Developing a Method for a Holistic Design of Mobile Learning

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By

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ABSTRACT

Mobile learning provides unique learning experiences for learners in both formal and informal environments, supporting various pedagogies with the unique characteristics that are afforded by mobile technology. Mobile learning, as a growing topic of interest, brings challenges of design for teachers and course designers alike. Current research on mobile learning has covered various aspects such as personalisation, context sensitivity, ubiquity and pedagogy. While existing theories and findings are valuable to the understanding of mobile learning, they are fragmented and separate, and need to be understood within the broader mobile learning paradigm.

This dissertation unifies existing theories into a method for mobile learning design that can be generalised across mobile learning applications. This method develops from a strategy. By seeking objectives, identifying different approaches to learning and understanding the context in which the course will exist; the method helps to guide the content, delivery and structure of the course towards a successful implementation that is evaluated against the initial objectives set out.

Using a design science research methodology the method was developed and evaluated. It was found to be a useful starting point for providing the holistic guide to designing mobile learning. This research contribution has brought to light the need for more guiding literature that assists teachers in applying the theory around mobile devices and the method proposed, is a step in this direction.

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1 INTRODUCTION

1.1 Background

Mobile learning has been an emerging topic since the introduction of cellular phones and wireless technology; recently this interest has picked up pace due to further technological advances that are making mobile technology simpler and more interesting to use as a means of learning (Burdick & Willis, 2011; Weilenmann & Juhlin, 2011). Mobile learning is the combination of mobile technology and its affordances that create a unique learning environment and opportunities that can span across time and place.

Learning is a form of communication, of transferring knowledge and information, so it makes sense that the most “ubiquitous form of communication” (Franklin, 2011) is used as a tool for learning. What is questioned, however, is not so much whether mobile technology should be used but how it should be used. The uniqueness of mobile learning lies in it being a ubiquitous, social, context sensitive, and collaborative tool (Ozdamli & Cavus, 2011; Patokorpi, 2006). Various models for understanding mobile learning systems have been created and adapted to measure performance, user acceptance, understand the user’s context, and understand and develop mobile systems and technology (Parsons & Ryu, 2006; Sha, Looi, Chen, Seow, & Wong, 2012; Williams, 2009).

Mobile learning design is the design of a mobile learning course taking into account what needs to be delivered, how it will be done and the structure of such a delivery. This design needs to look at the “real needs of instructors and learners” (Alvarez, Alarcon, & Nussbaum, 2011) and at the social aspects that mobile technology was originally intended for to get the most out of mobile learning. In addition it should consider the ‘as-lived-experience’ of mobile learners (Kjeldskov & Stage, 2012), because in essence learning is deeply social (Burdick & Willis, 2011). However, the determining factor for mobile technologies in learning will be dependent on its adoption by both educators and the learners (Alvarez et al., 2011).

Williams (2009) considers the major element of a successful mobile learning platform to be the “instructional design”; by simply posting lecture content as-is on the Web, the teacher is not necessarily creating “a viable tool” for learners. While many universities have provided applications, these have been non-instructional, and thus there is little experience of how to deliver learning through mobile technology (Cheon, Lee, Crooks, & Song, 2012).

Another issue is that “few researchers have discussed ways of integrating mobile devices with web-based learning systems to cover most learning processes by generating a ubiquitous learning environment” (Chen et al., 2008, p.78). Designers and teachers need to have a basic understanding of the various characteristics of mobile learning and how they can best be used. The use of traditional user experience knowledge is insufficient for this as it doesn’t take into account those unique characteristics of mobile learning such as mobility and how smaller screens

limit the type of content delivered (Chittaro, 2011; Costabile et al., 2008; Naismith, Lonsdale, Vavoula, & Sharples, 2004).

Where mobile learning is a supporting tool to the classroom, understanding the contexts and teaching concepts are required to effectively implement the system (Alvarez et al., 2011). The theme that arises in the literature is one of understanding: the designer needs to be able to understand and conceptualise all aspects of the mobile learning system to be as effective as possible in delivering the objectives.

1.2 Purpose of the research

This dissertation brings together the research around mobile learning to create a method for mobile learning design that does not prescribe the content and structure but rather facilitates the process of planning and creating a course while ensuring that the various aspects such as technology, context, usability, and pedagogy are considered along with the objectives of the course.

The objective of this research is to create and evaluate a method for mobile learning design from existing mobile and learning theory that can be used by business persons and teachers alike. By evaluating the method through an experiment this research hopes to explore how mobile learning differs from current pedagogical learning methods and understandings, and what mobile learning lacks compared to current channels of learning. The experiment will test the proposed method to see how mobile learning can be designed to support abductive reasoning, to ensure

sense making and to cater for different learning styles in different contexts. The research explores the following questions:

- How can the technical aspect of mobile learning research and educational research be combined to get a holistic and effective approach to designing mobile learning?
- What would a framework for mobile learning design look like, and what are the steps to follow this method?
- How can an understanding of a mobile user's as-lived mobile experience be used to maximise the potential of mobile learning?

1.3 Scope of the research

This dissertation explores mobile learning from a pedagogical, technological and as-lived perspective, to combine these different lenses into creating a method of learning that is holistic in its approach.

This dissertation does not go into the content creation, implementation or final evaluation of the mobile learning; though these phases are mentioned as completing the process for designing mobile learning and may be influenced by the steps described and leading up to these final phases. In conducting the experiments it was assumed that the participant(s) had a good idea of what they were going to teach and had access to the relevant and necessary content to create such a course.

The dissertation is aimed at a large audience from educators, business professionals and any person interested in designing mobile courses. Due to time constraints only two rounds of experiments were conducted, once by the researcher and again with an external participant. To generalise the research artefact there would need to be further practice and implementation of the method.

1.4 Significance of the research

This dissertation proposes a method with a description of the steps to implement it, supported by literature that can be used by both practitioners and academics alike.

The academic significance of this dissertation is in its attempts to create an understanding of a complex system of mobile learning design. By combining existing research, finding the similarities in the literature; using different lenses from the technological impacts to the pedagogical requirements as well as the influences that touch mobile learning; this dissertation provides the groundwork for a holistic approach to mobile learning design.

In describing the steps to implement the method created from the literature, this method is significant to practitioners that are designing or want to design mobile learning. It provides a guide that is approachable and can be followed by the practitioner. It is also hoped that this method will have an implied effect on the learners using mobile learning, as the courses are improved with this holistic approach in mind.

1.5 Outline of the Study

Following the introduction this dissertation begins with a literature review in Chapter 2. The literature review investigates what mobile learning is, the characteristics of mobile learning, learning theories and existing mobile design theories that could be used to develop the mobile learning design method. Chapter 3 describes the design science research methodology applied in this research and its significance. Chapter 4 describes the research artefact – the method for mobile learning design– drawing from the literature review and explaining the steps in implementing the method. Chapter 5 looks at the observations and feedback from the experiments, implementing the method, and the evaluation of this research. The research is concluded with a summary and recommendations for further research in Chapter 6.

2 LITERATURE REVIEW

2.1 Introduction

The literature review begins by defining what mobile learning is. From there it delves into the various characteristics of mobile learning and its affordances to learning as well as the many contexts of mobile learning and the consideration of an as-lived experience in mobile learning design. Next some existing processes for mobile learning design are discussed, as well as the main objectives of learning in general. Thereafter the dissertation examines the knowledge dimensions of learning and the categories of learning that can be translated into mobile learning. From these explorations this dissertation then presents and discusses a method for mobile learning design based on these areas, and a research proposal to test the method through a design-science approach.

2.2 What is Mobile Learning?

There are various definitions of mobile learning. The basic understanding is that mobile learning is the “provision of education and training on mobile devices” (Yousuf, 2007, p.117) or it is a combination of e-learning and mobile technology (Ketterl, Heinrich, Mertens, & Morisse, 2007; Parsons & Ryu, 2006). While mobile learning may resemble e-learning in some cases this view is limited in that it removes all other features of the mobile device such as messaging and it also

excludes the limitations of mobile devices such as the small interface that limits the ability to simply view e-learning on a mobile device.

A further look into what it is that makes mobile learning different to face to face and e-Learning is mobility. Being able to move around is a key feature that differentiates mobile learning from other learning environments; it is seen as freeing the learner from the classroom, allowing learning to take place anywhere and anytime. Mobility has become a major focus of mobile learning design alongside personalisation (Botha, Herselman, & van Greunen, 2010; Costabile et al., 2008).

Developing the definition of mobile learning, Yordanova (2007) sees mobile learning as “learning that is wireless and ubiquitous” in nature. This ubiquity is a common concept brought up around mobile learning that is seen as not simply a portable device but “the ability to learn across contexts” (Al-masri & Mahmoud, 2012, p.604; Cavus & Al-Momani, 2011, p.1476). From these ideas, the understanding underlying this dissertation will be that mobile learning is unique by nature and is the combination of mobile technology and its affordances that create a unique learning environment and opportunities that can span across time and place.

Research on mobile learning has emphasized and repeated the advantage of using mobile technology because of the characteristics and opportunities that mobile learning offers. Common characteristics that are brought up in many research papers around m-learning are those of ubiquity, nomadicy, personalisation, interactivity, and collaboration. The technology itself allows for these characteristics because of its size, weight and portability. The small screen size has been noted as

a drawback. Being a part of most people's daily lives, mobile technology doesn't need to be taught and so learning can be integrated quickly and easily into a persons' everyday life (Al-Hmouz, Shen, Yan, & Al-Hmouz, 2010; Cavus & Uzunboylu, 2009; Ozdamli & Cavus, 2011; Rogers, Connelly, Hazlewood, & Tedesco, 2009).

2.3 Mobile Technology

Mobile technology is becoming more and more available to the world at large bringing the opportunity to reach a wider audience with ease. A study showed that "communications seems to be a necessity once relative spending increases towards the lower income segments of world population" (Pöllänen & Eloranta, 2008), meaning that even very low income people have access to mobile technology as a form of communication. This holds a huge potential for innovation and learning in its attempts to reach every sphere of society (Alvarez et al., 2011).

This growth in smartphone and tablet usage is promising for education as mobile technology "offers the appropriate educational environment to assist learning activities both inside and outside the classroom" (Yousuf, 2007, p.117). The flexibility and attraction to smartphones and tablets, while becoming cheaper and more accessible, are fast becoming the most ubiquitous form of communication (Franklin, 2011). Mobile technology's ease of use and accessibility to an entire population and the world at large makes them a powerful tool for communication and sharing knowledge (Alvarez et al., 2011).

There is a great need to reach disadvantaged communities, and mobile technology offers an affordable and effective option. Mobile devices have been developed in such a way that they can support multiple computing properties and resources. The drawback is that the devices often have small interfaces, bringing about various technical challenges of how to design learning in an appropriate way for users to attain knowledge successfully and without interruption (Dunlop & Brewster, 2002).

Further to the reach and accessibility of mobile technology, is the familiarity of it to learners. Cavus and Al-Momani (2011) points out that “mobile telephones do not require technological training, do not intimidate users, and remain unobtrusive in classrooms.” Alvarez et al. (2011, p.1975) makes an important statement that should be kept in mind while advocating for mobile technology in a learning environment, “technology does not have an intrinsic effect on learning outcomes” but technology as it is can be used to support teaching methods where it is most effective.

Mobile Technology is one of the most accessible means of communication because of its affordability and maintains high appeal with the many characteristics that it brings. The characteristics afforded to Mobile technology in a learning environment include: “portability, instant connectivity, context sensitivity” (Cheon et al., 2012) as well as social interactivity and individuality (Klopfer et al., 2002 as cited in Naismith, Lonsdale, Vavoula, and Sharples, 2004).

2.4 Mobile Learning Characteristics

The mobile learning characteristics discussed here give a picture of what is contained in mobile learning and how it can be used most effectively to bring about learning. First the dissertation looks at the portability of mobile phones, which is categorised within nomadicy. Being nomadic in nature leads into the ubiquitous nature of mobile technology, the idea of instant connectivity and the ability to connect in any situation. With the idea of being nomadic and ubiquitous it is then important to consider the context sensitivity of mobile learning. Within these contexts the next characteristic to consider is the interaction and collaboration that mobile learning can afford. Finally, mobile learning also considers personalisation or the individuality of the user, their preferences etc. Figure 1 illustrates the major characteristics and contexts of mobile learning that are discussed here.

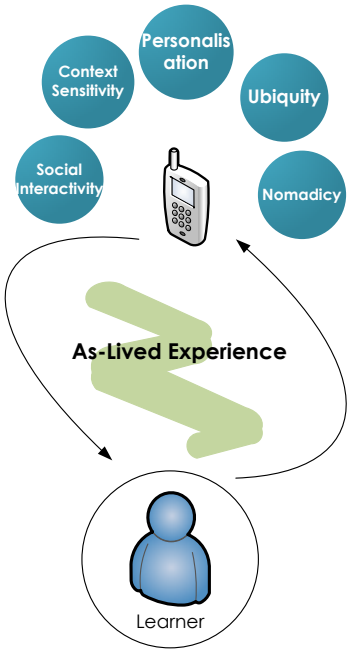

Figure 1: Contexts and characteristics of Mobile Learning paradigm

2.4.1 Nomadicy

The most obvious difference with mobile learning is its portability. Mobile devices can travel anywhere with a person, with relative ease, but it's not just the moving around but rather a nomadicy. Nomadic refers to "a phenomenon in which the state of being on the move is the normal state and not a break from the normal" (Patokorpi, 2006, p.21); even when the device is disconnected, the learner is able to access certain material nomadically. So "being mobile is understood as a form of being-in-the-world" (Fällman, 2003 as cited in Fischer, 2011, p.19) This changes our perspective of mobile use from something that we are introducing to a learning environment to something that already exists and is part of that environment, as well as learning being something that is not exclusive to a formal situation but can be nomadic as well.

Being nomadic in nature is the very first intention of mobile technology and allows users of this technology to move about and still have the ability to use all the features of the device to make calls, search the web and more, the nomadic nature brings out technological possibilities coupled with the personal aspect of mobile phones (Arnold, 2003; Naismith et al., 2004). The learner is thus able to take their learning anywhere and anytime without the constraints of a classroom, making learning available at times that are more suitable to the learner, even on the move; this freedom empowers learners (Cavus & Al-Momani, 2011).

