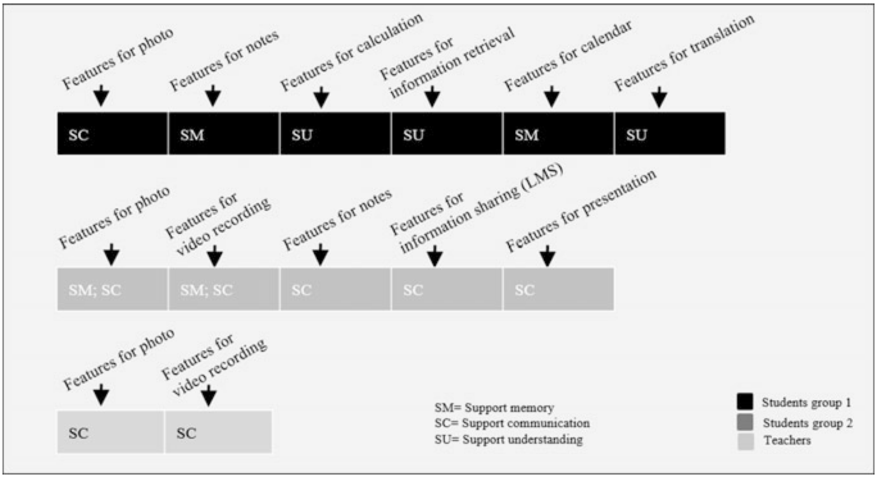

Fig. 19.2 Overview over supportive functions related to use of mobile features

Support understanding. In addition to communicative and memory-supporting functions, students also mentioned that mobile use can have a function where it increases their understanding. In student group 1, participants discussed how they can use mobiles for searching for information in order to increase their knowledge of an area where they, for instance, lack an adequate understanding of the content. They can learn more about an area they do not know anything about, or they can look up words they do not understand. In the same way, translation tools can be useful for translating difficult terms and expressions. The students expressed that the function can be useful when they are working on 3D visualizing a product in CAD. There are many instructions in English in the software that they find difficult to understand and that they need to have translated. They also mentioned that the calculator was useful during an exercise that involved making difficult calculations to solve tasks. In that way, mobiles' calculators can be helpful when the individual lacks the knowledge to perform certain calculations.

19.6.2 Functions with Contradictions

Except for supportive functions, mobile use risks assuming functions with contradictions. A potential challenge mentioned by all participants is the risk that mobile phones are used for objectives other than the school assignment. Several students stated that it can be distracting if mobile phones are used during lectures since that means there is a risk that the students are not paying attention.

Students also stated that limited mobile capacity may restrict any roles mobile use can have. Computers have software that can be used to visualize constructions in a way that cannot be done with mobile phones. When students have access to computers, they state that their need for mobile phones is not as urgent. Another tension with mobile phone use is that it is often tied to one individual. Teachers have mentioned that students sometimes use each other's mobile phones during group tasks and that this causes problems when someone in the group falls ill, because the other group members cannot access that information. A third limitation brought up by some students is that information on the Internet can be seen as less reliable compared to, for example, textbooks. However, these students also share that they find it easier to access information on the Internet through mobile phones when compared to searching for that same information through books. They argue that mobile phones are simply more accessible than books.

Some students mentioned that mobile use may cause some ethical challenges. There is a risk that students may be photographed or filmed against their will during the course of a task. Additionally, these photographs and videos can be shared on social media with people outside of school. Finally, students mentioned that they find it problematic covering the data charges when searching for information that is related to schoolwork. Table 19.1 summarizes possible challenges with mobile use in the activity, by the described functions with contradictions.

Table 19.1 Described functions with contradictions, and possible challenges

Challenges	Functions with contradictions
Distraction risk	• There is a risk that students will use their mobile phones for purposes other than schoolwork, which can distract them from completing their tasks
Limited capacity	• Compared to computers, mobile phones in some cases have a limited capacity
	• The fact that mobiles are tied to one owner can be limiting for group work
	• Information taken from the Internet with the help of mobile phones can be perceived as less reliable than, for example, that taken from textbooks
Ethical aspects	• Students can photograph or video record other students against their will. There is a risk that these videos and photographs will be shared on social media
Cost for students	• Students may need to cover data charges

19.6.3 Desirable Structures

During discussions with teachers and students, guidelines for mobile use were talked about. These guidelines pertain to how mobile use can be structured in order to encourage the use of supportive functions. In addition, discussions were held about how potential distractions can be alleviated with the help of structured mobile use. We start by giving an account of their suggestions for rules in the community, and then we go on to describe the desirable division of labor.

Rules in the community. All three focus groups expressed the opinion that there should be a rule that students should not use their mobiles for anything other than school tasks. All groups and individuals agreed on that point. They did, however, have different ideas for how these rules could be applied in practice. All groups discussed whether students should be allowed to keep their mobile phones close at hand, or whether the teachers should store them. In group 2, students discussed whether student access to mobile phones should be regulated according to their ability to comply with the rule to only use the phones for schoolwork. They did not agree on this point. One student opposed these restrictions and pointed out that students need access to their mobile phones. In the second student group, they also discussed how to keep mobiles in the community in order to comply with the rule. In that group, they expressed doubt as to whether storing the phones with a teacher would be the best solution. They reasoned that if students can fetch their mobile phones from the teacher when they need it to do schoolwork, students whose objectives are not work related can just as easily fetch their phone from the teacher. In this example, they expressed that storing phones with a teacher is no guarantee of compliance with the rule. The teacher group also expressed uncertainty with regard to the best solution for storing mobile phones. They also talked, without reaching a resolution, about whether students should have access to their mobile phones, or whether the teachers should hold them during class time.

Division of labor. The question of who should store mobile phones also raises concerns about the division of labor and the hierarchies among students and teachers. In order to create structures and comply with the rule to only use mobile phones for schoolwork, student group 1 felt that there should be a division of labor where students may hold onto their mobile phones, but teachers can remove them if the students are not using them for schoolwork. Students in group 2 did not agree with this point. Teachers expressed uncertainty as to their role. They felt that it could be an advantage if they stored mobile phones, since this would give them the opportunity to remind students to complete their tasks. Then, they can tell the students to fetch their phones to, for example, take pictures as part of their task. The students in group 2 also stated that it would be good if teachers took on the role of reminding them of when they may use their mobile phones. The reason for this, according to students, is that they want to know whether and when they are allowed to use their mobile phones.

Although the groups were not clear over the exact division of labor and how mobiles should be stored, all of them suggested that students should work in groups. They also agreed on group sizes, believing that two to four group members would be best. The teachers recommended group work because students would then definitely have access to mobile phones, as well as the opportunity to exchange ideas. When groups are smaller, there is a better chance that all students will actively participate. Students also mentioned that, in smaller groups, they can share their mobile phones. Another benefit of forming groups is that students can divide the work. They suggested no more than three members in a group so that all students would be able to participate in the work. They want a structure in which everyone can contribute, but where the students themselves decide on the division of labor between them.

19.7 Discussion and Conclusion

19.7.1 Supportive Functions

Like many other studies, this one shows that the use of mobile phones does have the potential to assume supportive functions with regard to students' schoolwork (Danaher et al., 2009; Kinuthia & Marshall, 2012; Milrad & Spikol, 2007; Repetto & Trentin, 2013). Students and teachers have shared for what objectives mobile phones can be used meaningfully. These studies offer new contributions to previous research, focusing on features that have supportive functions (O'Bannon & Thomas, 2015; Sarrab et al., 2014). By broadening horizons, more dimensions emerge that demonstrate the various ways these features can support students at school. Students have stated that mobile phones can be used to support their memory (e.g., Gikas & Grant, 2013; Kearney et al., 2015). Both students and teachers have pointed out the usefulness for communication (e.g., Gikas & Grant, 2013; Şad & Göktaş 2014). Further, students have explained that mobile use can facilitate their understanding (Sarrab et al., 2014).

At the same time, the research is not entirely unambiguous on these points. There is varied thinking about the usefulness of mobile devices for students. If we look at, for example, the use of features such as photograph and video recording, this study, like others, shows that it can help students to remember what they have done (Gikas & Grant, 2013; Kearney et al., 2015). This study also finds that these features can be beneficial for students when they intend to communicate their experiences with each other. Also, other studies show that these resources can also stimulate students' reflections, analyses, and discussions (Chan et al., 2015). An explanation for the diversity we see probably lies in the different objectives for and the contexts of the use of these features. Just as students can choose to share photographs on various forums, depending upon their aim (Chan et al., 2015), different educational objectives can affect which supporting functions photographs may have. Because of this, the landscape of mobile use is not a barren zone, but rather one that supports a rich flora of possible uses. Additionally, the context might explain the fact that students in this study see the possibility of using online resources such as LMS in order to communicate their experiences with each other. These students and their teachers are interacting within a context in which they need to move through different environments outside their traditional school setting. Students also have access to their own mobile phones, which in previous studies has been shown to be effective for online communication (Kearney et al., 2015).

19.7.2 Functions with Contradictions

The main concern with mobile use, mentioned by both teachers and students, is the risk that students will be distracted. That student can use their mobile phones for other objectives than that of schoolwork is one source of concern (Gikas & Grant, 2013; Sarrab et al., 2014). Moreover, students are also concerned that mobile use can distract their focus during lectures (O'Bannon & Thomas, 2015; Sarrab et al., 2014).

The fact that students own their phones poses another interesting tension, as, according to teachers, it can cause challenges during group work. If a student has shared working material on his or her mobile phone, this can cause problems if all students cannot access it. The challenge is interesting because it also questions the widespread statement that learning with mobile devices is equal to personal learning (Chan et al., 2015; Gikas & Grant, 2013; O'Bannon & Thomas, 2015). In this study, what we see is that school material that has been saved on personal phones can also be accessed by and affect more than one student. In this way, the use of mobile phones does not just support individual learning. Mobile phones can also be used as shared resources at school. The border between the personal and the public thereby becomes blurred in this type of learning context. The line between the personal and the public is also unclear when it comes to funding mobile use at school. When students have limited access to the school's wireless network, this can cause problems (cf. Hopkins et al., 2016). In this case, we see that students state that it can be problematic if they have to pay the data charges for obligatory school activities.

Apart from issues about the border between private and public, mobile devices also have some inherent limitations. In certain aspects, which students have described, mobiles have a limited capacity when compared with those of computers (Gikas & Grant, 2013; Hopkins et al., 2016; Şad & Göktaş, 2014). When students use computers to perform tasks, it at the same time reduces their need to use mobile phones.

Another factor that is restricting the use of mobile devices is the students' attitudes toward information acquired through the use of mobiles. Even though many students describe the constant access to information as advantageous (Gikas & Grant, 2013; Şad & Göktaş, 2014), they can perceive the mobile devices as less reliable than, for example, textbooks. Perhaps some of this attitude stems from the fact that it is possible to access less-appropriate or untrustworthy information via the Internet (cf. Chan et al. 2015; O'Bannon & Thomas, 2015). That this phenomenon exists shows that these types of attitudes toward mobile phones are a challenge in school contexts. Another challenge, pointed out by students, is the risk of e-harassment (Dykes & Knight, 2012; O'Bannon & Thomas, 2015; Pachler et al., 2010). This is a challenge that needs to be dealt with. By highlighting the challenges of mobile use, we can become aware of what we need to think about when developing future learning contexts that include them.

19.7.3 Desirable Structures

One way to counteract distractions and contribute to a positive use of mobiles is to develop pedagogical structures that support the main objective. Related to this school task, both students and teachers agree that it is advantageous to work with mobile devices in smaller groups (e.g., Kearney et al., 2015). They also agree that mobile phones should only be used for schoolwork. Where they differ is in their ideas about how mobile use can be structured to counteract use that is not school related. In the discussions, certain indecisiveness can be detected when it comes to the question of where mobiles should be stored—with students or with teachers. Both groups find advantages and disadvantages with the different scenarios. We can also see tensions between students who think phones should be stored with teachers and those who do not want to surrender their belongings. At the same time, it is worth noting that students also doubted whether storing phones with teachers really is a tenable solution to the potential problem. The fact that students and teachers have discussed this is interesting, since it counterbalances the advantages that other studies have shown in regards to mobiles, namely their constant access to information (Gikas & Grant, 2013; O'Bannon & Thomas, 2015). It can also limit the possibility of students exercising full control of what and how they learn (Chan et al., 2015).

Another suggestion that was debated by teachers and students was that mobile phones should be used under teachers' control (Sarrab et al., 2014). Contrary to Hopkins et al.'s (2016) study, in this context, students signaled that they do not have sufficient self-confidence to structure their own mobile use. Instead of taking full control over and responsibility for their learning process, they suggest that the teacher's control role is increased in different ways. In a way, this phenomenon is surprising. Although the students' descriptions of benefits and challenges are more extensive than the teachers', they have proposed this division of labor. One question is how students' non-educative use can be limited in a school context in such a way that they still maintain control over and responsibility for their learning. Kearney et al. (2015) have seen that increased experience of mobile usage in teaching also tends to give students increased responsibility for when and how they perform their tasks. Perhaps the result of this study is an expression of how students do not have enough experience in using mobiles for schoolwork to feel comfortable. The fact that students want teachers to let them know when they are allowed to use mobile phones also suggests an uncertainty regarding rules. How mobile use for students can be structured to be mainly supportive is still a challenge for mobile learning. At the same time, it is worth asking whether there is any learning situation where there is no risk of distractions.

19.7.4 Summary

In this study, both teachers and students have described that mobile phone use can offer supportive functions for communication. In addition, both groups of students described that the use may be supportive for their memory. Further, one student group pointed out that mobile use, in many ways, also can support their understanding. Regarding functions with contradictions, both teachers and students stated that there is a risk of distraction if the mobiles are used for other objectives than the tasks. The teachers also highlighted that it can be problematic if the students use each other's phones. Some students described that use during lectures can be distracting, mobile phones to some extent have limited capacity, information received from the Internet is not always reliable, mobile use brings ethical risks, and students might be charged for related costs.

Regarding how mobile phone use can be structured, both teachers and students desired rules to provide use only supporting assignments. However, both teachers and students were not sure about how the use might be structured in this way. All groups discussed a division of labor where teachers can have enhanced control concerning students' mobile use. According to teachers, it might even be beneficial if they store the students' mobile phones, as a way to remind students to do their tasks. Similar, students have also described benefits if teachers have a role to ask students to use their devices when needed. This since, some students are not sure when they are allowed to use mobile phones. Neither teachers nor students have been able to agree about an ultimate solution regarding the teachers' role, or how to store students' mobile phones. However, this study shows that all groups agree upon that the students shall work in groups of 2–4 people with mobile phones during the task.

19.7.5 Tenable Future Mobile Use

In the mobile learning research, we can see clear patterns starting to emerge of different functions for mobile use. The map of the field is, however, only roughly drawn. There are many places left to explore in order to reach a sufficient understanding of how the use of mobiles during tasks can become efficacious (e.g., Beland & Murphy, 2016; Kiger & Herro, 2015; Kuznekoff et al., 2015). We can likely discover both positive and negative impacts. It is, for instance, not unlikely that the use of mobile devices can support even more objectives than the ones we are currently aware of. Right now, we also do not know how to structure a tenable mobile use (Ally & Prieto-Blázquez, 2014; Hopkins et al., 2016).

While the research continues to map our collective knowledge, we call upon teachers to continue building on local experiences. Teachers and students need experience from which to draw well-founded conclusions about which structures best suit their specific contexts. Through these shared experiences and conclusions, students can begin to take more control over their own learning with mobile devices. The general increase in the use of mobile phones can also lead to discovering more advantages for using them in class (O'Bannon & Thomas, 2015). For teachers who are planning to design tasks that involve the use of mobile phones, it can be a good idea to plan the "rules of engagement" together with their students. It is clear that students have plenty of knowledge of how mobile phones can be used for specific objectives, and they can offer teachers many complementary suggestions. We agree with Hopkins et al. 2016 that students are not unaware of the challenges and obstacles associated with the use of mobiles.

The use of mobile phones offers exciting learning possibilities in different environments and which include both personal and public interests. This also creates new challenges. By building on the knowledge of what works and what does not, we can together develop tenable structures for the future use of mobile phones in school tasks.

Glossary

Activity theory (AT) A theoretical framework focusing on people's actions with, for example, mobile features in school activities

Community A component of AT that defines a cultural context shared by people

Computer-aided design (CAD) Computer software commonly used to produce 3D visualizations of product designs and construction

Division of labor A component of AT that describes how people share and negotiate the distribution of tasks. It also highlights social hierarchies between individuals. For example, students' ability to participate in activities with mobile phones can be regulated by the division of labor between students and teachers

Learning management system (LMS) A virtual classroom where students and teachers can communicate and exchange documents. It is a web-based learning environment that is protected by a password

Rules A component of AT that refers to the norms of a community. For example, students' actions with mobile phones can be regulated by norms of expected and accepted mobile use at school

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Chapter 20
Design and Development of Mobile EZ-Arabic.Net for Ubiquitous Learning Among Malaysian Primary School Learners from Experts' Perspective

Muhammad Sabri Sahrir, Mohd Firdaus Yahaya, Mohd Shahrizal Nasir and Mohd Fauzi Abdul Hamid

Abstract Ubiquitous learning, also known as u-learning is based on ubiquitous technology. The most significant role of ubiquitous computing technology in u-learning is to construct a ubiquitous learning environment, which enables anyone to learn at anyplace at any time. This article is focusing on the design and development of a mobile learning platform known as mobile EZ-Arabic.net that serves as a medium of ubiquitous learning in Arabic for Malaysian Primary school learners. The design of this mobile learning application is conducted by transformation a web-based version of EZ-Arabic.net into a mobile application that is suitable for mobile and ubiquitous learning environment. ADDIE model for mobile learning is used for the design and development of this learning platform. The objective of the research is to evaluate a mobile ubiquitous learning platform that was specifically designed for Malaysian primary school learners among subject matter experts (SMEs) from International Islamic University Malaysia (IIUM), Universiti Teknologi MARA (UiTM), Universiti Sains Islam Malaysia (USIM) and Universiti Sultan Zainal Abidin (UniSZA). Based on the findings of the analysis, the learning will be built with content appropriate to meet with students' needs and syllabus. The final evaluation is also to be conducted among teachers and learners for the improvement of this mobile learning application.

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_20

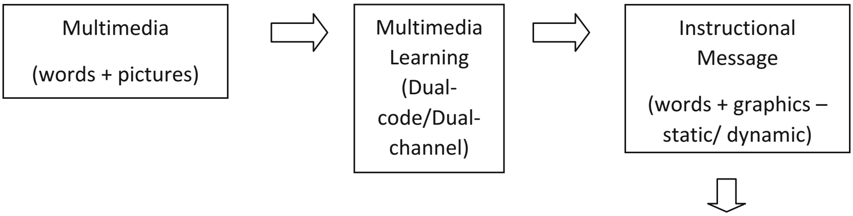
Keywords EZ-Arabic · Arabic · Mobile learning · Ubiquitous learning
Design and development

20.1 Introduction

The rapid emergence of technology today is among the reasons of the needs of teachers and students to the use technology in teaching and learning. This situation involves all levels of education including language education either in the school or higher learning institution. In particular, the use of multimedia in teaching and learning is one of the methods that are widely used in all levels of education. Teaching and learning through multimedia is now among the most celebrated learning aids and tools throughout the world. The term 'multimedia' as defined by Mayer (2001) is the presentation of materials using both words (verbal) and pictures (pictorial). Integrating the element of multimedia in a learning process would simply mean learning from words and pictures (Mayer, 2001). The full view of multimedia learning flow as discussed by Mayer (2001) is shown in the following Fig. 20.1.