The drawback of this nomadicy is that it expands the users' context and control over the situation of learning, allowing for distractions and interruptions to be part of the

learning experience (Costabile et al., 2008). Fischer (2011) focuses on the interruptions that users' experience with mobile phones and has created a model to help understand the nature of both positive (such as reminders and initiating engagement) and negative interruptions (which affect the user's ability to continue a task). Fischer's (2011) main conclusion around interruptions was that, the degree to which something interrupts a user is dependent on the context - the importance they place on what is interrupting the situation; and the timing of it in each moment.

Interruptions can include messages, calls and reminders that can interrupt the flow of the context, either on the device while the user is learning or in the actual situation that the person is present in. The nomadic nature of the user implies that "the user is distracted and has a short attention span" (Botha et al., 2010, p.35). This short attention span is affected by the overwhelming amount of information available to an individual using their mobile phone, so it's important that mobile learning as a nomadic way of learning, supplies users with exactly what they need in the right context (Bray, Epstein, Hill, & Thomas, 2006). This leads us to consider ubiquity in mobile learning.

2.4.2 Ubiquity

Ubiquity refers to the interconnectedness of the mobile device within its environment, and other devices, it's more than just being able to move about, it's being able to access information simply and fluidly in any situation (Patokorpi, 2006). "Mobile technologies forge ubiquitous learning spaces and experiences across different scenarios or contexts" (Sha et al., 2012). Ubiquity also refers to the spontaneity of

mobile learning, which is allowed because of its on-the-move context. Ozdamli and Cavus (2011) consider spontaneity as a defining characteristic, “revolutionising education” to being nomadic and contextualised. The ability to learn in just about any context with any mobile device is ubiquitous (Chen et al., 2008).

“Mobile devices have become one of the most powerful technologies available to the individual for acquiring knowledge in a ubiquitous manner” (Al-masri & Mahmoud, 2012, p.603). Being connected to the internet, through wireless networks, and telecommunications, means that the world is more connected than ever before. This influences the way we see ourselves in the world, where we are and who we’re able to connect to, and the information that is available to us all the time; which leads us to consider what contexts exist in a mobile learning environment.

2.4.3 Personalisation

Mobile phones cannot know what context you are in and the sensitivities of it, such as if you are in a meeting or socialising. They act independently of the situational context (Fischer, 2011). It is however important that the context is considered in the design to give the user the best experience possible. A lot of research has been conducted in this area aiming to get to an intelligent device that can react to the environment and respond appropriately (Al-Hmouz et al., 2010; Kearney, Schuck, Burden, & Aubusson, 2012).

Using a mobile device for learning personalises learning and creates anonymity and privacy simply through ownership of that device and the control of the user.

Numerous studies have been done to attempt to customise a mobile learning environment to a particular learner's context and history. One side of personalisation is allowing for the learner to "have the option to choose learning content based on their interest" (Al-Hmouz et al., 2010); they can also make small customisations to the look and feel of the content. Personalisation goes even further though, where algorithms have been produced that will use the data collected from the users' performance to customise content that is at their level and preference of learning (Al-Hmouz et al., 2010; Ozdamli & Cavus, 2011). This research is at a technological level and lacks the "user's point of view" (Patokorpi, 2006) towards being personalised.

Kass (1991 as cited in Al-Hmouz et al., 2010, p.784) speaks about "systems that tailor their behaviour to individual users' needs" as well as containing personal information about the user that can help to tailor the mobile technology's behaviour. "Learning is no longer restricted by space and time" (Arnold, 2003; Sha et al., 2012) so it becomes fundamentally important that the user is able to call up the information that is required in their situational context. The learner should be able to choose when and where and how much learning to consume using their mobile devices (Williams, 2009).

2.4.4 Social Interactivity

Collaboration is highly supported for mobile learning. The technology removes borders and allows learners to collaborate with peers or teachers around the world, how and when they want to. This collaboration increases active participation by

students. There is a parody at play here where mobile learning affords both privacy and freedom to the learner (Alvarez et al., 2011; Ozdamli & Cavus, 2011; Patokorpi, 2006) and “it provides its users with a high degree of independence, mobility and flexibility” (Arnold, 2003, p.243) as well as allowing for teachers to respond “in ways that are meaningful to the learner” (Schultz, 2011).

Although there are many advantages to having this collaborative communication it can also be disadvantageous for the learner. Being out in the real world means there are plenty of distractions that can disturb a learner’s pattern of thought (Rogers et al., 2009), so when a learner is interacting with the learning environment it is just as easy for the learner to get involved in something that is happening more immediately in their situational context, and disconnecting from that engagement. The recent developments in mobile technology have increased interaction (Al-masri & Mahmoud, 2012).

Mobile learning offers the opportunity to move beyond the formal classroom and allow more freedom for learning anywhere, anytime. The nature of mobile devices being portable and personal, support many types of interaction (Naismith et al., 2004) “One way of ensuring that learners engage in fruitful collaboration is to engage them in structured interactions, based on prescribed rules establishing how they should form groups, collaborate, and solve problems” (Alvarez et al., 2011, p.1962)

A useful model for understanding the types of interactions that exist has been proposed by Moore (1989 as cited in Abdous & Yen, 2010), in this model there are three types of interaction: learner-to-content interaction (LCI), learner-to-teacher

interaction (LII), learner-to-learner interaction. Willis and Gunawardena (1994 as cited in Abdous and Yen, 2010) introduced the fourth type of interaction: learner-interface interaction.

These interactions are highly supported by mobile technology and can be utilised quite effectively in a mobile learning environment. Learner-to-Content interaction plays a key role in forming ways of thinking for the learner that will facilitate learning. Learner-to-Teacher interaction is a motivational and facilitation role in learning as well as providing a supporting role. Learner-to-learner interaction allows for more collaboration to take place. Learner-to-interface interaction is about the learner's experience with the mobile learning and the quality of it (Abdous & Yen, 2010). These interactions also create formal, informal, social and personal spaces for learning.

2.5 Limitations of Mobile Learning

There are many limitations that need to be considered with mobile learning. The obvious limitations are the ones of the small screen size, the audio quality and connection to the network affecting the speed and quality of delivery for learning content. While a small interface might be limiting in regard to what can be delivered to a learner it could also be advantageous, in that it forces the content to be to the point and meaningful or presented in a more creative manner, which could benefit learners. Attention span or the ability to take in large amounts of information at a time is a shortcoming of learning itself, so the limitation of the small interface actually

assists this shortcoming by catering for it in small chunks of information (Chittaro, 2011; Fischer, 2011; Yordanova, 2007).

In some cases the limitation of battery life and the small screen life mean that mobile learning might be better used as a support system to traditional learning, as a middle path between e-learning and the classroom; allowing for just what is necessary when on the move (Chen et al., 2008).

Moving away from the technical aspects of the devices, the vast amount of information available on the internet has made it a common resource to find out or learn about something. Mistaking the internet as "reflecting reality" (Bray et al., 2006) can be a problem for learners as misunderstandings or confusion arises over a topic. It is necessary that mobile learning guides the student, and helps to filter unnecessary information.

Common design issues in mobile learning are those of: "usability, communication and interactivity" (Ali, Ouda, & Capretz, 2012). Other things that should be considered are features such as location-based services that could be seen as an infringement on a learner's privacy, so a learner may not be willing to allow for it. If learning becomes so invasive in an informal environment that it overtakes their social network then learners may have more reason to get rid of the mobile learning than to use it (Naismith et al., 2004).

After exploring the many characteristics of mobile technology and the affordances to mobile learning as well as its limitations, the next section focuses on the contexts that surround mobile learning.

2.6 Context Sensitivity in Mobile Learning

Keeping in mind that mobile learning is ubiquitous and nomadic in nature, this section considers the contexts that exist, are crossed and are created through mobile learning. Context is important as it can help in the design of the mobile learning environment. Delivering learning content that is based on the current context of a user should be an important goal of mobile learning (Al-Hmouz et al., 2010).

“Today, we live in two spheres of existence, a physical sphere and a digital sphere” (Bray et al., 2006) and then these spheres overlap and this can be seen as the interacting of these two worlds. These two spheres are often out of our control, but what can be controlled is what and how we deliver learning into these two spheres to influence the user’s interaction within these overlapping spheres. Further investigation into these spheres is required. Mobile devices and technology in general are now part of our daily lives, and this means that there exists very little separation between work, socialising and our private lives as it is all accessible wherever we are (Weilenmann & Juhlin, 2011).

Within these digital and physical sphere’s Al-Hmouz et al. (2010) proposes a framework for learner personalisation that takes into account different contexts, he refers to these as statuses. The four major statuses that Al-Hmouz et al. (2010) propose are (1) “situation status”, “learner status”, “knowledge and shared properties status” and “educational activity status”. The FRAME model as designed by Koole (2009) identifies information contexts and describes how these overlap each other to

create further contexts; the main contexts are the device aspect, learner aspect and social aspect. Combining these perspectives this dissertation has grouped the contexts into three major contexts that will be explored more fully. These are the (1) learner's status, referring to the person's personal being and preferences, the (2) situational context refers to the world that exists physically and nomadically around the user and then the (3) learning environment context that takes into account the environment that is created through the integration of the digital and physical spheres. These contexts are represented in Figure 2 for visual understanding.

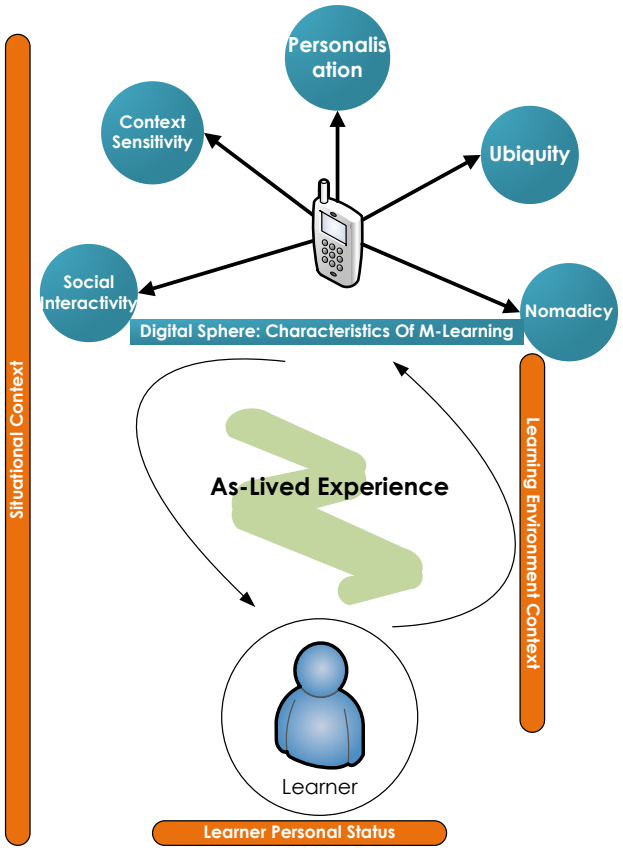

Figure 2: Different contexts in mobile learning

2.6.1 Learner's Personal Status

The learner's context considers aspects of the learner such as preferences, demographic information, and learner history as well as "cognitive ability, memory, prior knowledge , emotions and possible motivations" (Al-Hmouz et al., 2010; Koole, 2009).

Being in a constantly changing environment means there are numerous influences surrounding the learner that can affect their behaviour, emotional state and concentration and ultimately their ability to use the mobile learning service appropriately. While there is no control over these aspects it is important to keep these in mind when considering the implications of our design.

2.6.2 Situational Context

Context can be many things for mobile learning. For one, being mobile in nature means that every situation brings its own context that is unpredictable and determined by the user and their environment; thus "mobility and context are seen as inextricably intertwined" (Fischer, 2011, p.19). The nomadic and ubiquitous nature of mobile technology means that a user's context is constantly changing due to that movement (Patokorpi, 2006).

The social/situational context is the actual context in which the learner is currently existing as they access or receive learning from a mobile device (Al-Hmouz et al., 2010). It can be defined by the social interactions, cultural surroundings and rules around communication (Koole, 2009). This context will involve any distractions or

interruptions to the learning environment context. Chittaro (2011) points out that using mobile technology can often be a secondary task within our social context, mobile phones have introduced an unpredictability, when one person calls another they are not sure what situation that person is in and cannot know whether they are interrupting that person. It is also a common expectation that someone can answer a call at any time as they will always have access to their phone. The mobile device is then an extension of that person's situation, so while a user is interacting with the mobile technology they are also involved with "the world as negotiated and enacted in the moment" (Fischer, 2011, p. 19).

Fischer (2011) further delves into the idea of 'anywhere, anytime' and questions whether people do actually have their devices on them all the time. While Patel et al. (2006 as cited in Fischer, 2011) found that users "keep their phones switched on 85% of the time on average, but only 58% of the time on average did they also have the phone within arm's reach." So while mobile devices are definitely a part of a person's daily living, it's not necessarily something that is continuously consumed as some might be led to believe. This is an important consideration as it questions how often and how regularly users would engage with their phones for mobile learning. Fischer (2011) also noted that "when users were away from home, they carried their mobile phone with them significantly more often than when at home." This means that the situational context of a user will often be in a non-constant situation; this being on the move often means "that people can devote only a very limited attention to the device while they are on the move" (Chittaro, 2011, p.331). This brings up an interesting conflict that needs to be taken into account when designing, even though

learners are able to learn on the move there is also higher chance of distraction and interruptions.

2.6.3 Learning Environment Context

Mobile learning has the ability to cross the boundary of a learner's context and "facilitate sense making activities" (Rogers et al., 2009). The learner is now able to move beyond the classroom, both taking the classroom with them while being removed from that context. The mobile learning environment is able to create its own environment within any situational context and engage the learner (Alvarez et al., 2011; Patokorpi, 2006).

The mobile learning environment is thus created in a way that it is delivered and the learning styles that it caters for (Al-Hmouz et al., 2010). The mobile learning context is where the situational and learner's personal context meet within the digital sphere. The digital sphere can be seen as the device aspect looking at the functional ability of the device, its physical and technical attributes from the hardware and software (Koole, 2009).

This learning space where designers and teachers have the most influence over. Mobile phones have been observed as only being "used for short bursts of times" (Rogers et al., 2009), so learning material would need to cater for such. Being out in the world means that learners can stop and "reflect… deepen their understanding and help integrate their ideas" (Rogers et al., 2009, p.112). Furthermore, mobile

phones are capable of delivering games that stimulate learning and engagement in a subject (Burdick & Willis, 2011).