The potential use of multimedia learning specifically in texts and images as previously elaborated by Mayer (2001) was further expanded by other researchers by adding on other characteristics such as sounds in facilitating and exploring language instructions (Bush, 2007), exploiting the mass delivery of World Wide Web (WWW) to enhance learning process and outcome (Joliffe, Ritter, & Stevens, 2001), facilitating modified graphics for learning language vocabularies (Bush, 2007; Salsbury, 2006) implementing various technology-enhanced syllabus in enhancing the effects on language learning such as electronic workbook, digitalized video, interactive listening comprehension quizzes, online reading materials and virtual community (Gill, 2006), and edutainment games that consist of many mediums such as sound, animation, video, text and images (Embi & Hussain, 2005). Thus, the terms 'multimedia' and 'technology' are consisting of many elements in addition to words and pictures due to their dramatic increase and expansion over the past decade in second language learning in the USA (Gill, 2006).

Referring to the positive use of technology in teaching language, it is highly recommended to be used in the teaching of Arabic language in particular, especially among students of non-native speakers. Attractive and interactive teaching materials are able to attract and motivate students to learn this language easily and effectively. In addition, with the use of technology in language teaching, learners are able to increase their language skills more quickly and effectively.



Presentation Modes View	Definition	Example	Mayer's response
Delivery Media	Combination of 2 or more delivery devices	Computer + amplified speakers/ projector + lecturer's voice	Rejected because it emphasizes technology over learner.
Presentation Modes	Verbal and pictorial representations	On-screen text + animation/ printed text + illustration	Accepted because it focuses on learner's processing systems based on dual- channel assumptions from verbal and pictorial knowledge.
Sensory Modalities	Auditory and Visual Senses	Narration + animation/ lecture + slides	Accepted because it focuses on learner's processing systems based on dual- channel assumptions from auditory and visual images.

Fig. 20.1 Multimedia learning based on Mayer (2001)

20.2 Multimedia Learning in Arabic Language

The teaching and learning of Arabic language in Malaysia is still in dire needs for improvement when compared to the growth of advanced technology in twenty-first century education. The needs and gaps are obvious especially when softwares and coursewares developed for other subjects such as English, Science and Mathematics are scrutinized. According to Holmes (1999), the integration of technology in teaching and learning requires teachers who are willing and flexible to use technology in their daily teaching of subjects. Basic knowledge in the use of technology is not sufficient to enable a teacher to incorporate the technology in the teaching and learning process. Arabic learning is more textbooks and workbooks oriented and mostly supplemented by additional exercises. The rapid development of information and communication technology (ICT) in Malaysia, clearly visible through the emergence of a variety of computers and sophisticated gadgets such as laptops, notebooks, netbooks, e-book, podcasting, tablet PCs and smart phones, signals the necessity for the enhancement of Arabic teaching materials to become more attractive and to slowly break away from sole dependency on the use of textbooks and the blackboard in order to cater to multi-skilled twenty-first century learners (Azman, 2012).

The necessity for the 'Arabization' of machinery technological production in language teaching and learning has been emphasized by Ditter (2006), as it is currently dominated by the American English language, be it in software or hardware. Ghalib (2006) claims that the Arabic language is merely following the trend in using instructional technology rather than finding and creating new invention and innovation. The use of instructional technology such as educational software and courseware is limited due to several reasons as observed by Ismail (2008) in his investigation on the use of instructional teaching aids in Arabic language classrooms among selected Malaysian Secondary Religious School. His study found that the application of computer-based and web-based instructional aids is at low frequency. The teachers preferred using traditional and non-computer instructional aids primarily due to convenience as they do not require additional time and effort in preparing teaching aids.

Furthermore, the majority of Arabic language teachers are incompetent in computer skills and lacking knowledge of courseware in teaching process especially among the veteran educators, the difficulties in obtaining Arabic courseware (Ismail, 2008) and the incapability of handling a computer (Ghalib & Sarudin, 2000). In addition, the nature of the Arabic language has contributed to the scarcity of computer instructional aids due to its writing system that differs from the Latin-based writing systems. The integration of Arabic materials and contents into web-based environment should be handled carefully because the right-to-left writing system requires specially enabled Arabic software in stages of composing, editing and implementing (Ghalib 2006). The attempt to apply new CALL technology in Arabic environment especially in Malaysia is still at the early stages and requires extensive cooperation between Arabic learning content experts and instructional designers to expedite and improve its development. The instructional research in this language is still very limited except for notable ones by Alosh (2008) and Ghalib (2006). The low frequency in using computer-based or web-based instructional aids in teaching and learning Arabic is found to be affected by reasons such as: (a) preference in using traditional and non-computer instructional aids among teachers, (b) poor computer literacy especially among the veteran educators, (Ismail, 2008), (c) the incapability of handling a computer (Ghalib & Sarudin, 2000) and (d) the lack of computer training (Ashinida, Afendi, & Yusof, 2004).

Therefore, the use of technology in teaching and learning is seen as a necessity for students of Arabic language at all levels, starting from primary school. The introduction of j-QAF program that stands for Jawi, Quran, Arabic and Fardu Ain (Islamic teaching for personal obligation) to all students is among the major factors of the utilization of technology-based teaching aids. With such efforts, some constraints in the process of learning Arabic language can be overcome gradually. However, the situation changes for the better condition which requires special effort and positive spirit among teachers. It is one of the issues mentioned by Ahmad and Tamuri (2010) in their study of teachers' perceptions related to the use of teaching aids based on multimedia technology in the teaching of j-QAF. Therefore, as stated by Hamid (2005), all parties, especially teachers, have to master the use of multimedia technology in order to apply it in the teaching process.

20.3 The Design and Development of EZ-Arabic.Net Based on Rapid Prototyping Model

The design and development of EZ-Arabic.net is conducted based on rapid prototyping model based on the improvement of the EZ-Arabic 1.0 for educational purposes (Yahaya, Sabri, & Shahrizal, 2013). The earlier prototype of EZ-Arabic 1.0 was designed by using HyperText Markup Language (HTML) code and supported by Hypertext Preprocessor (PHP). The platform was developed by using the Linux platform. The URL link for the initial prototype of EZ-Arabic is http://ezarabic.net/v1. At the earlier stage, the development and improvement of the prototype EZ-Arabic was done as outlined in Fig. 20.2.

The EZ-Arabic.net prototype was initially designed as a virtual learning platform and tool for learning Arabic, especially for children learners of Standard 1 to Standard 6 from Malaysian primary schools. It is proposed as an alternative supplementing reference for the traditional textbook as initiated by the Malaysian Ministry of Education in its recent workshop in transforming the hard copy textbook into digital versions (Azman, 2012). This virtual platform supports the learners via various multimedia support files such as pictures, sounds and videos in order to enhance learners' interest and motivation towards learning Arabic. The details of the design and development process and phases of EZ-Arabic are as shown in Table 20.1.

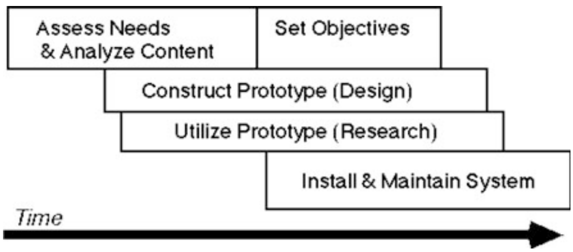


Fig. 20.2 Adapted model of rapid prototyping (Tripp & Bichelmeyer, 1990)

Table 20.1 Design and development process and phases of EZ-Arabic

Phase(s)	Process(es)
Assess needs and analyse contents	• Analyse needs of learners
	• Analyse needs of institutions
	• Analyse learning contents
	• Analyse existing or other online courseware
Set objectives	• Set objectives of language learning
	• Set objectives of language skills
	• Design principles
Construct prototype	• Collaborative works and partnership
	• Iterative, cyclic and teamwork
	• Using various research technologies
Utilize prototype	• Conduct small user testing sessions
	• Conduct online user testing sessions via Facebook®
	• Gather comments and feedbacks
Instal and maintain system	• Review process of design and development
	• Continuous improvement of prototype

20.4 Samples of Screenshots from EZ-Arabic.Net

EZ-Arabic.net was developed and enhanced by several multimedia components to assist the process of learning Arabic. The multimedia learning contents in the prototype EZ-Arabic.net is the result of a combination and integration of Arabic textbooks in the Malaysian Primary School Standard Curriculum (KSSR) that is used by the Ministry of Education with other open sources learning tools such as the followings (Fig. 20.3):

(a) E-book of Arabic text books, including story books for extra reading,
(b) Educational Arabic games,
(c) Audio learning aids (MP3) in Arabic,
(d) Visual learning aids (MP4) in Arabic,
(e) Online dictionary and translator for Arabic,
(f) Online chat-box for virtual discussion and synchronous learning,
(g) Arabic keyboard for PC without Arabic letters stickers, and
(h) Links of various websites in learning Arabic for children.

Based on studies conducted by Yahya, Sahrir and Nasir (2013), a prototype version of EZ-Arabic, improvements have been made in accordance with some of the comments and suggestions provided by respondents. Based on the suggestions and comments, some improvements have been done starting from the new main interface such as shown in Fig. 20.4.

Fig. 20.3 Main interface of EZ-Arabic 1.0

Fig. 20.4 New main interface of EZ-Arabic.net

(i) Use the EZ-Arabic Bilingual 2.0

EZ-Arabic.net comes with two main languages, namely Bahasa Melayu and English. The users can choose either to use the EZ-Arabic 2.0 in Malay or English as a medium of learning Arabic when using this site as shown in Fig. 20.5.

Fig. 20.5 Bilingual option in EZ-Arabic 2.0

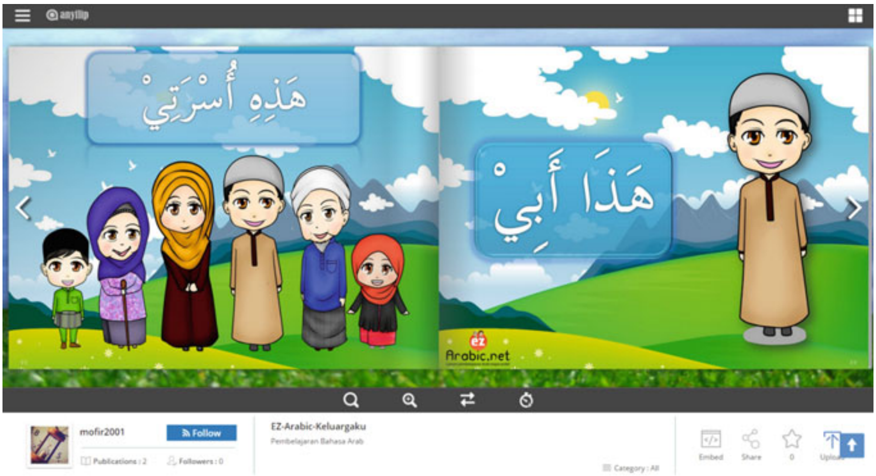


Fig. 20.6 Sample of e-book by using *anyflip.com*

(ii) Electronic books (e-Book)

Improvements were also made by the use of electronic books. In EZ-Arabic 2.0, the new view shows a sheet of books that are more interactive and user-friendly. It can be used as a real book (hard copy). This electronic book was developed by using an online software from 'www.anyflip.com' as shown in Fig. 20.6 and the software of iSpring as shown in Fig. 20.7.

(iii) Language activities and exercises

The language activities and exercises in EZ-Arabic.net have been enhanced and improved with various language quizzes such as matching, multiple choice and hotspot. These quizzes were developed by using Raptivity (A Rapid Interactivity

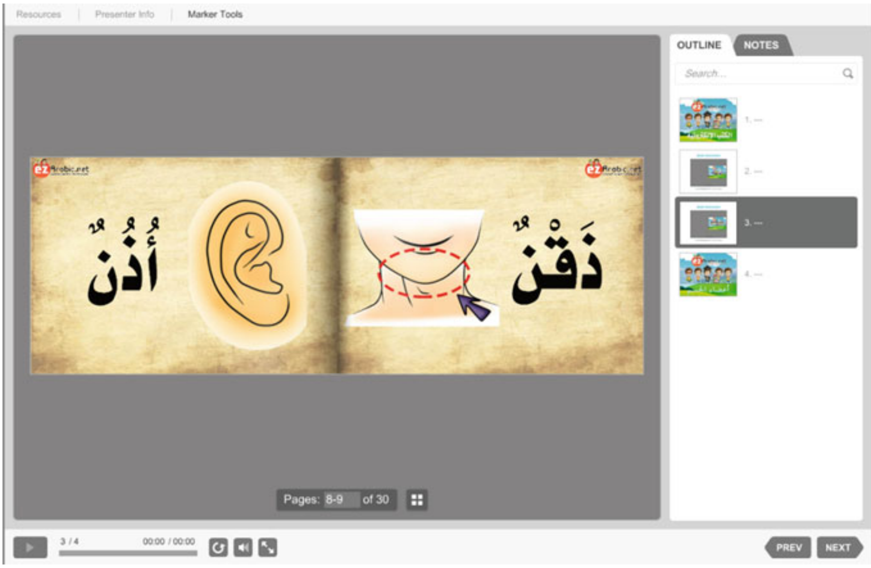


Fig. 20.7 Sample of e-book by using iSpring software

Fig. 20.8 Language activities and exercises in EZ-Arabic 2.0

Building Tool) and also iSpring software. Figures 20.8 and 20.9 show the nature of language activities and exercises developed by using iSpring software.

Figure 20.10 shows the types of questions that are included in EZ-Arabic.net. The development of these questions was conducted by using iSpring software. In

Fig. 20.9 Displayed feedback after completion of quizzes

iSpring, there are more than ten types of questions and activities that are available and ready to be used. However, only some forms of questions that have been developed and integrated in this latest version of EZ-Arabic.net.

Graded language quizzes in EZ-Arabic.net

- True/False
  This question requires the user to determine whether the statements are true or false.
- Multiple Choice Answers
  These questions show some answers as options, and there is only one correct answer
- Matching
  Users are required to perform drag and drop activities on a given item with the right fit.
- Numbering
  Users are required to put the numbers in the spaces provided.
- Fill in the blank
  It contains one or more empty spaces to be filled in with the correct answer.
- Multiple Choices of Text Answers
  Users have to choose one word of response options on the drop-down menu for each of empty space.
- Vocabulary Bank
  Users need to drag and drop the words into the blank spaces provided. Number of spaces available may be less than the answers provided.
- Hotspot

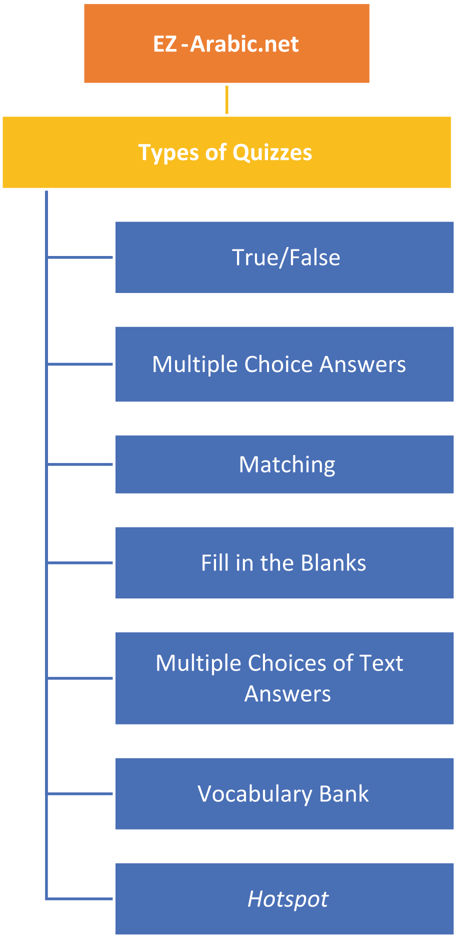


Fig. 20.10 Types of quizzes in iSpring

This question requires the user to click correctly to a certain area on the images provided.

(iv) Special appearance of new icons in EZ-Arabic.net

Among the improvements in this new EZ-Arabic.net is by displaying new special icons and images. The use of special icons and images in the e-learning is important because it can turn on the learning environment itself two main characters of images were chosen to represent the characters of a boy and a girl in EZ-Arabic.net, and they will appear in the most interface and web pages as shown in Fig. 20.11. Other icons and images used EZ-Arabic.net are shown in Fig. 20.12.

All improvements made in the EZ-Arabic.net are an effort completed based on users' feedbacks and responses. It is a crucial step to remain EZ-Arabic.net as a relevant e-learning platform in helping students to learn the Arabic language more

Fig. 20.11 Main logo of EZ-Arabic.net

Fig. 20.12 New icons and images used in EZ-Arabic.net

effectively. This is in line with the recommendations of Harun and Hadi (2010) that emphasize on conducting need analysis for the website in the development of multimedia learning process, including the phases of planning, design and evaluation.

20.5 Transformation of EZ-Arabic.Net from Web-Based to Mobile Ubiquitous Platform

In order to facilitate mobile learning for ubiquitous learners, the web-based platform of EZ-Arabic.net has been enhanced and upgraded to mobile version. Below are the design and development phases, tools and new characteristics of this mobile version for EZ-Arabic.net.

Fig. 20.13 EZ-Arabic.net mobile apps development process

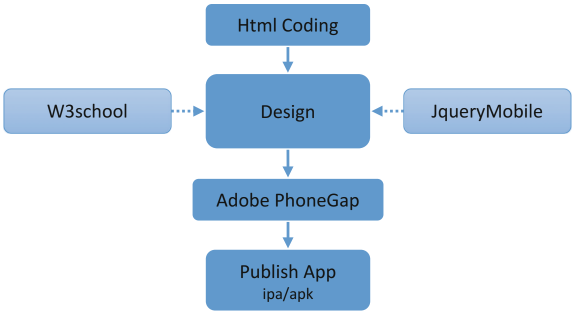


Table 20.2 Design and development phases and process

Phases	Process
Coding	The development of EZ-Arabic.net apps using basic html code
Design	The design process involves few advanced coding from JqueryMobile website. This website provides several templates. It addition to that, it also allows customization of the mobile apps templates
Publish	Adobe PhoneGap is a platform to convert/publish html coding to apps. It can convert to *apk* format which is for android operating system base, *ipa* format for iOS operating system and for windows phone app format

(a) Design and development phases and process

The design and development tool for this mobile ubiquitous learning platform was conducted based on following tools, phases and process.

The development of EZ-Arabic.net is using basic html coding. The code can be retrieved from w3school.com and Jquerymobile.com. These websites provide for its users the coding for basic mobile apps development. The mobile code later uploaded into online software Adobe mobile apps development called 'Adobe PhoneGap' (2015). The Adobe PhoneGap later converts the coding into mobile apps. At this point, the users are allowed to convert the coding into APK format which is can be used for all android users, and windows format for mobile windows users and IPA format for iOS users. Figure 20.13 and Table 20.2 show the process of development EZ-Arabic.net mobile apps from basic html code.