Using mobile devices in museums, it has been observed that children tend to read the device on their own as opposed to when there was no device, where they would work things out together. There is a difference in the learning experience created through mobile devices and this is the learning environment context created (Rogers et al., 2009).

Mobile learning thus includes the learner's personal context within a situational context, and these can be considered physical spheres and by introducing the digital sphere into the learning context we have a mobile learning environment.

2.7 As-Lived Experience

A theoretical approach to designing for mobile learning should observe the as-lived experience. To create this as-lived lens this dissertation focuses on the phenomenon as proposed by Winograd and Flores (1986) from the chapter "using computers: a direction for design" that is built upon an understanding of communication as being made up of commitments and breakdowns. McCarthy and Wright's (2005) use of felt-life, which is another term for as-lived, within human computer interaction is also focused on in this section. This section falls within the understanding of context for mobile learning design as it provides the lens to understand the learner's context further, though it is particularly influencing on the actual design of the course from a designer's perspective.

As-lived experience is understood as looking at the way that people experience technology in a natural setting, the experience as it is beyond logical thinking and rationalism and within a domain of understanding. It allows us to take into account the complexities of as-lived experiences including emotions, feelings and cognitive beliefs and ask questions that were not previously considered. It also considers people as having a relationship with technology, and that relationship is governed by our values and goals (McCarthy & Wright, 2005; Winograd & Flores, 1986). Taking an as-lived approach means looking at the world as it is "sensed and experienced" (McCarthy & Wright, 2005, p. 262) by people. Within a mobile learning designing perspective this means understanding how users interact and feel about learning using mobile technology in their specific context (Winograd & Flores, 1986). The as-lived experience provides an approach to considering the usability of the technology within the context of learning.

Winograd and Flores (1986 p.163) look at designing systems in an ontological framework "that facilitate human work and interaction." Mobile learning is an interactive space as discussed previously when looking at the different contexts. This ontological design "constitutes an intervention in the background of our heritage, growing out of our already existent ways of *being-in-the-world*, and deeply affecting the kinds of beings that we are." The as-lived approach to thinking allows us to think about the users' experience in designing a mobile learning environment. Winograd and Flores (1986) propose phenomenological insights (i.e. about the users' experience of mobile learning) into the ways of design.

The three major ones are readiness-to-hand, anticipation of breakdown and the blindness created by design; these phenomenologies can be combined into our model for consideration, bringing concepts of context, thoroughness and domains of understanding.

'Readiness to Hand' is when something is designed in such a way that a user can simply use it without much thought such as driving a car or making a phone call; it is a concept that is important to consider in design in ensuring that the user is comfortable with and doesn't need hand-holding. Part of this is to make sure that a domain of understanding is defined, this is the context that is created within the mobile learning system; once this is defined then it is easy to identify where parts of the system might confuse or deter a learner, "a bad design forces the user to deal with complexities that belong to the wrong domain" (Winograd & Flores, 1986, p.165).

This can also be seen as an 'anticipation in breakdown', identifying something that might cause a break in communication between the device and the use; designers should be aware of anything like this; a breakdown is not a negative situation to be avoided, but a situation of non-obviousness, in which the recognition that something is missing leads to 'unconcealing' (Winograd & Flores, 1986). The breakdowns create clear objectives, providing possibilities for action for when these breakdowns happen (Winograd & Flores, 1986).

Another concept of Winograd and Flores (1986) is blindness in design; this asks us, when creating the mobile learning system what is not being considered; for instance,

in the creation of a searchable online database of books the user is able to find books more efficiently but the ability to browse for similar material. For design, this means taking into account many possibilities to know what to expect.

McCarthy and Wright (2005) use the term 'felt-life' and explain how combining this lens with human computer interaction will allow us to deal with "issues such as resistance, identity, and attachment that are not otherwise addressed in HCI" (p. 262). As the as-lived experience takes into account the sensual and emotional experiences that cannot necessarily be measured and gives us a clearer understanding. Technology is increasingly becoming a part of our daily life, especially mobile technology, and they are more than just work tools but are part of our social lives as well. This relationship with technology can define the way we use and interact with technology, making this as-lived lens necessary.

Nussbaum (2001) connects people's actions to their emotions by explaining that emotions are linked to a person's 'goals, needs, desires, and values' which can be used to locate the relationship between self and technology. By recognising emotions, the as-lived approach considers these emotions as responding to the immediate environment in the interests of that person's goals. "Although these feelings are associated with bodily sensations, they never quite belong in the body, rather they are qualities of interactions between organisms and things in their environments" (McCarthy & Wright, 2005, p.264), which gives us some measure of the user's experience that could identify underlying reasons for breakdowns.

“For people, feeling is inevitably intertwined with language, intentions, and values. Combined with language and intention, feelings become more sophisticated forms of knowledge or sense making, partly because of their proliferation and partly because of their association with a person’s sense of self” (McCarthy & Wright, 2005, p.264). This understanding means that there are underlying reasons to people’s resistance to technology, that can be understood through the as-lived approach, and might otherwise be swept over and not considered; it “requires us to model people as always involved and always having preferences, priorities, and values” (McCarthy & Wright, 2005, p.270). There is the need to explore “how the person felt about the experience, what it meant to them, whether it was important to them, and whether it sat comfortably with their other values and goals” (McCarthy & Wright, 2005, p.266) to get an understanding of that relationship between technology and the user.

2.8 Existing Processes for Mobile Learning Design

Current research around mobile learning design is very focused on only a few aspects of the mobile learning paradigm. The research described below is considered in the method that this dissertation proposes and are combined in a way that seemed logical and relevant.

Mobile Human Computer Interaction is an area of research that is “concerned with the reasons and ways in which people act and interact with data that is accessed through the mobile device” (Botha et al., 2010, p.33) looking at the relationship that

people have between their mobile devices. Botha et al. (2010, p.33) has summarised mobile human computer interaction into comprising of “five interlinked focus areas: mobile users, mobile devices, mobile networks, mobile business processes and mobile use”.

Hemabala and Suresh (2012, p.179) identify three modules to mobile learning: (1) the content module; consisting of “five authoring tools: development, management, distribution, collaboration, delivery”. The delivery and distribution described here are inherently similar, and collaboration can be rather seen as a characteristic of the mobile learning system, while the management tool is part of the users’ experience is similar to the development tool. (2) The learning module is described as where learning takes place and how it should be designed through a behaviourist or constructivist approach. The active approach to learning is advocated for. (3) The evaluation module is about knowledge sharing and management which goes back to the collaboration and management authoring tools that are mentioned in the content module. The evaluation itself is about performance and measuring knowledge acquisition.

The aspects that are most prominent from this model are the content development, related to pedagogy and specifically referring to “Dale’s cone of experience” where active learning is shown to be more effective than passive learning (Hemabala & Suresh, 2012, p.181).

Killilea (2012) has proposed five best practices to the design and use of mobile learning. When designing a mobile course (1) clear objectives to the course should

be setup and made clear to all learners. This includes “goals, expectations, and standards to be met” (p.3). (2) Feedback should be built into the course consistently; using assessments is one way of allowing learners to gain feedback and see how they are faring in meeting the objectives of the course. (3) Content should be structured to some extent, while learners are able to choose where and when they’ll learn, the content should be easily navigable and consistent. (4) Active learning techniques should be used in the course where possible and should encourage to “be thinking about how the material relates to them on a personal level” (p.4). Last but not least, (5) realistic timeframes for lessons should be considered so that learners plan their course schedule at the start, ensuring that learners also have the flexibility of learning at their own pace.

Ryokai (2012) proposes four design principles for mobile learning: Connect, contextualise access, capture and multimodal. These design principles refer to the importance of creating a connection between what takes place in the classroom and what is delivered through the mobile device; and the importance of creating a personal connection to the material for the learner by ensuring it is relevant and meaningful to the learner. Multimodal refers to making the content accessible via multiple ‘learning styles: visual, auditory and kinaesthetic’ (Killilea, 2012).

2.9 Objectives to Learning

Bloom's (1956) taxonomy has been widely referenced and used over the last few decades. The main principle behind the taxonomy is the way teaching is practiced by

creating objectives that encompass higher levels of thinking. The taxonomy has been made easily accessible through various depictions such as pyramids and wheel diagrams to explain the concepts (Krathwohl, 2002; Munzenmaier & Rubin, 2013). Figure 3 illustrates the progressive levels of Bloom's taxonomy.

Bloom's taxonomy is highly suitable for putting together objectives around learning that apply to all levels of thinking and crosses the knowledge dimensions. Creating objectives are made simply by choosing a level of thinking, choosing a verb of learning that is associated to that level and then choosing an activity for that level. For example, an objective around understanding would be to get learners to 'interpret' through the use of a 'report'. They can further add value to this objective by adding 'real-world' conditions and criteria to the activity and knowledge area (Munzenmaier & Rubin, 2013).

By selecting objectives along this taxonomy, one also chooses the activities and hence the content that will be required for the course. So it can be seen how the pedagogy and objectives influence the content that is to be delivered for learning.

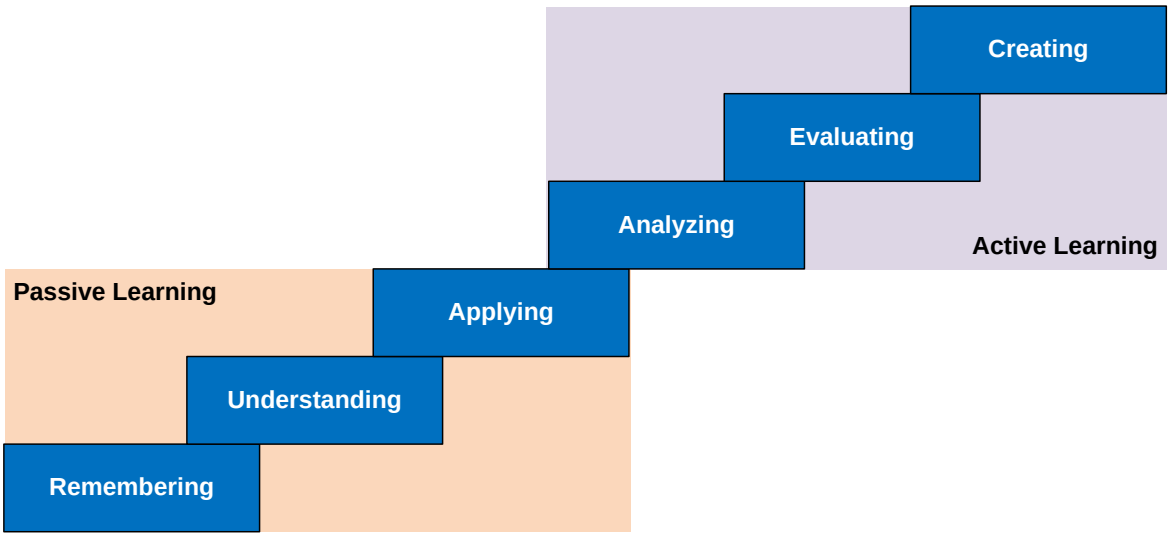

Figure 3: Combining pedagogy for mobile learning design (Krathwohl, 2002)

2.9.1 Knowledge Dimensions

There are various aspects of learning styles, from how a learner absorbs and translates information to the different ways in which this can be achieved. Franklin (2011, p.264) suggests that educators must "enable learners to reach their potential" by allowing learners to access knowledge beyond the classroom; encouraging critical thinking and problem solving skills and encouraging learners to take responsibility for their learning. Learning style is important to the design of mobile learning. It is then necessary to draw from common pedagogical understandings and apply this to mobile learning where applicable. The pedagogy and understandings that underly a mobile learning course will ultimately guide the way in which the course is put together. Clarity on what learning styles to focus on from the start will give a method for designing mobile learning more direction and purpose.

Furthermore, it is necessary to link where mobile learning supports these learning styles and to take advantage of these opportunities.

2.9.2 Access to Knowledge

Mobile technology allows instructors to share information in numerous ways, that caters for various learner styles such as “auditory (audio lectures), visual (diagrams, graphs), and linguistic (Word, PowerPoint), (Al-Hmouz et al., 2010, p. 785). Being able to share and distribute information to learners is important for extending learning to outside of the formal classroom and “allowing flexible and instance access to rich digital resources” (Cheon et al., 2012, p.2) in an informal environment through mobile technology.

It has been identified in some studies that learners use the internet mostly for help on their homework and for social networking (Bennett, Maton, & Kervin, 2008). “Learning as it takes place informally and via social media tools is deeply social as is design” (Burdick & Willis, 2011, p.548) and is an important part of increasing access to knowledge to learners.

Also, the use of games and simulations as a learning tool, applying the “natural and universal behaviour of children and adults” (Costabile et al., 2008, p.146) provides the necessary shift towards a constructivist approach that encourages collaboration, problem solving, imagination, communication skills and authentic learning (Bennett et al., 2008; Costabile et al., 2008).

2.9.3 Responsibility for Learning

Encouraging learners to take responsibility for their learning also involves giving them an understanding of why they are learning and how learning takes place (Franklin, 2011). There are two popular models that could help in this.

The conscious competence ladder or matrix is a commonly used analogy of how a learner goes through stages of learning. A leaner starts ‘unconsciously incompetent’ where they are not aware of what they don’t know and as they learn about something they move up to ‘consciously incompetent’, that gives intrigue to a learner and as they learn and begin to understand they become ‘consciously competent’; the final stage of the ladder is ‘unconscious competence’ when the learner is now an expert in the topic and does the job without having to think it through (Watkins, Carnell, Lodge, Wagner, & Whalley, 2002).

Cockburn's (2003) stages of learning are very similar to the competence ladder, he describes the stages as ‘following’, when one is new to a subject people tend to copy and will concentrate on a single method until they get to grips with it; ‘detaching’, is a phase where the learner starts questioning the model and its rules and starts to learn some alternative methods. ‘Fluency’ is a stage where the learner is no longer concerned about which technique to follow and the knowledge is used unconsciously to get the desired outcome

Learners should be taught about learning stages while learning other subjects. To assist learners through the stages of learning, such as the competence ladder, and giving them understanding about how that works can help the process. This can also

be seen as an abductive approach that allows for deeper insight and reflection (Watkins et al., 2002).