(b) Development tools

The details of development tools, details of tools and purpose of use in this study are shown in Table 20.3.

An online tool developed by Adobe System Inc. can be retrieved via www.phonegap.com. The vendor offers three types of packages to its users, for free user which is limited to only one app and its size is not more than 50 MB. Meanwhile, the paid package allows user to upload up to 25 apps at one time and 100 MB storage for apps. The third package is meant for users with adobe ID with 1 GB

Table 20.3 An online tool to build EZ-Arabic.net app

Development tools	Details of tools	Purpose of use
Adobe PhoneGap Build	PhoneGap is a mobile application development framework, based upon the open source Apache Cordova project. It allows user to write an app once with HTML, CSS and JavaScript, and then deploys it to a wide range of mobile devices without losing the features of a native app. PhoneGap Build is a cloud-based service built on top of the PhoneGap framework. It allows user to easily build those same mobile apps in the cloud (Adobe PhoneGap)	To build EZ-Arabic Apps and convert html codes into various mobile application format such as windows, android and iOS

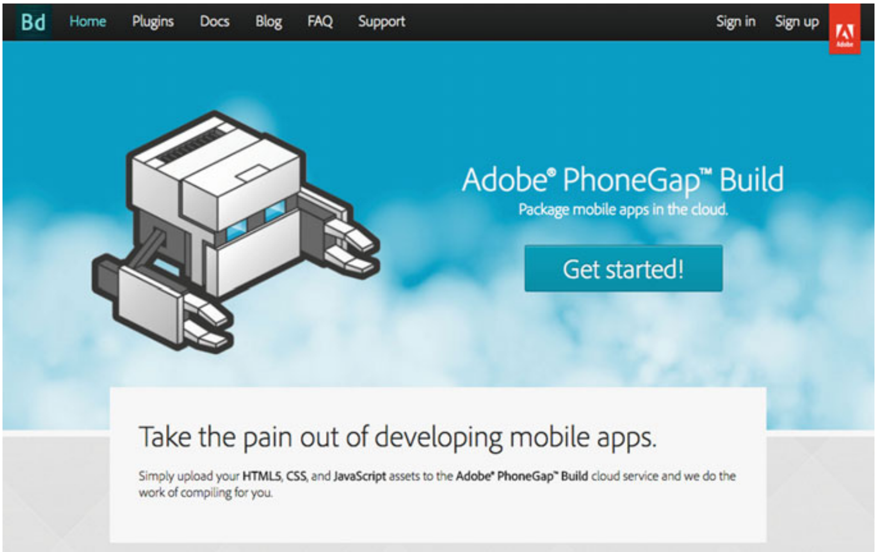


Fig. 20.14 Adobe PhoneGap Build is an online application to develop mobile apps

storage. Figure 20.14 shows main interface for Adobe PhoneGap, an online tool to build mobile apps.

(c) New characteristics of EZ-Arabic.net for mobile ubiquitous platform

The new features of EZ-Arabic.net for mobile ubiquitous platform are listed as the following:

i. Electronic books. It consists of several topics such as ‘Number’, ‘My Family’, ‘Animals’ and ‘Clock’ for beginner level.
ii. Audio, for audio components in mobile apps, it focuses only for *nasheed* by ‘Ustaz Mior’.
iii. Video, this component also has several topics for beginner level. In addition, it also consists *nasheed* performed by Ustaz Mior.
iv. Exercises. Several exercises are also included in EZ-Arabic.net app. It covers lesson from e-Book, video and audio.

20.6 Formative Evaluation of Mobile EZ-Arabic by Subject Matter Experts (SMEs)

The formative evaluation with the instructional designers and Arabic language experts was conducted with six (6) experts from four (4) different universities which are International Islamic University Malaysia (IIUM), Universiti Teknologi MARA (UiTM), Universiti Sains Islam Malaysia (USIM) and Universiti Sultan Zainal Abidin (UniSZA), Malaysia based on a suggested checklist by Vincent (2012). The expert review was the formative evaluation survey that was conducted online and sent through the main researcher’s email to the purposively selected respondents. The selection of the five (5) experts from different and various expertise field was based on recommendation and suggestion from Nielsen (1997) who suggested the use of five or six expert reviews and Alessi and Trollip (2001) who suggested the use of more than three experts in the evaluation process.

(i) Demographic data of the SMEs:

The demographic data of the experts who contributed to the mobile prototype evaluation are as the followings in Table 4.

(ii) Formative evaluation results by SMEs:

The evaluation results by the experts for this mobile prototype are shown in Table 5.

(iii) General comments and feedbacks by SMEs:

The general comments and feedback by the experts are as follows.

- Positive aspects related to the useful use of this e-learning platform for the basic learners in Arabic language. The learning content is quite straightforward to the targeted learners as they are interactive and helpful.
- Negative aspects are related to few simple grammatical and spelling errors that are found in the learning contents. The experts were suggesting the corrections of all mentioned errors before the actual implementation among the school learners.

Table 20.4 Demographic data of SMEs

Expert No.	Field of expertise	Academic position	Teaching experience	University
1.	Curriculum evaluation	Assistant Professor	16 years	UiTM
2.	Corpus linguistics, comparative linguistics	Associate Professor	15 years	IIUM
3.	Instructional technology	Associate Professor	23 years	IIUM
4.	Computer assisted language learning	Assistant Professor	9 years	USIM
5.	Arabic linguistics	Assistant Professor	16 years	UniSZA
6.	Technology in teaching Arabic as second language	Assistant Professor	15 years	IIUM

Discussion of findings

Based on the data obtained from this study conducted on the design and development of mobile EZ-Arabic for ubiquitous learning, there are several observations as follows.

(a) *EZ-Arabic transformation from website to mobile platform through a systematic process*

The learning process involves Arabic language in particular must be in line with the change of time. The importance of using technological materials in the teaching and learning of Arabic language needs to be recognized by educators with immediate steps towards its realization. Thus, an effort to transform the EZ-Arabic website in the mobile form is seen as a necessity to ensure that teaching and learning Arabic in line and updated with other educational fields. This is also a part of taking advantage of today's technology in the field of Arabic language studies. The need to revive the atmosphere of self-directed learning which is not limited in the classroom learning is the most important input in order to realize the use of mobile for accessing EZ-Arabic. Moreover, mobile devices minimize the separation between in-class and out-of-class learning (Reinders & Lewis, 2009). However, this transformation effort requires systematic measures to ensure that EZ-Arabic content can be accessed from mobile. There are three main phases in the transformation process of mobile Arabic EZ which are coding, design and publish as shown in Table 20.2. These phases are the steps that must be taken carefully in order to make EZ-Arabic content can be accessed through mobile.

(b) *New characteristics of EZ-Arabic.net for mobile ubiquitous platform*

Although the EZ-Arabic website is a form of learning platforms that feature current technology, but efforts to make improvements through other technology features

Table 20.5 Formative evaluation results by the experts

Item	Strongly disagree (SD)	Disagree (D)	Neutral (NA)	Agree (A)	Strongly agree (SA)
1. The use of mobile EZ-Arabic is relevant to the purpose and student needs	0 (0%)	0 (0%)	0 (0%)	2 (33.3%)	4 (66.7%)
2. Learning tutorial is available and helpful	0 (0%)	0 (0%)	0 (0%)	2 (33.3%)	4 (66.7%)
3. Learning content is appropriate for the student	0 (0%)	0 (0%)	0 (0%)	3 (50%)	3 (50%)
4. The content is error-free, factual and reliable	1 (16.7%)	0 (0%)	1 (16.7%)	2 (33.3%)	2 (33.3%)
5. Design of mobile EZ-Arabic is functional and visually stimulating	0 (0%)	0 (0%)	0 (0%)	1 (16.7%)	5 (83.3%)
6. Student can exit at any time without losing progress	0 (0%)	0 (0%)	1 (16.7%)	1 (16.7%)	4 (66.7%)
7. The use of mobile EZ-Arabic is free of charge	0 (0%)	0 (0%)	0 (0%)	1 (16.7%)	5 (83.3%)
8. No in-app purchases are necessary for intended use of this learning platform	0 (0%)	0 (0%)	0 (0%)	1 (16.7%)	5 (83.3%)
9. It loads quickly and does not crash	0 (0%)	0 (0%)	0 (0%)	1 (16.7%)	5 (83.3%)
10. It promotes creativity and imagination	0 (0%)	0 (0%)	0 (0%)	2 (33.3%)	4 (66.7%)
11. It provides opportunities to use higher-order thinking skills	0 (0%)	0 (0%)	3 (50%)	1 (16.7%)	2 (33.3%)
12. It promotes collaboration and idea sharing in language learning	0 (0%)	0 (0%)	1 (16.7%)	3 (50%)	2 (33.3%)
13. It provides useful feedback for learners	0 (0%)	0 (0%)	0 (0%)	5 (83.3%)	1 (16.7%)
14. In general, mobile EZ-Arabic is ready to be used by primary school learners	0 (0%)	1 (16.7%)	0 (0%)	3 (50%)	2 (33.3%)

must be taken in particularly in mobile form. Therefore, in order to ensure that there is a difference of EZ-Arabic content in this current form, some new characteristics of EZ-Arabic are included. It involves electronic books, audio, video and exercises. With these new characteristics of EZ-Arabic, it is seen to be able to attract not only new users through mobile EZ-Arabic, but also attracted the attention of the EZ-Arabic website users. This is in line with Bachore (2015) who claim that mobile learning is creating an interactive learning environment with multiple contexts using different kinds of applications which are available in the mobile.