2.9.4 Thinking Behind the Learning

It is important that we do not box learners into a type, as individuals can have parts of each learning style. This makes it difficult for teachers to isolate the right approach to teaching (Watkins et al., 2002). The traditional passive learning assumes that learners are best taught by giving them knowledge and allowing them to assimilate this on their own as opposed to active learning approaches that rely on a more social process; this has become a more favourable approach recently (Schultz, 2011). As can be seen in Figure 3, Bloom's taxonomy could be seen as moving learning from a passive approach to a more active approach in learning. Active learning is very possible through mobile technology through the many functionalities that allow for "talking and listening, reading, writing, and reflection" (Franklin, 2011, p.264).

Abductive reasoning is being discussed as a more viable and logical learning approach that can be translated to mobile technology. "When we encounter a world that rarely supplies all the information we need" (Burdick & Willis, 2011, p.549) then we use abductive reasoning to make the world more understandable. Patokorpi (2006) suggests that the design of learning using technology could be better understood by studying abductive reasoning. Mobile technology is capable of providing "partially formed ideas and understanding" (Rogers et al., 2009, p.21) that will engage the natural abductive thinking of learners.

It is possible to take learning approaches and transform them to a different platform as the “learning environment does not change the essential aspects of how people learn” (Franklin, 2011, p.264) but can rather support and enhance the learning.

Bloom’s taxonomy describes four knowledge dimensions: factual knowledge (where basic information is gained), conceptual knowledge (where tools and techniques and diagrams are used to understand the functioning of a concept), procedural knowledge (knowing how to do something) and metacognitive knowledge (knowledge of thinking) (Merhbi, 2011).

Metacognitive knowledge can be tied back to the responsibility of learning objectives; procedural and conceptual knowledge are linked to critical thinking and factual knowledge is linked to the objective of having access to knowledge as shown in Figure 4. It is useful for the designer of the course to see where the different knowledge dimensions are addressed by the objectives.

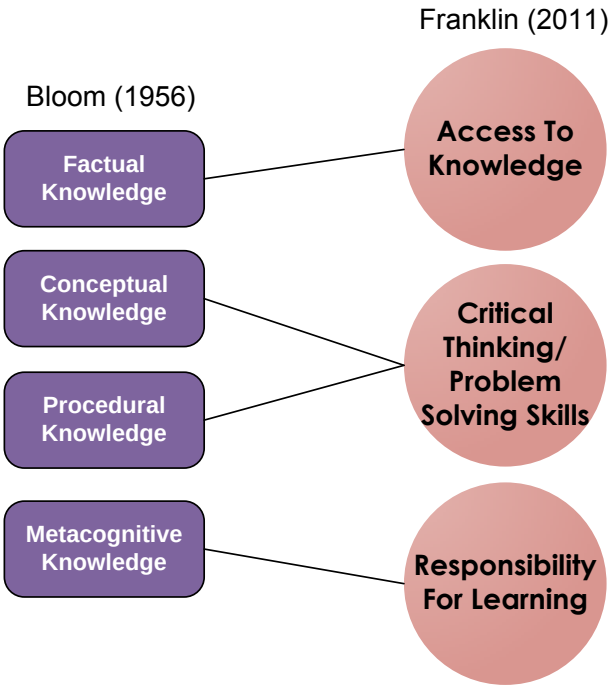

Figure 4: Knowledge dimensions linked to main objectives of learning (Merhbi, 2011; Franklin, 2011)

2.10 Categories of Learning Theory

From Cheon et al. (2012) and Naismith et al. (2004) seven broad categories of learning activity theories can be put forth that mobile learning can support or be used because of the characteristics that lend to these learning activities. The first, is that of an individualised learning; mobile learning allows for learners to “pace learning at their own speed” (Cheon, 2012, p.4) so that they are not left behind when stuck on a concept or losing interest if it is too slow. The second activity is behaviourist learning, where the learner is able to get learning material through their mobile device, respond to it and get the appropriate feedback to encourage learning (Naismith et al., 2004).

The third category is a constructivist learning, this is where abductive thinking comes in, and the learner will “construct new ideas or concepts based on both their previous and current knowledge” (Naismith et al., 2004, p.2). In this case the learner is encouraged to understand principles actively on their own. mobile learning is capable of providing the collaborative environment necessary for this alongside the supportive tools and real context to do so (Naismith et al., 2004). The fourth category is situated learning, this allows students to learn within a real context, where the information provided is based specifically on the learners surroundings or situation, and they can be guided through an unfamiliar task or activity to achieve real world learning (Cheon et al., 2012; Naismith et al., 2004). Situated Learning gives rise to specific outcome based opportunities: ‘problem-based learning, case-based learning, and context-aware learning’ (Naismith et al., 2004).

Fifth, is collaborative mobile learning, that uses the ability to interact and communicate both with mentors and other learners to complete tasks and activities towards learning objectives (Cheon et al., 2012; Naismith et al., 2004). The sixth category is informal learning. mobile learning allows for students to learn beyond the classroom at their own pace and preference, as well as learning that might not have occurred in a more structured environment (Cheon et al., 2012; Naismith et al., 2004; Siemens, 2004). Siemens (2004) considers informal learning to be one of the most significant categories in the learning experience. The last category suggested by Naismith et al. (2004) is ‘learning and teaching support’ , this is the ability for mobile

learning to help with administration and coordination of resources and learners in delivering a successful curriculum.

Mobile learning allows for teachers to deliver the appropriate content within the many learning styles available, while encouraging learner responsibility and encouraging particular skills in problem solving and critical thinking. With the knowledge that mobile learning can offer all this, the next question that arises is how we get it to do this, and ensure that quality learning is happening.

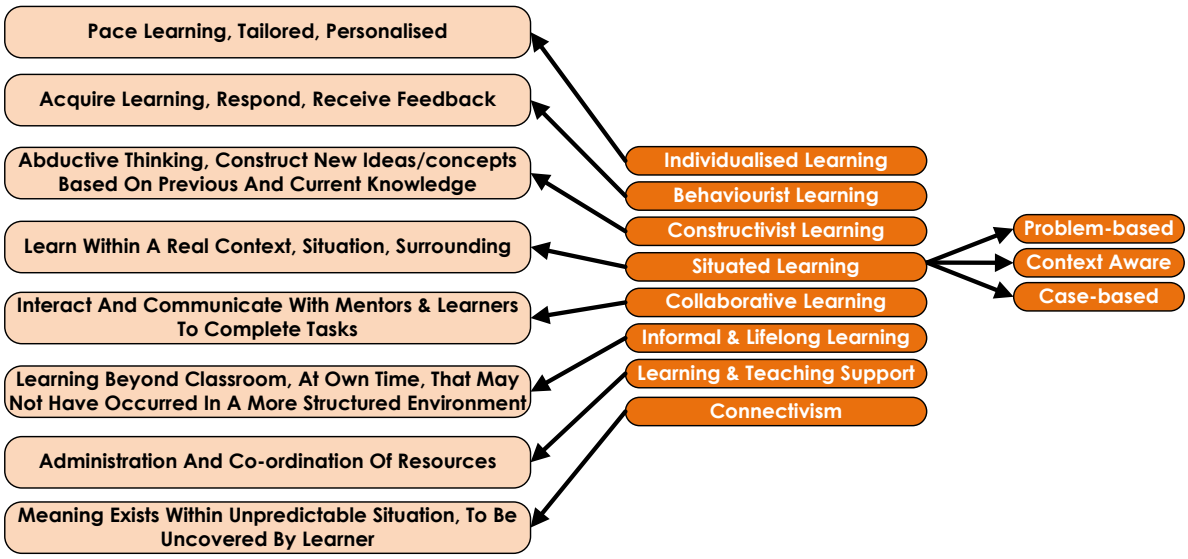

Figure 5: Combination of m-learning categories from theory (Based on Cheon et al., 2012; Naismith et al., 2004; Siemens, 2004)

An addition to this list of categories is one proposed by Siemens (2004), who elaborates on the theory of connectivism, which is contrasted from that of behaviourism and constructivist approaches. It is based on the idea of chaos, "the breakdown of predictability" (Siemens, 2004, p.3) and upon the idea that meaning exists and it only needs to be uncovered by the learner. So learning takes place in

an environment that is constantly changing and mostly out of the learner's control, and that the learning "is focused on connecting specialised information sets, and the connections that enable us to learn more" (Siemens, 2004, p.4). These categories are summarised in Figure 5 for easy reference.

2.11 Summary

Mobile learning has many facets to it from the technological aspects that are constantly changing and becoming increasingly popular around the world to the many mobile learning characteristics that are afforded by these mobile devices such as nomadicy, ubiquity, personalisation and social interactivity.

With the on-the-move environment being created by the mobile devices, context sensitivity becomes a major influencer on how mobile learning is designed. Aspects of the learner's context that are repeated in the literature are the learner's personal context, situational context, technological sphere and the 'as-lived' experience.

While mobile learning is highlighted by the use of technology to assist learning, many of the pedagogical theories are still applicable to the designing of mobile learning. Creating objectives for learning using methods from Bloom's (1956) taxonomy gives a course direction that is learner-oriented.

Franklin (2011, p.264) suggests that educators must "enable learners to reach their potential" by allowing learners to access knowledge beyond the classroom; encouraging critical thinking and problem solving skills and encouraging learners to take responsibility for their learning.

3 RESEARCH DESIGN

For the purposes of this research a design science research methodology was adopted. Design science is a more creative and generative approach to other research methods which is appropriate for the type of contribution that this research is attempting to create. It is important to realise that knowledge is at the core of the research, and in this research the aim is to create prescriptive knowledge from evaluating the identified problem and creating an artefact (method) to address these problems (Baskerville, Kaul, & Storey, 2011; Hevner, March, Park, and Ram, 2004).

Design science compliments both a positivist and interpretive approach and can be seen as a lens or set of analytical techniques to conduct Information Systems research (Iivari & Venable, 2009). Design science can be considered innovative in its attempts to create a construct, model, method or instantiation known as an artefact. The aim of design science research is to analyse a designed artefact's use and performance to understand, explain or improve on a particular behaviour within Information Systems (Iivari & Venable, 2009; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007).

3.1 Philosophy and Approach/Purpose

A constructivist and subjective epistemology supports this research. Crotty (1998 as cited in Feast & Melles, 2010, p.4) describes Constructivism as rejecting the belief that an objective truth exists but "rather truth and meaning is constructed out of the

engagement of our minds with the world". The constructionist view is that numerous meanings about the same phenomena can be constructed by different people so that there is not only one truth. This view is particularly applicable to the mobile learning space because of the numerous contexts, learning styles and complexity of the area.

Design science research does not prescribe ontology or epistemology. These viewpoints often shift throughout the cycles of design science research (Vaishnavi & Kuechler, 2004). For this research, a pragmatic and interpretive approach was taken. Bunge (1984 as cited in Vaishnavi & Kuechler, 2011) "implies that design science research is most effective when its practitioners shift between pragmatic and critical realist perspectives, guided by a pragmatic assessment of progress in the design cycle". The pragmatic researcher is not so much interested in unpacking the understanding around what did or did not work in the experiment but rather whether it worked or not; while some basic understanding and findings will be described, the point of the experiment is to identify whether the method is useful and how components of the experiment/method could be altered to achieve a different outcome, ultimately impacting the theory in an empirical manner (Hevner, 2007; Vaishnavi & Kuechler, 2004).

"Knowledge about the designing process and properties of a design solution is prescriptive" (Juuti, 2006, p.63). This research is prescriptive in nature with the purpose of using both abductive and deductive approaches in the different cycles of design science research. In designing and developing of the artefact "the first stage of DSR can involve all of abductive, inductive and deductive thinking" (Fischer &

Gregor, 2011, p.29; Vaishnavi & Kuechler, 2004). When testing the artefacts in their environments, through experiments in the case of this research, a deductive approach is being utilised. With design science research, “research is usually conducted in the design domain and is potentially interventionalist in nature” (Baskerville et al., 2011, p.9).

3.2 Design Science Research Guidelines

The research proposed here will use a design science research methodology using qualitative field test/simulation evaluation methods. Hevner et al. (2004) propose seven guidelines when doing design science research; Table 1 below gives an overview of these seven guidelines. What follows is a brief explanation of each guideline and how this research is designed to satisfy each guideline.

3.2.1 Design as an Artefact

Design science research must produce a meaningful IT artefact that can provide an approach to a specified problem. This artefact needs to be implementable, applicable and appropriate to its context. The artefact is seen as “interdependent and coequal” (Hevner et al., 2004, p.83) with the people and social context in which it is applied.

Table 1: Design-Science Research Guidelines (Hevner et al., 2004, p.83)

Guideline	Description
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

The four types of artefacts are described as a construct, model, method, or an instantiation. An artefact could be any one or multiple of these:

- Construct – “provide(s) the vocabulary and symbols used to define problems and solutions” (Hevner et al., 2004, p.83).
- Model – Is made of constructs to represent a system, with generalised patterns (March & Storey, 2008).
- Method – is a procedure or approach that illustrates “ways of performing goal-directed activities” (March & Smith, 1995)
- Instantiation – represents ideas as “physical implementations intended to perform certain tasks" (March & Storey, 2008).

In this research the aim was to construct a method that would give a generalised procedure to approach the design of a mobile learning course or interaction. The research used existing pedagogy, methods and models that are applied in a classroom environment and translated these to the opportunity of mobile technology. This is the basis to the various aspects necessary for an effective learning experience. Such a method would look at optimising the way we approach the designing of mobile learning, taking into consideration the interdependencies between learners, teachers and the mobile device within various social contexts.

3.2.2 Problem Relevance

The second guideline deals directly with the relevance of the problem and hence the research being conducted. The main goal of information systems research using design science is to provide a solution to a problem (Fischer, 2011). Design science research uses the development of artefacts to specifically address these problems and the research must be relevant to the community that is being addressed (Hevner et al., 2004).

The mobile learning community that is approached in this research includes various types of people from organisations, institutions, teachers, learners, designers and developers. Mobile learning is at a point where research has been developed around its usefulness and applicability and has proven its ability to be a viable tool for learning. With this knowledge, the opportunity to create and deliver such learning has been slowed by the ‘newness’ and lack of congruity of how to apply all the

theory practically. This research hopes to address these concerns by giving an approach that practitioners can follow in designing their mobile learning courses.

3.2.3 Design Evaluation

The artefacts created must be rigorously evaluated for their quality, utility and efficacy. Evaluation needs to include the application of the artefact in its appropriate environment. Appropriate metrics should be defined for the artefact to be evaluated; some of these include “functionality, completeness, consistency, accuracy, performance, reliability, usability, fit with the organisation, and other relevant quality attributes” (Hevner et al., 2004, p.85). These metrics allow for mathematical evaluation; however, in cases of high innovation a more descriptive evaluation may be applicable and this match needs to be appropriate and justified for.