(c) Positive views of experts in the field of Arabic language studies

Some experts in the field of Arabic language studies have responded positively to the design and development of mobile EZ-Arabic for ubiquitous learning. All experts agree (33.3%) and strongly agree (66.7%) that the use of mobile EZ-Arabic is relevant to the purpose and student needs. This finding is a clear indicator that the experts in the field of Arabic language agreed with the need to enhance Arabic language studies through the use of current technological devices such as mobile gadgets. This current technology is able to continuously maintain the demand of Arabic language by the students through mobile learning as they are learning ubiquitously. As mentioned by Ogata and Yano (2005), the main features of mobile learning are accessibility, immediacy, interactivity and situating of instructional activities. Accessibility refers to the extent to which every learner or majority of them owes the mobile. Although the EZ-Arabic content focused on the basic Arabic language learning for primary school students, but it is still relevant for use by adults as beginners in learning the language.

(d) *Expert review and validation for a reliable mobile ubiquitous learning content*

The response from the expert also pointed out that mobile content EZ-Arabic includes error-free, factual and reliable. This is based on the responses of the majority of experts involved. However, there is an expert (16.7%) who strongly disagrees and another expert who represented (16.7%) took the option of neutral for the statement regarding the characteristics of error-free, factual and reliable for mobile EZ-Arabic. Undoubtedly, there are some minor errors in the original form of mobile EZ-Arabic assessed by experts. However, based on the input from experts, the corrections and improvements have been adopted. This proves that the mobile development process of EZ-Arabic absolutely needs the views of experts in Arabic language field, so that the contents of mobile EZ-Arabic are accurate and able to help the student to learn Arabic in easy way via current use of technology. In general, majority of the experts which representing 83.3% agree that mobile EZ-Arabic is ready to be used by primary school learners. This response indicates that the existing mobile content of mobile EZ-Arabic can be used by students in primary schools with the support of teachers and adults who have the access to their mobile devices.

20.7 Conclusion

The use of technology in the learning process of Arabic language gives students the opportunity to learn this language easily and effectively. By integrating learning contents through a special mobile app such as EZ-Arabic.net, the students can learn the language interactively through a smartphone only. Available software in EZ-Arabic.net is able to attract students to learn Arabic because it is user-friendly, in addition to the diversity of colours, illustrations and icons available. EZ-Arabic.

net is also the one medium that can help teachers and students for teaching and learning language in a simple and comprehensive way, comprising of various language skills such as listening, reading, speaking and writing. The enhanced mobile version of EZ-Arabic.net provides additional option for ubiquitous learners to learn Arabic outside classrooms by using their mobile gadgets and smartphones. From the experts' evaluation of practical use of mobile EZ-Arabic, it is clear that they totally agreed between 'agree' and 'strongly agree' on the attractive use of this mobile version in learning Arabic such as functionality and visually stimulating (100%), free of use (100%) and promoting creativity and imagination (100%). However, this mobile app received high moderate experts' rating in terms of promoting collaboration and idea sharing in language learning (83.3%) and moderate rating in the use higher-order thinking skills (50%). It can be concluded in general that the experts have very high confidence with the promising potential of this mobile version in the use of Arabic learning among children. The potential use of mobile EZ-Arabic can be exploited further to enhance collaborative learning among children, to promote higher-order thinking skills and to nurture children's creativity and imagination.

Acknowledgements The authors would like to express their acknowledgement and appreciation to Universiti Sultan Zainal Abidin (UniSZA) and Ministry of Higher Education Malaysia for providing the support and research grant for this project under Research Acculturation Grant Scheme (RAGS) with the amount of RM 45,000.00 from 2014 until November 2016.

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Chapter 21
Social Network Analysis of MOOC Learners' Knowledge Building

Liujie Xu, Fancong Wang and Bo Yu

Abstract With the development of information and communication technology, a variety of online platforms began to provide support for mobile learning. Some MOOC platforms provide terminal apps. Learners can use smart phones, pads, and other mobile devices to carry out mobile learning. In MOOC-based mobile learning research, many researchers place attention on the construction of the learning environment and resources, teaching mode design, evaluation and learning effect, etc. From the perspective of social networks, the paper uses social network analysis and content analysis to analyze knowledge building combined with the learners' social attributes. The results showed that MOOC learners take interaction positively, but could not achieve high-level knowledge building.

Keywords Knowledge building · MOOC · Social network analysis

21.1 Introduction

Massive open online courses (MOOCs), which are open access and scalable online educational courses that can be used by anyone worldwide, have become a trend since the first MOOC, Connectivism and Connective Knowledge (CCK08), was

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S. Yu et al. (eds.), *Mobile and Ubiquitous Learning*, Perspectives on Rethinking and Reforming Education, https://doi.org/10.1007/978-981-10-6144-8_21

offered by the University of Manitoba in 2008 (Fini, 2009). Private organizations and higher education institutions have been expending resources to experiment with MOOCs and create a more available, affordable, and responsive platform than traditional university degrees (Nicoara, 2013). One of the barriers to learner learning in MOOCs is the lack of social interaction, online learning skills, confidence, and learning outcomes, which are strongly associated with social interactions, management, and mentoring (Hui, Liang, & Li, 2013).

Learning is the process of establishing the connection between the new knowledge and old knowledge; the process of interacting among students and teachers; the process of establishing the social connection between people (Keith Sawyer, 2006). Knowledge is constructed meaningfully by social collaborative negotiation and discourses. The group's interaction structures and participatory traits not only affect the learning atmosphere, but also, to a large extent, determine the quality of collaborative learning and the quality of group knowledge building. Learners and learner groups implement behaviors of cooperation, collaboration, and interaction to share information, to compare perspectives, and to construct knowledge (Wang, 2011). MOOC learners attain learning goals by sharing resources, exchanging ideas, negotiating opinions, and constructing new knowledge. Individuals produce ideas, theories, or assumptions by collaborating with each other, participating in purposeful learning activities in specific communities. Simultaneously, individuals gain relevant knowledge during the formation of public knowledge (Zhao, 2007). The knowledge of the whole learning community has been improved in depth and breadth by online dialogues and inquiry activities of students. Community consciousness is conducive to cooperative knowledge building and individual knowledge development (Jin, Zhang, & Sun, 2014). A study of two MOOC courses designed on the OpenHPI platform showed that active course participants achieve higher scores and are responsible for the social quality of the learning context (Grunewald et al., 2013). In summary, MOOC learner interaction can promote knowledge building for learners. However, there are doubts about the depth of MOOC learners' interaction and the level of knowledge building. Some scholars pointed out that the establishment of social network relationships cannot bring deep and sufficient interaction, the content of interaction was very simple, and the interaction remained relatively on a shallow level. The social interaction and knowledge building of MOOC learners still need to be studied continuously, which requires a lot of experimental validation. This paper uses the social network analysis method to analyze the interactive content and interaction frequency of MOOC learners in the forum to explore the degree of MOOC learners' knowledge building.

21.2 Literature

21.2.1 The Condition of Student Learning and Interactions in MOOCs

The development of open resources has gone from multimedia courseware, network courses, and video open classes to MOOCs. Coursera, edX, and Udacity laid the cornerstone of MOOC development. Most of the courses on these platforms are dedicated online micro-videos, and the platforms also add elements that can facilitate learners' online learning and interaction. Compared with the previous network learning, MOOCs truly realized effective interaction, truly embody the learner as the center. The platform promotes interaction and learners' self-learning and supports learners' online learning. (Wang and Wang 2014) For improving learners' experience, most MOOC platforms provide a search engine; easy, useful, and clear navigation; and clear section classification and instructions.

MOOC platforms are based on three areas to promote students' engagement (Grainger, 2013): video lectures, assessment, and forums. Assignments are primarily evaluated through the use of: (a) auto-graded multiple choice questions or auto-graded programming assignments, (b) peer-review assessment where students themselves evaluate and grade assignments based on a defined rubric set. Forums are where students post questions and other students reply and are the main method of student interaction with course takers and instructors. Forums usually consist of general discussion, subject-specific discussion, course feedback, and technical feedback threads. Glance, Forsey, and Riley (2013) conducted a narrative analysis to explore whether MOOCs represent a pedagogically sound format for higher education. They claimed that online quizzes and assessments could enhance learning through the mechanism of retrieval practice; short videos allow for mastery learning and complement the optimal attention span of students; and discussion forums help to provide peer assistance interaction.

On MOOC platform, cognitively, participants broadened their perspective of thinking, raised cultural awareness, and shared many learning strategies. Learners established a strong sense of community and gained motivation for learning. Learners also increased action tendencies toward trying out MOOC platform functions, new courses, and learning strategies, and they became more cognizant of the benefits and procedures of the MOOC study group (Chen & Chen, 2015).

21.2.2 The Application of Social Network Analysis of MOOC Platform

A social network (Sharma, Sharma, & Khatri, 2014) consists of a group of people and links between them. These connections can be any type of social link that makes a relationship between two people. Social networks are a popular way to mock-up the interactions among the people in a group or community. Social networks are highly vital in nature. They can grow and change as time variations, and they can be visualized as graphs, in which a vertex denoted as a person in some group and link represents some form of association between the consequent persons (Barabasi et al., 2002). In the current era of big data (including big social network data), various social networking sites or services—such as Facebook, Google+, LinkedIn, Twitter, and Weibo—are commonly in use (Braun, Cuzzocrea, Leung, Pazdor, & Tran, 2016). The social network analysis method has been used more widely than before.

SNA aims to describe structural patterns of relationships among social actors, groups, and organizations and their implications (Scott, 2013). It is an effective means for collecting, storing, and managing big data and analyzing and facilitating data visualization, which explains the relationship of exponential information (Suh & Shin, 2012). A number of previous studies have considered SNA to be a theory or analytic technique, or an interdisciplinary methodology for identifying social structural variables and properties. Hoff, Raftery, and Handcock (2002) said that SNA can demonstrate the relationships among interactive actors in an unobserved social space and provide more information such as actor's power, prestige, and information authority in networks, which makes it a sophisticated statistical and useful research tool (Aviv, Erlich, Ravid, & Geva, 2003).