The contribution made by this research through design science comes through using experimental proof as a method. Hevner et al. (2004) have identified five methods of evaluation that are relevant to design science research, as described in Table 2.The Research conducted for a mobile learning method for design used experiments followed by semi-structured interviews as an evaluation for the method developed and proposed through the literature review.

Table 2: Design Evaluation Methods (Hevner et al., 2004, p.86)

1. Observational	Case Study: Study artifact in depth in business environment
	Field Study: Monitor use of artifact in multiple projects
2. Analytical	Static Analysis: Examine structure of artifact for static qualities (e.g., complexity)
	Architecture Analysis: Study fit of artifact into technical IS architecture
	Optimization: Demonstrate inherent optimal properties of artifact or provide optimality bounds on artifact behavior
	Dynamic Analysis: Study artifact in use for dynamic qualities (e.g., performance)
3. Experimental	Controlled Experiment: Study artifact in controlled environment for qualities (e.g., usability)
	Simulation – Execute artifact with artificial data
4. Testing	Functional (Black Box) Testing: Execute artifact interfaces to discover failures and identify defects
	Structural (White Box) Testing: Perform coverage testing of some metric (e.g., execution paths) in the artifact implementation
5. Descriptive	Informed Argument: Use information from the knowledge base (e.g., relevant research) to build a convincing argument for the artifact's utility
	Scenarios: Construct detailed scenarios around the artifact to demonstrate its utility

3.2.4 Research Contributions

The contribution made through design science should be through the novel design of the artefact. In the case of this research it will be the development of a method that contributes to the existing knowledge in the mobile learning area. The method contributes to solving the problem that is being faced in the transition between knowing that a company or institution wants to implement mobile learning and how to actually go about it.

3.2.5 Research Rigour

“Rigor addresses the way in which research is conducted.” (Hevner et al., 2004, p.87)

Rigour needs to be displayed in both the construction and evaluation of the designed artefact; however a balance of both rigour and relevance needs to be maintained; as implementing rigour can lessen the relevance of the research. Assessing the appropriateness of metrics as discussed in the evaluation guideline as well as ensuring that the artefact is “exercised within appropriate environments” (Hevner et al., 2004, p.88) will help in maintaining rigour.

This research displays rigour in its extensive use of theory described in Chapter 2 that is used to form the artefact. It was also important to not put overemphasis on the rigour, as this could deter from the relevance of the study that is equally important. With the pragmatic approach in mind, “the principal aim is to determine how well an artefact works, not to theorise about or prove anything about why the artefact works” (Hevner et al., 2004, p.88).

3.2.6 Design as a Search Process

Design science research requires an iterative approach to design. Hevner et al. (2004, p.88) speak about design as being a “search process to discover an effective solution to a problem” that involves creativity in using the means (actions and resources) to get to an end (goals and constraints) within the laws (of the environment). In some cases it “may not be possible to determine, let alone explicitly

describe, the relevant means, ends, or laws" and given the complexity of system involved it is not feasible to compute the problem-solving in such a way. It then falls to the researcher to provide a satisfactory solution "without explicitly specifying all possible solutions" (Hevner et al., 2004, p.89).

Design science research focuses its intention on proving whether the solution actually works, without delving into the deep understanding of why. Design science research provides the basis for further research to be done on the underlying artefacts that are provided. In this research, experiments were conducted to test the method developed. The research was conducted as a search process that is described in the three cycles of design.

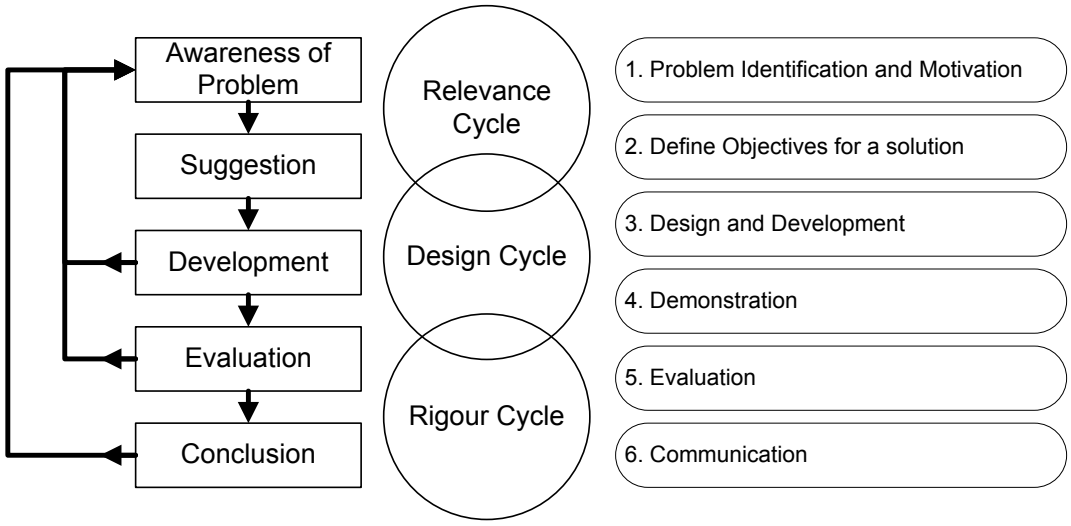

Figure 6: Combining the five Process Steps (Vaishnavi & Kuechler, 2011) three cycles (Hevner, 2007) and the six Activities (Peffers et al., 2007) of design science research

Figure 6 illustrates the similarities in the different approaches to creating a design science research methodology; combining The five Process Steps (Vaishnavi &

Kuechler, 2004) three cycles (Hevner, 2007) and the six Activities (Peffers et al., 2007) of design science research. When seen alongside each other it can be seen that they are all describing a similar process in a different manner. Table 3 describes these processes and it can be seen how they relate to one another. It can be seen that the Cycles are the overall approach and the five Process Steps and six Activities being the lower level steps in the cycles.

It is important to note that these steps, activities and cycles are iterative, meaning that the results of one step may require the researcher to further investigate and return to a previous step, adjusting initial objectives and redesigning the artefact in a continuous improvement cycle (Hevner, 2007). The aim is not to come up with the right answer, but to suggest the best solution. The research can then be brought to a close when there is a satisficing solution, but it does not close the door to future research but rather encourages further improvements by future researchers.

3.2.7 Communication of Research

“Design-science research must be presented both to technology-oriented as well as management-oriented audiences” (Hevner et al., 2004, p.90). This means supplying the right amount of technical detail while also supplying information on the implementation from a business perspective. This is about choosing the right communication style for the audience. In writing up this research the various audiences that this research will attract were kept in mind: educators, business people and possibly more technical persons.

3.3 Ethics and Confidentiality

Design science research is strongly means-end-oriented, where the artefact must serve some purpose (Hevner et al., 2004). For the purposes of this research the experiment involved a single participant, who gave their consent to being part of the research, and were assured that they would not be named in the written report. Answers to the interview and observations in the experiment were used for research purposes only and answers were kept anonymous.

Observations during the experiment were also recorded to add to the research findings. The results of the research were offered and discussed with the participant to confirm their accuracy.

Table 3: Design Cycles, steps and activities of design science Research.

Cycles (Hevner, 2007)	*Process Steps* (Vaishnavi & Kuechler, 2004)	*Activities (Peffers et al., 2007)*
Relevance Cycle – "Good design science research often begins by identifying and representing opportunities and problems in an actual application environment…the relevance cycle initiates design science research with an application context that not only provides the requirements for the research (e.g., the opportunity/problem to be addressed) as inputs but also defines acceptance criteria for the ultimate evaluation of the research results"	**Awareness of Problem** – "An awareness of an interesting problem may come from multiple sources…The output of this phase is a Proposal, formal or informal, for a new research effort."	**Problem Identification and Motivation** – "Resources required for this activity include knowledge of the state of the problem and the importance of its solution."
	Suggestion – "Suggestion is an essentially creative step wherein new functionality is envisioned based on a novel configuration of either existing or new and existing elements."	**Define Objectives for a solution** – "Infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible."
Design Cycle – "The requirements are input from the relevance cycle and the design and evaluation theories and methods are drawn from the rigor cycle. However, the design cycle is where the hard work of design science research is done…artefacts must be rigorously and thoroughly tested in laboratory and experimental situations before releasing the artefact into field testing along the relevance cycle. This calls for multiple iterations of the design cycle in design science research before contributions are output into the relevance cycle and the rigor cycle."	**Development** – "The Tentative Design is implemented in this phase. The techniques for implementation will of course vary depending on the artefact to be constructed…The implementation itself can be very pedestrian and need not involve novelty beyond the state-of-practice for the given artefact; the novelty is primarily in the design, not the construction of the artefact."	**Design and Development** – "Create the artefact. Artefacts are potentially constructs, models, methods, or instantiations …Conceptually, a design research artefact can be any designed object in which a research contribution is embedded in the design"
		Demonstration – "Demonstrate the use of the artefact to solve one or more instances of the problem. This could involve its use in experimentation, simulation, case study, proof, or other appropriate activity."
Rigour Cycle - The rigor cycle provides past knowledge to the research project to ensure its innovation. It is contingent on the researchers to thoroughly research and reference the knowledge base in order to guarantee that the designs produced are research contributions and not routine designs based upon the application of well-known processes Research rigor in design science is predicated on the researcher's skilled selection and application of the appropriate theories and methods for constructing and evaluating the artefact."	**Evaluation** – "Once constructed, the artefact is evaluated according to criteria that are always implicit and frequently made explicit in the Proposal…the evaluation phase results and additional information gained in the construction and running of the artefact are brought together and fed back to another round of Suggestion."	**Evaluation** – "Observe and measure how well the artefact supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the artefact in the demonstration. It requires knowledge of relevant metrics and analysis techniques."
	Conclusion – "This phase…is the result of satisficing, that is…the results are adjudged "good enough." Not only are the results of the effort consolidated and "written up" at this phase, but the knowledge gained in the effort is frequently categorised as either 'firm'… or as 'loose ends'"	**Communication** – "Communicate the problem and its importance, the artefact, its utility and novelty, the rigor of its design, and its effectiveness to researchers and other relevant audiences such as practicing professionals, when appropriate."

3.4 Data Analysis and Techniques

3.4.1 Data Collection Method and Analysis

The experiments took a semi-structured approach. The experiment involved a workshop using the proposed method. During the workshop qualitative data was recorded. This involved a high-level plan, as described in the steps of the process in Chapter 4. For the workshop and during the workshop observations and comments about the method were recorded. Further to this, a short semi-structured interview was conducted with the participant following the experiment to get a fuller understanding of her experience using the method.

3.4.2 Target Population and Sample

Due to restrictions on time, the target of this study needed to be focused on a particular audience. The target audience identified was educators teaching project management, as this is a subject that is becoming widely accepted as a transferable skill that needs to be taught across industries. With many common practices of project management, the content of the course becomes less of an issue and the experiment can focus more on the actual method of designing for mobile learning.

The participant selected has taught and tutored project management within companies for several years as well as having experience in requirements gathering for businesses. With this person's firm grasp of the subject and the experience in teaching project management

the participant was considered a suitable person to use the method with and design the course, with their feedback being valuable from an educator's and requirements gathering perspective.

3.5 Summary

This research is based on a design science research methodology, with a prescriptive approach in creating and proposing a method for mobile learning. This approach is appropriate as the method is a new concept that has not been explored previously, and this approach allows for the construction and continuous development of the method through different cycles of implementing the method.

4 METHOD FOR MOBILE LEARNING

This chapter combines the reviewed literature into a proposed method for designing mobile learning. For the method being proposed Figure *7* outlines the eight phases that will be described in designing and implementing mobile learning. The first five phases (highlighted in orange) illustrate the general design process of considering the context, objectives, pedagogy, the delivery and the structure of the course. The last three phases (highlighted in blue), are the content, implementation and evaluation of the course that are outside of the design of the course and are included as completing the process ensuring that the design meets its objectives. The phases proceed in order as indicated by the arrows. The following sections will describe each phase in detail.

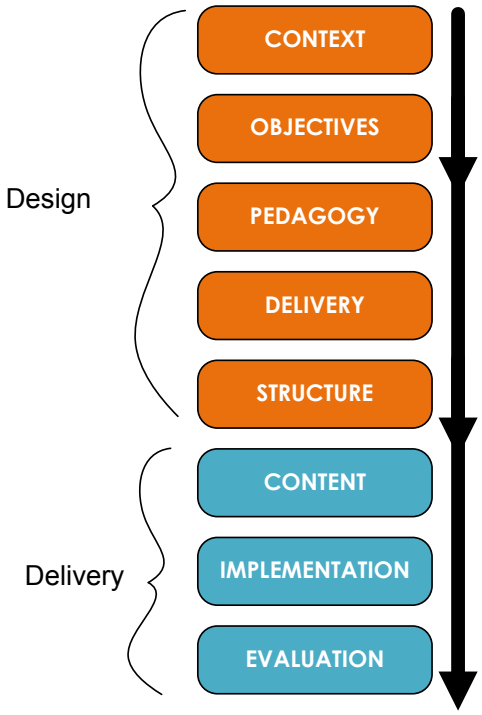

Figure 7: Phases in designing mobile learning

4.1 Context

Creating the context around the course is the first step in the method. The context has multiple parts and assists in guiding the designers and teachers as to what is appropriate and expected from the course. For example, if the context is in an impoverished area that does not have high connectivity then it would be unrealistic to use images when text and voice would be easier to access for the learners, whereas a university with good connectivity and access to multiple devices would expect a higher quality of presentation.