Learners' participation—of the factors predicting learners' achievements—expressed as posts and/or comments in online discussion environment was influenced by learners' interactions (Moore & Marra, 2005). So the SNA method, which is a tool considering actors' interactions (including direct and indirect connections), can make it easy to comprehend the influence of each actor in networks. In this regard, it is highly possible that using SNA indexes can lead to concluding unprecedented implications which could not be revealed by using a simple count of meaningful posts, because of SNA indexes demonstrating interactive relations between actors. Consequently, this study aims to demonstrate the difference between counting meaningful posts and SNA of posts as a form of learners' participation in online discussions by using the closeness centrality of posts to analyze authentic relations, interactions, and the position of actors (Lee & Lee, 2016).

MOOC learning is one of the most popular forms of online learning. Students can watch video and browse text and other teaching resources on the MOOC platform. The learners interact with peers, teaching assistants, and teachers and express their personal opinions and learning experiences in the forum. The learners assess peers' work among themselves. There are interactions between learners and instructional videos, between learners and learning peers, and between teachers and assistants on MOOC platform. MOOC learning interaction is a complex process of collaborative network conditions. The boundaries of learning interaction go across time and space constraints and across the virtual network environment and the real world. So MOOC learning interaction is not only between people, but also is an interactive form between relations of interactions (Tian & Rui, 2014). Through interaction, learners, teaching assistants, teachers, and other personnel to form a social network; members of the network have certain social attributes and occupy different network locations. As the main form of interaction, online communication is one of the ways to achieve effective teaching (Yang & Rui, 2014), which has a significant impact on the efficiency of MOOC learning (Huang & Liu, 2014). Some researchers used the social network analysis method to analyze MOOC learning and found that participation in online communication can help learners to complete the learning (Xu, Zhang, Li, & Yang, 2015). The learners who participated the interaction had higher rate than those who did not interact with each other (Li, Xu, & Sun, 2015). Some scholars use the social network analysis method to analyze the interactive quality and interactive content of MOOC learners. It was found that there was a phenomenon of low overall activity and few people participated in the online discussion (Huang & Liu, 2014). MOOC learners have many problems such as looser communication, infrequent communication channels, insufficient willingness and ability to participate in communication, lack of core characters and opinion leaders, and too many isolated learners, and these lead to ineffective learning (Wang, 2016).

With the popularization of mobile Internet, and the increasing use of cell phones, pad, and other mobile terminals, many online learning platforms and online courses such as Coursera, Udemy, Edx, Khan Academy, and TED offer movable apps to users that support m-learning for learners. Because of the large number of participants, learning interaction of MOOCs is different from traditional classroom learning and online learning. The quality of the interaction of the learners in MOOC learning in a mobile environment is worthy of study. Using the social network analysis method to analyze MOOC learning interaction in the mobile environment will help us to understand the application of MOOC platforms in mobile learning.

21.2.3 Knowledge Building

Knowledge building may be defined as the production and continual improvement of ideas of value to a community, through means that increase the likelihood that what the community accomplishes will be greater than the sum of individual contributions and part of broader cultural efforts (Scardamalia & Bereiter, 2003). Knowledge is socially constructed and best supported through collaborations designed so that participants share knowledge and tackle projects that incorporate features of adult teamwork, real-world content, and use of varied information sources.

In knowledge building, knowledge building discourse such as viewpoint, discussion, revision, organization, integration is the core of collaborative knowledge building (Bereiter & Scardamalia, 2003). Knowledge building discourse focuses on issues and in-depth understanding, produced in a decentralized, open, collective understanding of the knowledge environment and resulting from interaction within knowledge building communities (Scardamalia & Bereiter, 1993). We can analyze knowledge building by analyzing the level of learner interaction and quality of interactive content and by analyzing the final examination scores and skill performance of learners. Knowledge building can be divided into shallow knowledge building and deep knowledge building (Scardamalia & Bereiter, 2003). Knowledge building emphasizes that knowledge is constructed by practicing and by solving real problems, and that knowledge can be improved. Knowledge building emphasizes group knowledge building, the responsibility of the collective and the democracy of knowledge. Knowledge building emphasizes the balance of knowledge progress; knowledge is distributed between the communities. Knowledge building community dialogue and exchange bring more knowledge sharing in the knowledge community dialogue and exchange of knowledge in the practice of fine processing and transformation (Scardamalia, 2002).

Scardamalia and Bereiter (2010) proposed twelve knowledge building principles: real ideas, authentic problems, epistemic agency, community knowledge, democratizing knowledge, symmetric knowledge advancement, pervasive knowledge building, constructive uses of authoritative sources, knowledge building discourse, and concurrent, embedded, and transformative assessment. In order to observe and analyze knowledge building, some researchers constructed knowledge building models. Gunawardena, Lowe, and Anderson (1997) reviewed strengths and shortcomings of existing interaction analysis techniques and propose a five-phase model based on grounded theory building for analyzing the quality of CMC interactions and learning experiences. Contents of the model are sharing/comparing of information (PH1), the discovery and exploration of dissonance or inconsistency among ideas (PH2), concepts or statements; negotiation of meaning/co-construction of knowledge (PH3), testing and modification of proposed synthesis or co-construction (PH4), and agreement statement/applications of newly constructed meaning (PH5). Hansen, Dirckinck-Holmfeld, Lewis, and Rugelj (1999) proposed six phases of knowledge building which contain group formation, problem setting, planning, research phase, and conclusion of work and evaluation. Stahl (2000a) established a double cycle model of knowledge building. Fisher, Bruhn, Grasel, and Mandl (2002) constructed a process model of collaborative knowledge building which contains externalization of task-relevant knowledge, elicitation of task-relevant knowledge, conflict-oriented consensus building, and integration-oriented consensus building. Singh, Hawkins, and Whymark (2007) proposed the integrated model of collaborative knowledge building.

Knowledge building needs support of the environment following from the learning/knowledge building distinction. A KBE (knowledge building environment) is defined as any environment (virtual or otherwise) that enhances collaborative efforts to create and continually improve ideas. Stahl (2000b) defines a KBE as “a software environment designed to support collaborative learning”. The following are recognizable characteristics of such an environment: (1) support for self-organization, (2) being shared and collaborative, (3) support for the evolution of ideas, (4) representing higher-order organizations of ideas, (5) support with varied and multiple contexts, (6) support feedback, (7) opportunistic linking of persons and groups, and (8) promoting interaction within and between communities. Yücel and Usluel (2016) suggested that scaffolds were one of the most important support tools for the epistemic agency of students in the knowledge building process, in which students followed their improvements. The scaffolds contributed to opinion building and expression; the quantity, content, and quality of interaction and participation; and thus the learning of students. Although the user interaction with content (tagging) would suggest higher levels of learning, the perception of knowledge building is not affected by user participation behavior, and lurkers and posters could equally benefit from the service (de Carvalho, Furtado, & Furtado, 2015).

In order to improve the scientific objectivity of knowledge building, many scholars put forward different knowledge building models, hoping to effectively analyze knowledge building. In some knowledge building models, it is difficult to code the contents of knowledge building, and in some, it is difficult to correspond with the process of knowledge building. In this way, there will be contradictions in guiding the knowledge building analysis. At present, the research on knowledge building still lies in the establishment of knowledge building models, content analysis, and knowledge building quality analysis. Qualitative research of content analysis and quantitative research of statistical analysis are mainly used in the research methods. The main content of the research lies in analyzing the quality of knowledge building and analyzing the level of learner knowledge building in different learning environments and teaching modes. With the development of computer and network technology, people began to pay attention to knowledge building (including group knowledge building) in collaborative learning environments supported by computers and began to pay attention to individual knowledge building and group knowledge building in online learning, and how to use technical support and to promote the construction of knowledge of individuals and groups. With the development of MOOC technology and platforms, the optimization and popularization of mobile learning terminal equipment, the global coverage of wireless networks, and the use of MOOCs to carry out mobile learning have attracted people's attention. However, in MOOC learning involving a large number of participants, the level of learner interaction is exactly what we need to study. This paper will study how the social network analysis used to evaluate the learners contributed to the quality of knowledge building of MOOC learners.

21.3 Methodology

We took *Classics of Chinese Humanities: Guided Readings* on the Coursera platform as a case study. We collected data of the number of learners participating in the interaction and the number of interactive topics and content. The social network analysis method and the content analysis method were used to discuss the learners' interaction behavior and knowledge building of the MOOC learning forum (six themed forums, respectively, recorded as topic1, topic2, topic3, topic4, topic5, and topic6). The case has 286 students, after removing one teacher and some anonymous users (which are unable to be determined to be the same person or not).

When using the social network analysis method, it is necessary to construct a two-dimensional matrix scale for each participant. The row of the scale represents the initiator of the interaction; the column represents the topic or knowledge building level; and the intersection of row and column is the number of interactions between the two. This study builds a matrix of learner–learner's subject and learner–knowledge building level to analyze the extent of learners' knowledge building. We used the UCINET 6 software to analyze the data, then used the NetDraw software to draw the social network graphs of students and knowledge building levels. UCINET 6 for Windows (Borgatti, Everett, & Freeman, 2002) is a software package for the analysis of social network data. It was developed by Lin Freeman, Martin Everett, and Steve Borgatti. It comes with the NetDraw network visualization tool. The program is menu-driven, which makes it very easy to use. The main window provides the following choices: File, Data, Transform, Tools, Network, Options, and Help together with three buttons. Each of these choices is itself a submenu with additional choices. We can analyze the density, centrality, subgroup, structure holes, two-mode data, and so on with UCINET 6 for Windows.

NetDraw (Borgatti, 2002) is a program for drawing social networks. It can be used to draw graphs with multiple relations and can read multiple relations on the same nodes and switch between them (or combine them) easily. It can present valued relations, such as selecting only strong ties, only weak ties, etc. It can represent the node attributes of the network graph. Also, it includes a limited set of analytical procedures, such as the identification of isolates, components, k-cores, cut-points, and bi-components (blocks). NetDraw can read and process two-mode data, such as the Davis, Gardner, and Gardner data and automatically create a bipartite representation of it.

We encoded the interactive contents based on the knowledge building analysis model, which includes five levels of knowledge building: PH1, PH2, PH3, PH4, and PH5. On the basis of the social network and the knowledge building level, we analyzed the relationship between social attributes and knowledge building.

21.4 Analysis and Discussion

21.4.1 Learners' Participation in Topic of Knowledge Building

The interactive data from the learners participating in the topic discussion is transformed into a two-mode matrix. The rows of the matrix are the learners, and the columns of the matrix are the discussion topics. The values of the intersections are the number of times the learners express their opinions in the topic forum. This matrix is analyzed using UCINET 6 software for Windows (version 6.624) and NetDraw to calculate the central value of each topic (as shown in Table 21.1) and draw a social network of subject knowledge constructs (Fig. 21.1).

Table 21.1 Central values of the six topics

	Degree	Eigenvector	Closeness	Betweenness
topic1	0.112	0.065	0.376	0.012
topic2	0.566	0.441	0.552	0.207
topic3	0.339	0.268	0.447	0.072
topic4	0.196	0.168	0.399	0.019
topic5	0.266	0.217	0.421	0.044
topic6	0.091	0.059	0.370	0.006

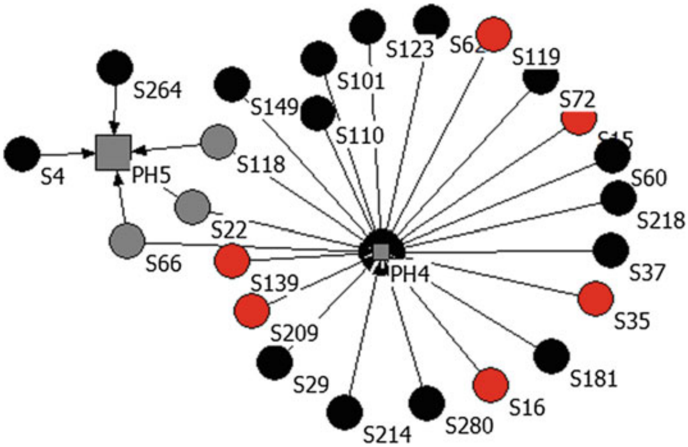

Fig. 21.1 Learners achieved high levels in PH4 and PH5

In Table 21.1, the Degree, the Eigenvector, the Closeness, and the Betweenness of topic2 are the largest, which shows that the topic2 is at the core of knowledge building, attracting the most users to participate. All the central values of topic6 are the smallest, indicating that topic6 is at the edge of the network location, having the minimum number of participants. For the aspect of time, topic1 to topic6 are based on the time to establish the theme of the forum, belonging to the first chapter to the sixth chapter of the learning content. At the beginning of the course, the number of participants is small, and the students are relatively unfamiliar, which are still in the intensive learning stage, having little knowledge of the curriculum. Not only are their ideas are not mature, but also the communications between them are relatively small. In the second chapter of the course, the sense of familiarity between students increased, and they also had a certain sense of belonging in the community. The communications between students began to increase gradually. From the study of the first chapter, the students had a deep understanding of the course and could use the thinking of the course to think and analyze problems. So, from the beginning of

Table 21.2 Central value of knowledge building level

	Degree	Eigenvector	Closeness	Betweenness
PH1	0.748	0.569	0.680	0.407
PH2	0.549	0.446	0.543	0.203
PH3	0.423	0.351	0.481	0.119
PH4	0.077	0.065	0.367	0.004
PH5	0.017	0.016	0.352	0.000

the second chapter to the end of the fifth chapter, the four central indicators are relatively high. However, there is a decline in topic 4 again, which is more difficult with the content of the chapter.

The contents of the speaker's speech in each topic forum are coded according to the knowledge building coding system with themselves to construct the two-mode matrix together. The row is the learner, and the column is the level of knowledge building. The intersection of rows and columns is recorded as the frequency of the knowledge building level of the learner. The central value of the knowledge building level is calculated as shown in Table 21.2. It can be seen that the central values of PH1 are the largest, which indicates that most students are at the lowest level of knowledge building. Then come the PH2 and PH3 levels of knowledge building, indicating that the vast majority of students are still in shallow knowledge building, and that it is difficult to achieve a high level of knowledge building. The central values of PH4 and PH5 were lower than the other three levels, which indicates that most students did not achieve a high level of knowledge building, and only a very small number of students had a high level of knowledge building. Most of their discussions were only in the level of the exchange of information, point of view sharing, problem solving, and meaning discussion.

NetDraw software was used to draw the high level of knowledge building in PH4 and PH5 of the social networks, as shown in Fig. 21.1. It can be seen that among the 286 learners, only S4, S22, S66, S118, and S264—five learners—had reached the highest knowledge building level (PH5). S22, S66, and S118 all achieved the PH4 and PH5 knowledge building levels. We suggest that learner engagement affected their performance. Those students who frequently communicated, discussed, shared, and collaborated with others could get a high level of knowledge building. As studies suggested that those learners who posted frequently in discussion forums would have a higher rate of passing the course (Anderson, Huttenlocher, Kleinberg, & Leskovec, 2014; Santos, Klerkx, Duval, Gago, & Rodríguez, 2014), those learners who participated in the topic discussions would get high knowledge levels. Anderson et al. (2014) found that high achievers consumed many lecture videos. Santos et al. (2014) analyzed students' behaviors in MOOCs and found that students who participated more in a course's activities had a better chance to pass the course.

21.4.2 Learners' Social Network Attributes in Knowledge Building

UCINET software was used to calculate the central attribute value of the two-mode matrix of *Classics of Chinese Humanities: Guided Readings* learners—knowledge building, as shown in Table 21.3. On the degree centrality index, the learner's S22, S66, and S118 Degree and Closeness are up to 1, which indicates that the three learners had the knowledge building of five levels from PH1 to PH5, and in the three learners' individual network, the distance of three people to five knowledge building levels was equal. Simultaneously, the learner's S22, S66, and S118 Eigenvector and Betweenness values all reached the maximum, which indicates that these three learners are at the core of the knowledge building network and occupy the most important position in knowledge building. They play an important role in improving the knowledge building level and have a great influence on controlling the knowledge building of other learners.

The learners who have high social network attributes are active learners, and they could achieve high knowledge building levels. Sharif and Magrill (2015) suggested that active learners in discussion forums might be a key component of successful online courses. But, the instructors had to review and respond to student comments, raise questions, and make observations to guide learner discussions in a desired direction. Active learners completed the course thoroughly, visited the course periodically, and took part in discussion forums frequently. The engaging behaviors and patterns of active learners are likely to prove the richest for improving the quality of learning (Tseng, Tsao, Yu, Chan, & Lai, 2016).

Table 21.3 Center results of *Classics of Chinese Humanities: Guided Readings* learners—knowledge building two-mode data (descending order by degree, taking the first 10 users)

User	Degree	Eigenvector	Closeness	Betweenness
S22	1	0.095	1	0.007
S66	1	0.095	1	0.007
S118	1	0.095	1	0.007
S37	0.8	0.094	0.997	0.004
S60	0.8	0.094	0.997	0.004
S72	0.8	0.094	0.997	0.004
S110	0.8	0.094	0.997	0.004
S123	0.8	0.094	0.997	0.004
S181	0.8	0.094	0.997	0.004
S214	0.8	0.094	0.997	0.004

21.5 Conclusion

This paper analyzed the relationship between social attributes and knowledge building of MOOC learners from the perspective of social networks. The main conclusions are as follows:

21.5.1 MOOC Learners Can Actively Participate in Topic Knowledge Building

With the progress of course teaching and the development of learning activities, the number of learners participating in courses and in topic discussion is increasing. At the same time, learners will have a deeper understanding of the curriculum after a period of teaching activities; then, they are able to think about the curriculum and issues and form a personal view. Therefore, the frequency of learner participation in the first two weeks of the course is relatively low. After 2 weeks, the frequency and depth of learner's participation in the course of discussion increase significantly. However, the difficulty of the discussion will affect the participation of learners in the course of discussion. At the end of the semester, learners mainly finish the final assignments and exams, so the frequency of learner participation in the topic discussion is reduced. The communication focuses more on peers' evaluation and final examinations, which are mainly information sharing and consulting; the knowledge building level is relatively low.

In addition, the learner's interest affects the learner's participation on the topic. It is difficult to promote students participating in the topic discussion, because they only participate in the topics which they are interested in; then, learners are willing to share ideas and information on topics (Chunngam, Chanchalor, & Murphy, 2014).

21.5.2 MOOC Learners' Knowledge Building Level is Generally Low

Most MOOC learners are in the middle and low stages of knowledge building, while there are deficiencies in high-level (PH4, PH5) knowledge building. MOOC learners' interaction is mainly on resource sharing, knowledge acquisition, viewpoint negotiation, and conflict and problem solving, which belong to low-level knowledge building. There are few constructs to test and modify new ideas and apply new knowledge when learners acquire new knowledge. Therefore, on the one hand, it is necessary to cultivate learners' advanced knowledge building ability, such as learners' thinking ability, analysis ability, and application ability. On the other hand, strengthening the transformation of learners' tacit knowledge to explicit knowledge is necessary. Learners acquire resources and construct knowledge is an externalization of tacit knowledge, which is the process of absorption and consumption. The exploitation of tacit knowledge is the process of learners expressing individually, creating knowledge, and giving feedback, which emphasizes the production of knowledge, the regeneration of high-level knowledge, and the cultivation of learners' innovation ability.

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