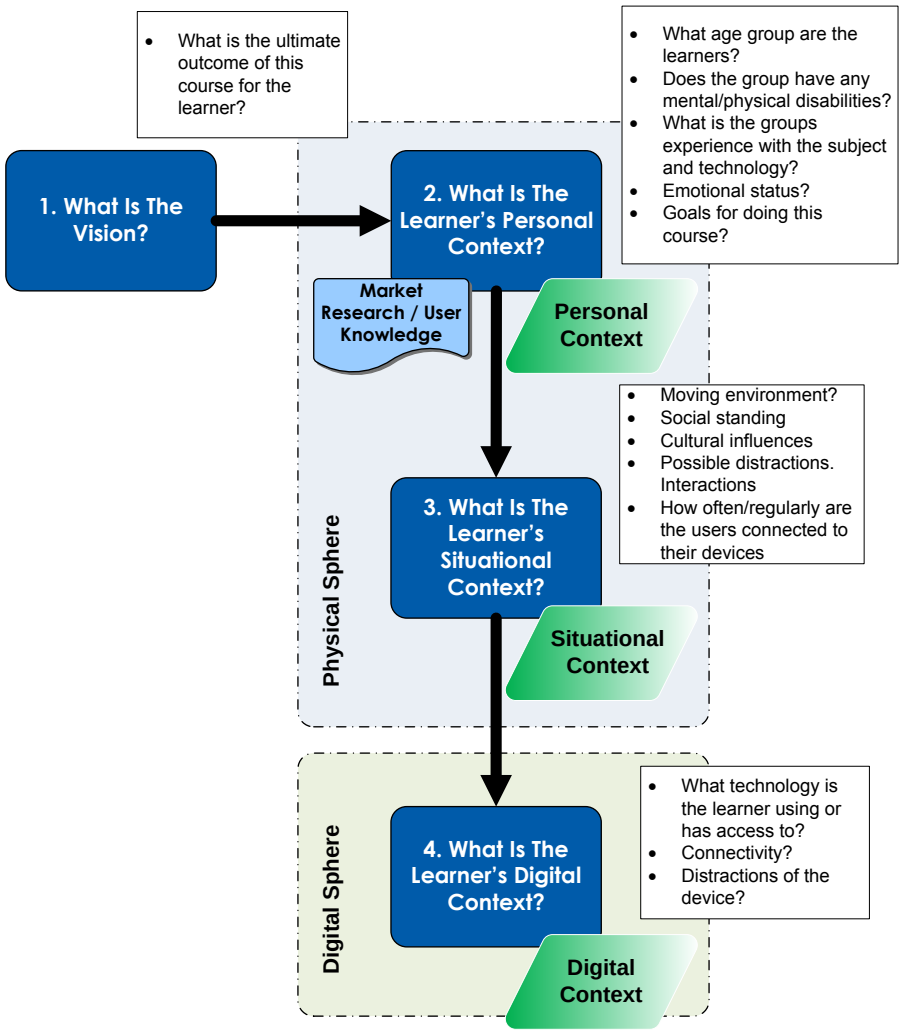

Figure 8: Initial considerations in creating context

Context is an area that needs to be considered and, depending on the category of learning chosen, the context may be more crucial to the success of the course; it ties strongly to the objectives of the course and 'how' it will be delivered. Figure *8* presents the Initial considerations in creating context and gives an example of what kinds of questions to ask for each of the contextual areas.

4.1.1 Creating a Vision

As an initial step to context, an overall vision should be put into place that will guide the design going forward. This vision should have a purpose. Purpose is important to any design: is the purpose simply to transfer information to a learner or is there a more intrinsic value to the purpose, perhaps to deepen the learner's understanding or thinking? The vision will provide the complexity of the design and content required.

It is important to note that at any point during the process described here aspects can be changed. So the vision can be changed later as the method develops, and a new aspect comes to light.

4.1.2 Physical and Digital Sphere

Al-Hmouz et al. (2010) and Koole (2009) described three major categories of context: (1) learner personal status that takes into account personal motivation and prior knowledge of the learner; (2) situational context that looks at where the learner is using the course, how often and when and what kind of social environments; (3) learning environment context that

is the the link between what the device can offer (digital sphere), the content and engagement with the learner.

The physical sphere (learner's personal and situational context) and the digital sphere are considered individually below and influence each other.

Learner's personal context

The learner's context considers aspect of the learner such as preferences, demographic information, and learner history as well as "cognitive ability, memory, prior knowledge, emotions and possible motivations" (Al-Hmouz et al., 2010; Koole, 2009).The designer/teacher should ask such questions as:

- What age group are the learners?
- Does the group have any mental/physical disabilities?
- What is the groups experience with the subject and technology?
- What is the learner's emotional status?
- What are the learner's reasons for doing this course?

These questions will establish the numerous influences surrounding the learner that can affect his/her behaviour, emotional state and concentration and ultimately his/her ability to use the mobile learning service appropriately. While there is no control over these influences, keeping these in mind when considering the implications of the design will assist in aligning the course to the learner and finding ways to engage the learner that will suit his/her personal context.

Situational context

The nomadic and ubiquitous nature of mobile technology means that a user's context is constantly changing due to the freedom of movement.

The social/situational context is the actual context in which the learner currently exists as they access or receive learning from a mobile device. It can be defined by the social interactions, cultural surroundings and rules around communication. This context will involve any distractions or interruptions to the learning environment context. Chittaro (2011) points out that using mobile technology can often be a secondary task within our social context - mobile phones have introduced an unpredictability, when one person calls another they are not sure what situation that person is in and cannot know whether they are interrupting that person. It is also a common expectation that someone can answer a call at any time as they will always have access to their phone. The mobile device is then an extension of that person's situation, so while a user is interacting with the mobile technology they are also involved with "the world as negotiated and enacted in the moment" (Fischer, 2011, p.19).

This is an important consideration as it questions how often and how regularly users would engage with their phones for mobile learning. Fischer (2011) also noted that "when users were away from home, they carried their mobile phone with them significantly more often than when at home." This means that the situational context of a user will often be in a non-constant state; being on the move often means "that people can devote only a very limited attention to the device while they are on the move" (Chittaro, 2011). This brings up an interesting conflict that needs to be taken into account when designing: even though

learners are able to learn on the move there is also a higher chance of distraction and interruptions. Questions to consider in this regard include:

- Whether the learner is in a moving environment? This will affect the length and type of delivery of the course.
- Are there cultural influences on these learners that may impact his/her learning? Some cultures may have a high resistance to the use of technology.
- What are the possible distractions and interactions that the learner might have with the technology being used for the delivery of the course? Think of text messaging, phone calls and other social media that may take preference over learning.
- How often/regularly are the users connected to their devices? If a learner can only get access to the device between certain hours or at a specific place then this will impact the regularity and type of material used on the device.

Digital sphere and learning environment

The digital sphere is defined as the device and technology, looking at the functional ability of the device, its physical and technical attributes from the hardware and software. Mobile learning includes the learner's personal context within a situational context, and these can be considered physical spheres. By introducing the digital sphere into the learning context we have a mobile learning environment.

The mobile learning context is thus created in the way that it is delivered and the learning styles that it caters for. The mobile learning context is where the situational and learner's

personal context meet with the digital sphere. The learning environment is what will be created by implementing this course and combining these contexts.

In essence, what is being sought is the 'target audience' and then looking at how the different contexts of this audience influences the design of the course. Figure *9* provides an example of how the answers may be captured. With these contexts described, the as-lived experience must be addressed to show the relationship between these contexts in creating the learning environment.

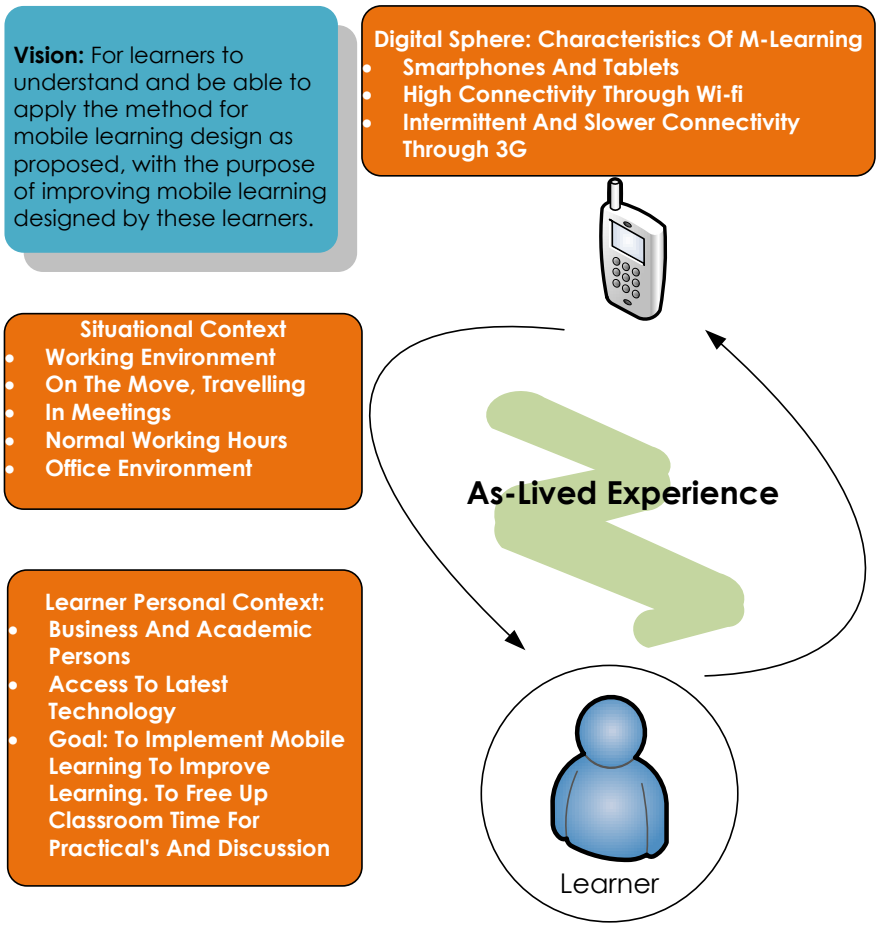

Figure 9: Example of creating context

4.1.3 As-lived Experience

As the various contexts are unpacked it becomes simpler to understand where the learning is going to take place. The as-lived experience takes this one step further, in understanding how the learner relates to mobile technology and hence will relate to the mobile learning designed.

The context leads to awareness of the as-lived experience where questions around readiness-to-hand, anticipation of breakdown and the blindness created by design can be offered to assist in usability and consideration of the user in design (Winograd & Flores, 1986).

The as-lived experience provides a look into 'the opportunities and restrictions created by this mobile learning course' – as seen in Figure *10*. Some of these aspects come from and have been mentioned in the context already created, in understanding the learner, his/her environment and access to technology. The as-lived experience takes this a step further and defines the users' relationship to technology and hence the course being created, as depicted in Section 2.6.

Step 5 in the process is about considering the different aspects of the as-lived experience, which may trigger certain requirements around how the course is to be put together and delivered to the learner. In discussing the as-lived experience the designer is looking for ways to create a 'Readiness to Hand' (Winograd & Flores, 1986).

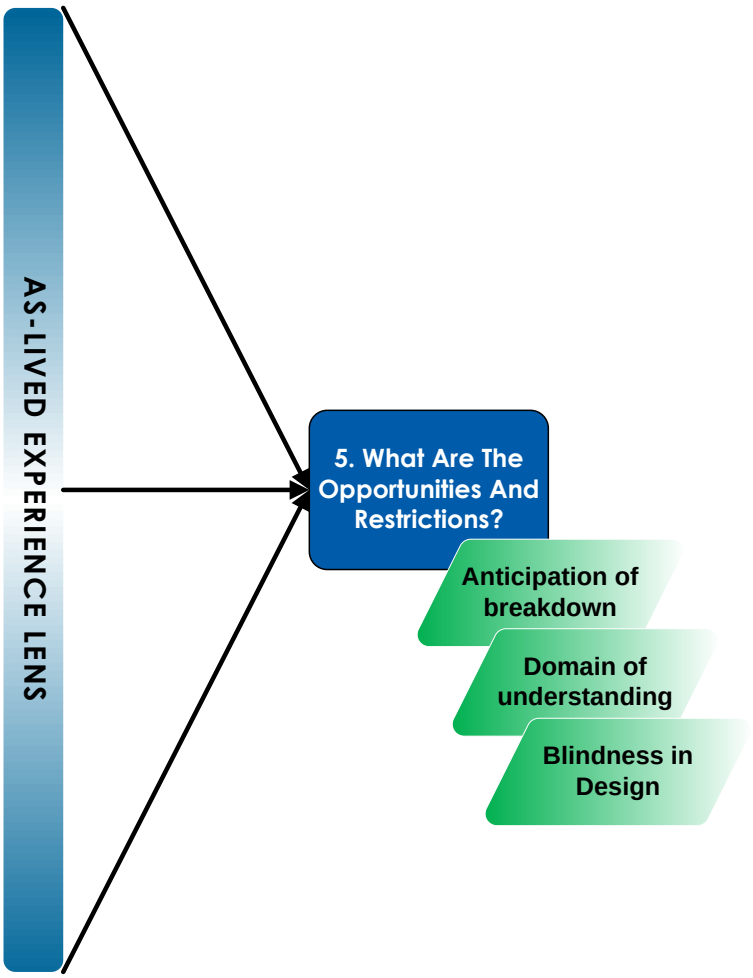

Figure 10: As-lived context considerations

The designer is looking to create the course in such a way that it is part of the environment that the learner exists in and is easy to use. The less foreign the implementation the more accessible and effective it may meet its objectives.

Identifying the domain of understanding in which the learner is working will provide information for design of the course that will allow the learner to interact with the course and technology intuitively. Using language and terminology that the learner relates to and understands is one way to ensure an uninterrupted experience to the learner. The learner's context, gathered in the previous steps, provides information about the learner's 'goals,

needs, desires and values' to assist in creating this domain of understanding of how and why the learner connects with technology (Nussbaum, 2001).

The designer should identify the possible 'blindness in design' that could come about from using mobile technology as a tool for learning, this means the designer must consider what is being removed that the user would have benefited from in traditional learning and what is being added. This consideration may lead to opportunities for enhancing the course (Winograd & Flores, 1986). An example of blindness in design may be that the course limits discussion that learners would have had in a classroom environment; however this may force the learner to seek more information in their own way. Now that this aspect has been identified, it is possible to decide on whether to intervene or allow it in the course.

4.1.4 Modules and the Depth of Mobile Learning to be Used

The next step is to split the course into manageable modules. This can be done in many ways and is up to the discretion of the designer. Following the next step is to identify areas where mobile learning is to be used as shown in Figure *11*. An overall decision as to whether the mobile learning will be used for the entire course or as a support or reference tool will help in splitting the classroom requirements from the technological ones if necessary.

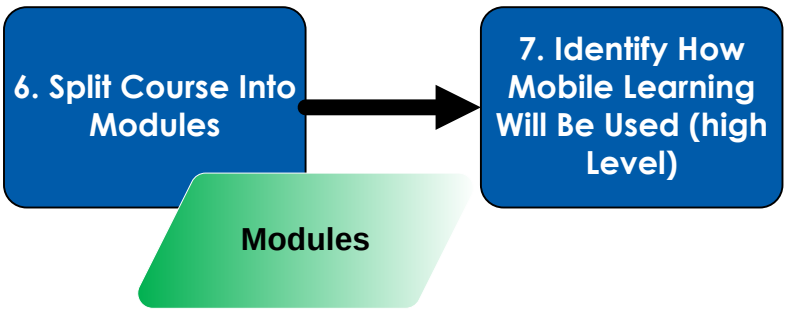

Figure 11: Final steps in creating context for mobile learning design

The classroom requirements would refer to venue bookings, material distribution and what the teacher would require in the physical environment to conduct the class; whereas the technological requirements are specific to the requirements around material, availability and approach using the device. For the purposes of this dissertation, the technological requirements will be the main focus. For the purposes of illustration, Figure *12* is an example of how this dissertation might be separated into several modules to be taught using a mobile phone.

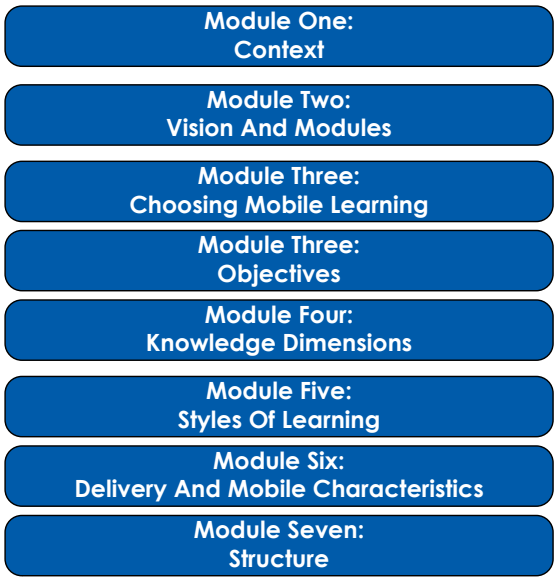

Figure 12: Example of separating a course into modules

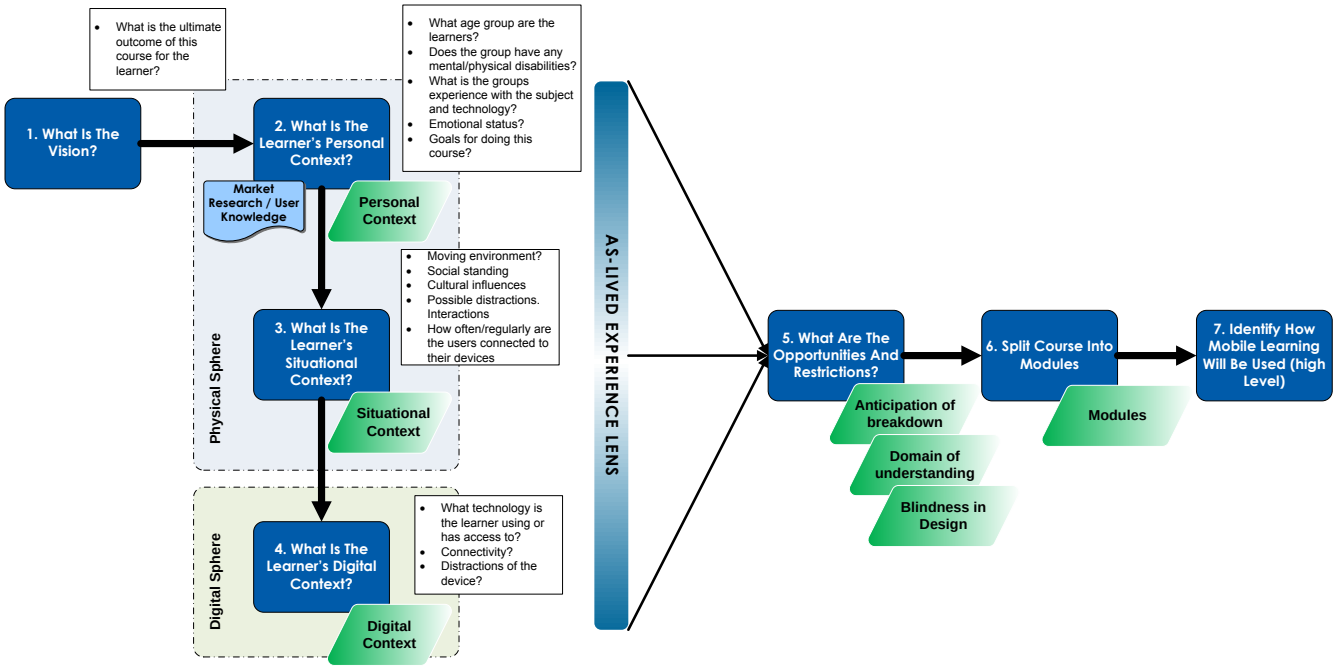

Figure 13: Complete process of creating context for mobile learning design

Figure *13* combines all the steps in creating context together as described above. A holistic context has been considered up to this point, and the designer should have a good idea as to who is receiving the learning, why they are receiving the learning, their domain of understanding and what needs to be taught to the learner.

4.2 Objectives

Identifying objectives, as illustrated in Figure *14*, is the next part of the design of the mobile learning course, it is the question 'why' are we doing this course and 'what' do we want out of it. The objectives should be made with the pedagogical and contextual considerations in mind using Bloom's Taxonomy (1956) and keeping in mind Franklin's (2011) high-level

objectives of learning, to give access to knowledge, encourage critical thinking and responsibility for learning to the learner. The objectives should not describe the technology - they should be the objectives of the learner, and the technology will need to match in the following steps to see how it can enhance and assist these objectives.

For each module or section of the course the high-level objectives need to be identified. Objectives must be learner oriented, this is to say that it is not about what the technology must do but rather what the learner must obtain from the course. The actual course must then be designed to cater to these objectives. Starting each objective with the words 'the learner' helps to orient the objective to what the learner must be able to do at the end of that module of the course (Bloom, 1956).

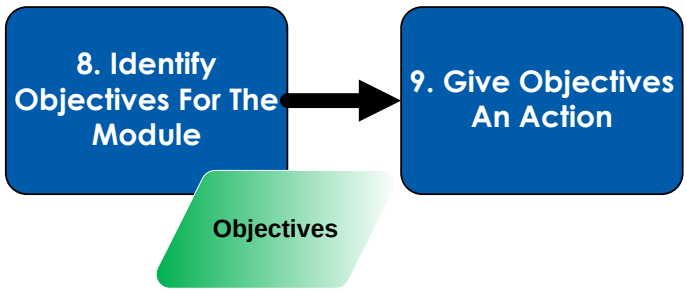

Figure 14: Steps in creating objectives for mobile learning

It may take some time to unpack the objectives. The modules that have been identified will assist in that they help to focus the attention of the objective, and the area it is specific to. Using Bloom's taxonomy (1956) will assist with triggering the wording of the objectives. It is important to define these and ensure that they are measurable so as to be able to evaluate the success of the course later on. Objectives will be the crux of the design as it influences

all other aspects of design. If a new objective comes to light then all other aspects of design need to be reconsidered.

Each objective must also be given an action, to explain how the objective will be achieved. Mobile characteristics become more important at this point as the designer begins to identify the kinds of activities that will assist in achieving the objective such as creating a discussion forum, an online test or assignment that will be assisted through the technology. The objective here is giving rise to a need that will be met with a mobile function.

4.3 Pedagogy

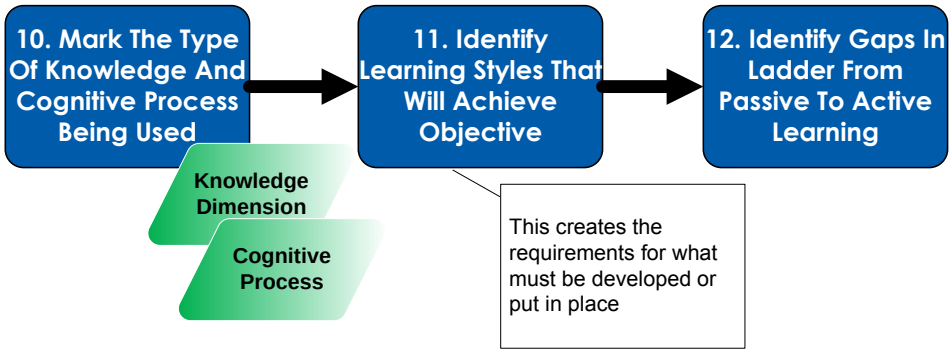

Figure 15: Pedagogical phase in the process of designing mobile learning

The next few steps as seen in

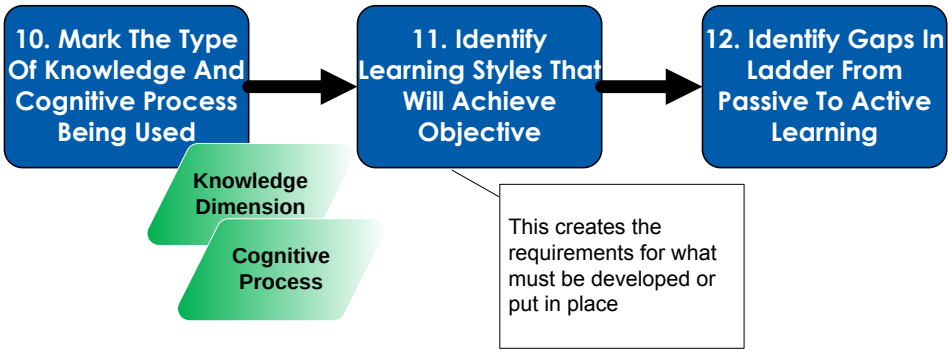

Figure *15* may occur simultaneously with the creation of objectives as they are developed. For each objective identify what the type of knowledge is (e.g. factual) and what cognitive process (e.g. remember) is being used to achieve the objective developed (Merhbi, 2011; Munzenmaier & Rubin, 2013).

The objectives should lead the learner from passive to active learning and into metacognitive thinking where possible. This allows for the educator to further understand the objectives that are being put into place and how it fits into pedagogical theory to ensure that the learning taking place is grounded by these tested theories. When it is visible where the passive and active learning is taking place, the mobile learning platform and its requirements for each of these objectives becomes clearer. For instance, where a more passive approach is being used then providing information to the user is what is required, whereas in a more active learning approach more dynamic mobile learning techniques can be used.

Pedagogy speaks to the learning styles, as shown in Figure *15*.It is interlinked with the objectives of the course and 'how' it will be delivered. The designer must decide how to cater for the various learning styles through audio, visual and interactive means. Using the main objectives of learning, as outlined by Franklin (2011) to guide the objectives of the course, the designer should be asking how the course is (1) enabling learners to reach their potential by allowing learners to access knowledge beyond the classroom; (2) encouraging critical thinking and problem solving skills; and (3) encouraging learners to take responsibility for their learning. It is also useful to identify in the objectives of the course what category of learning it will be and what that means for how it needs to be designed.

Taking Bloom's taxonomy into account the designer may want to use the overarching objective of moving a learner to a higher level of thinking(Forehand, 2010). The eight categories of learning activities theory as described in section 2.10 provide a good base for ways to reach these objectives.

Step 13 involves re-organising the objectives so that gaps can be identified in helping the learner to climb the ladder from passive to active learning. When re-organising the objectives in a grid with the knowledge dimensions as headers and the cognitive processes as the vertical headers, it will be easy to see where there are gaps. Perhaps the course does not take the learner to the cognitive level, or the course is moving too quickly in that it is jumping from remembering to creating without giving the learner time to assimilate and apply the knowledge. In this case new objectives may need to be created or objectives need to be adjusted to give a more fluid learning experience.Looking at what type of knowledge and cognitive processes are being used gaps in the objectives can be identified. Where there is a gap the educator should consider objectives that will improve the course by filling those gaps in the learner's education (Krathwohl, 2002; Munzenmaier & Rubin, 2013).

At the end of the objectives and pedagogical considerations, the designer may have something like the example in Figure *16*. From this example it can be seen how the course is going to achieve its objectives, whether it is a taking into account the multiple cognitive processes of learning according to pedagogy being applied here, and what mobile actions and types of learnings are going to influence the course. It then becomes necessary to consider how the course is to be delivered from what has been identified.

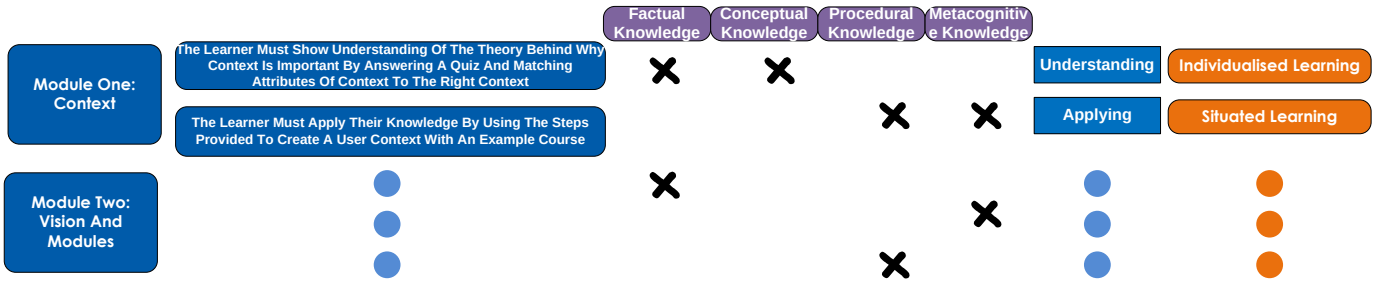

Figure 16: Example of creating an objective for a mobile learning course

4.4 Delivery

The delivery of each module needs to be defined. Delivery asks the question of 'how' we are going to get the information to the learners. The context, objectives, and pedagogy that have been considered should trigger how delivery takes place. The steps described in

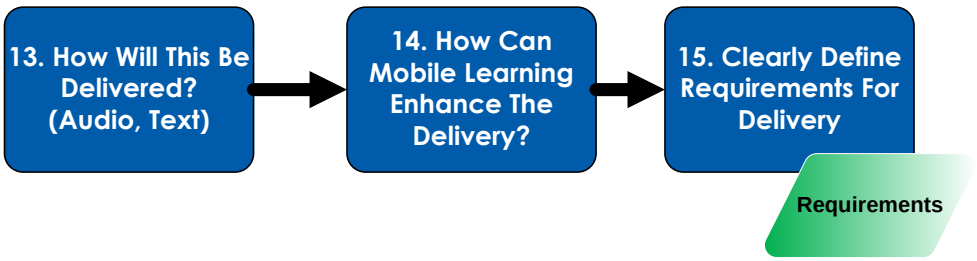

Figure *17* begin with deciding how to deliver the material of the course. Considering the context and objectives created, what aspects will be made available through audio or images. There may be multiple ways of delivering the material.

Step 15 in the process is about considering each of the mobile learning characteristics: ubiquity, nomadicy, social interactivity, personalisation, and context sensitivity against each module (Al-Hmouz et al., 2010). The question to be answered is how mobile technology could enhance the delivery of each module with the context and objectives created thus far.

It is important that the characteristic is necessary or enhances the learning experience and not just applied for the purposes of applying mobile technology.

With a clearer idea of what the objectives are and what and how it needs to be delivered within a context, Step 16 is to write out the requirements according to what has been decided on thus far. The requirements must provide a clear guideline as to the delivery. An example of a requirement may be that for a particular module the concepts must be displayed visually and when selecting a part of the visual it must provide the written description of it. This still allows the designer of the course to be creative in achieving this but provides a guideline as to what must be the input and result (output).

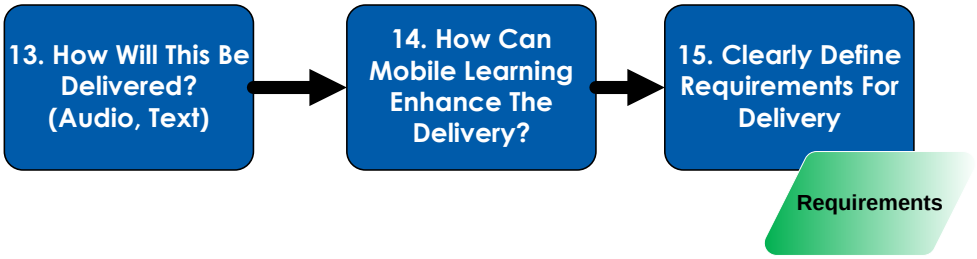

Figure 17: Steps to considering the delivery of mobile learning

4.5 Structure

Structure is ‘when’ the course will deliver the content to meet our objectives within the appropriate context and pedagogical considerations. This should be the final stage of the planning. It includes the timing of the course, bringing in all the previous aspects and monitoring the flow, ensuring it is put together in a way that will guide learners without being restrictive and allowing for the flexibility that the mobile learning environment affords. This can be done visually using a Gantt chart or simply by writing out the requirements and

deadlines of the delivery. Some courses may not have any timelines while others may prescribe reminders and penalties to be put in place.

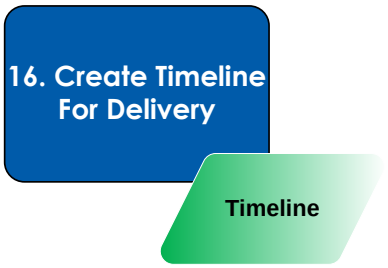

Figure 18: Delivery - the final stage

4.6 Content, Implementation and Evaluation

Content is the ‘what’ is being taught. It’s any research, collecting of necessary information, and resources. It’s not only creating the materials to be delivered but also ensuring that the objectives are met and all necessary information is available and can be made ready for the mobile learning platform, dependent on the contexts and requirements provided. The information made available here will feed directly into the implementation of the course. The content is not part of the overall process of design but rather a part of gathering the necessary information for the actual development of the course.

While implementation and evaluation of the mobile learning course are separate from the design of the mobile learning course, it is important to note that in implementation the aspects of the method are being followed and should be detailed enough to do so. The evaluation phase will also be influenced by the various aspects in the method, as the method allows for generalised areas to evaluate the mobile learning course. The evaluation

should also speak directly to the objectives that should have measurable outcomes. Figure *19* combines the steps in the five phases from end-to-end of mobile learning design as discussed in this chapter.

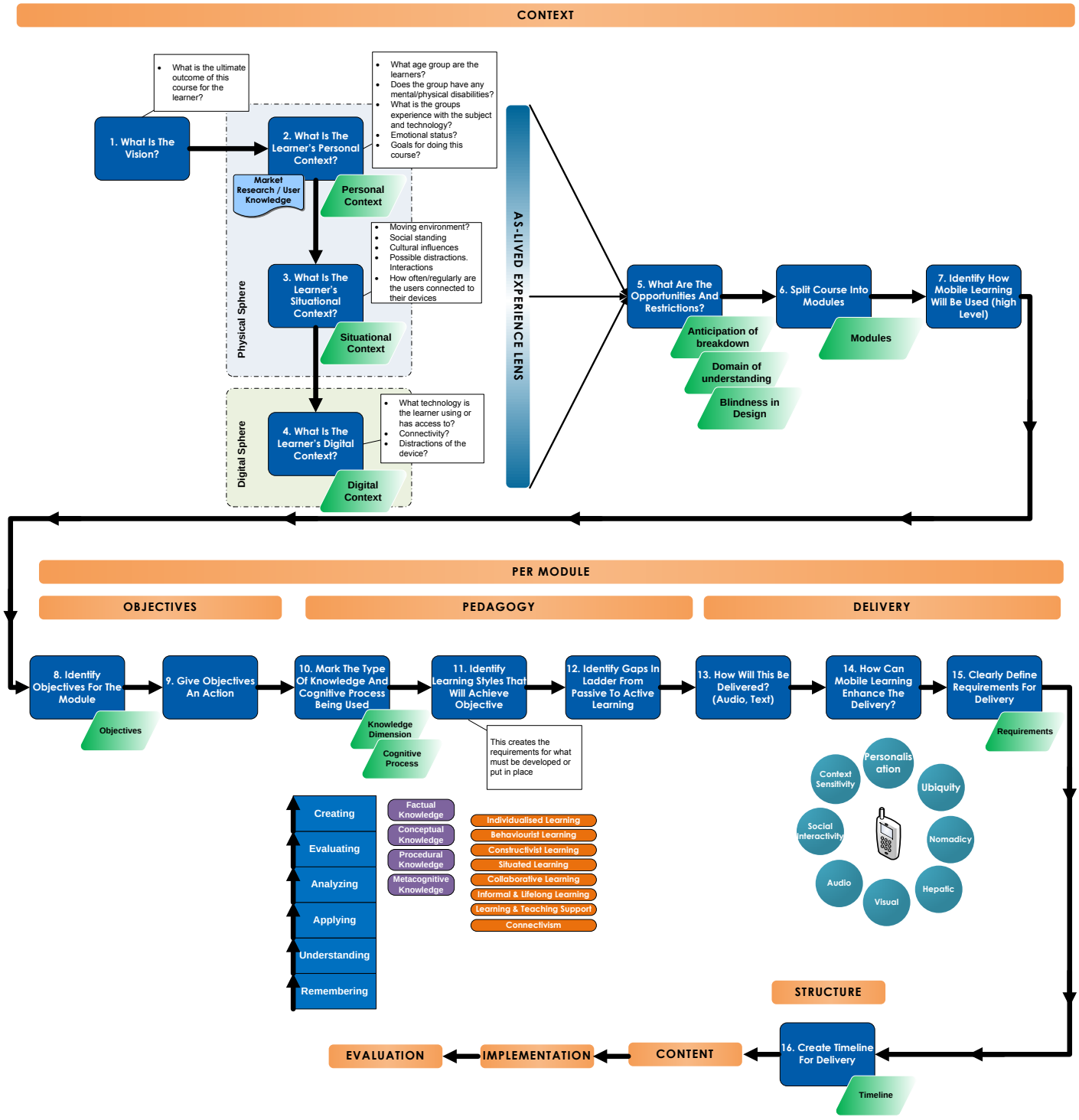

Figure 19: Process of Mobile Learning Design

4.7 Summary

The value in the proposed method is that it brings together various research topics in a structured way, allowing designers to consider the various aspects of a mobile learning course. By going through these steps the designer is able to get a more holistic view and is less likely to only focus on one aspect, such as personalisation, while ignoring other influencing theories. The method is general, in the hope that it can easily be adapted for future research. Figure *20* provides a summary of the phases and the steps within each phase that have been discussed in this chapter.

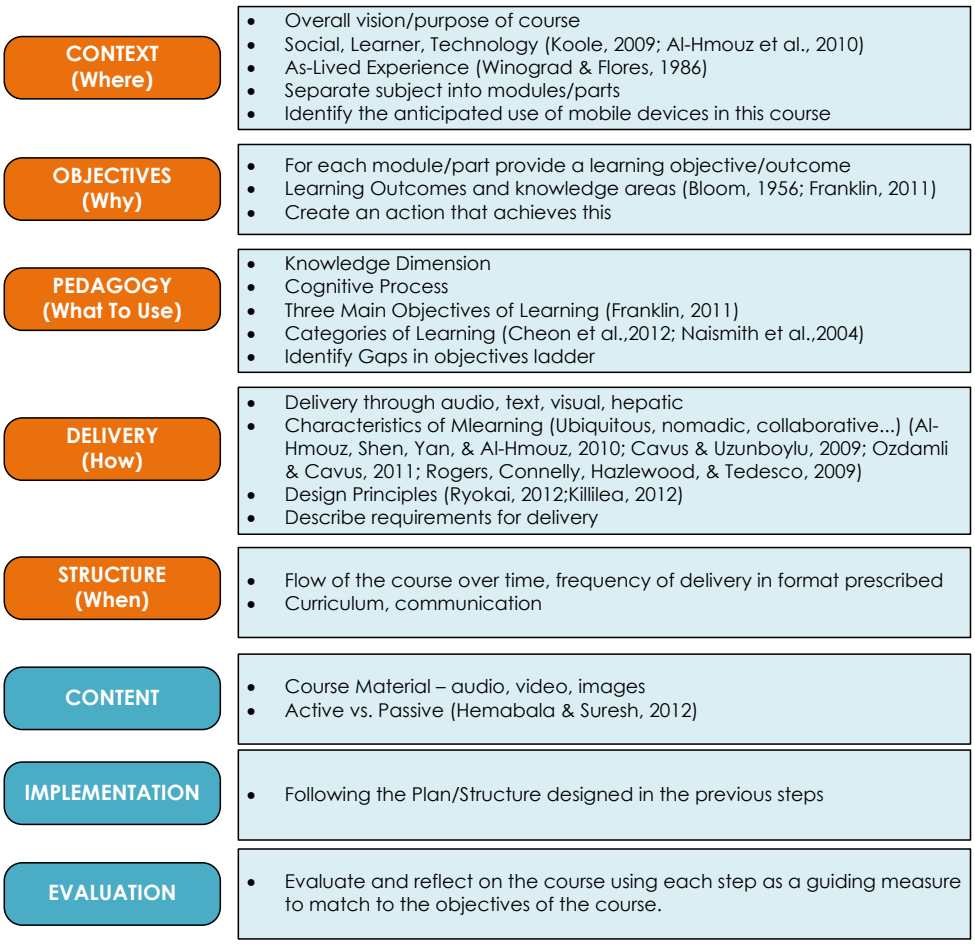

Figure 20: Summary of steps in each phase of designing mobile learning

5 EVALUATION OF METHOD

Three phases of evaluation were conducted. Firstly, the method was tested in isolation as a concept to develop the initial process for implementing the method. Once this was defined, it was presented to the academic community where the feedback of both reviewers and participants were taken into account. The method was finally tested with a practitioner in designing a mobile learning course for project management. What follows is a description of the search process that was following through the design science cycles. Each cycle contributed to the development of the method and the evaluation of it.

5.1 Initial development

In creating the initial version of the method based on the literature the various ideas from the literature were grouped together. It was observed where the ideas linked and overlapped. As the method developed the question remained as to how to implement it.

The first testing of the initial method is what developed and defined the steps and process as described throughout Section 4; this turned the method into a step by step process. This was done by taking the idea of wanting to teach the very method described in this research through mobile learning and questioning how each phase of the module could assist in this design.

Walking through the phases of the method, general ideas were made about where and how in the process different aspects would be picked up in designing the course. It became

clearer as to the types of questions that needed to be asked in each phase and how the phases impacted each other in the process.

5.2 Peer-review

The initial gathering of the literature and its resultant methodology was communicated at the Informing Science and IT Conference 2013, where several reviewers provided input into the method for improvement. Major enhancements from the conference included the inclusion of Bloom's Taxonomy (1956) as suggested by educators and more descriptive visual cues on the method being described. The participants of the conference responded to the research with intrigue and appreciated the simplicity to which the phases provided understanding of the numerous aspects of mobile learning design considerations.

The method was improved further from their responses to include a more descriptive approach to implementing the method. The initial method proposed was very high level and the questions raised resulted in the phases being broken up into steps.

The Informing Science Institute that hosted the conference is an international group that attracts colleagues in the academic area from all knowledge areas. The institution publishes seven journals and various books and offers them as open source resources to academics. The review process conducted is rigorous in that it must be peer reviewed by several persons that must provide substantial feedback and vote on the degree of contribution, originality and applicability of the paper.

5.3 Participant Feedback

As part of the third cycle of testing the method, along with the defined steps and visual cues, a small workshop was held with a project management professional. The project management professional tutored project management through an educational institution for several years while working as a project manager for a consulting firm for the last 7 years. The project manager was planning for a ten week course. The idea of using mobile technology was proposed to her and she agreed to do the workshop to see where mobile learning could assist her learner's progress. What follows is the feedback from taking the participant through the process of the method.

5.3.1 Context

The context was unravelled very quickly with ideas such as the intended ten week timeline being a restriction created by the situational context of the institution providing the course. The course was only an hours class once a week, so students would need to do some of the learning and practical work outside of the classes The guidelines on looking at different contexts assisted the participant in that she had "not considered the technical and mental ability of the student", allowing for the participant to consider the teaching style and what might be more appropriate.

Working through the types of learning styles that mobile learning can offer encouraged the participant to consider moving more toward active learning, and encouraging collaboration, and hence using the characteristics of mobile learning to enhance and assist such types of learning.

5.3.2 Modules and the Depth of Mobile Learning Used

The decision was made to use the mobile phone as a supporting and reference tool for learners, using quizzes to gauge learner's understandings before a physical class. The classroom environment would then be used for more interactive and discussion purposes. This decision was made as the project manager found it more useful to work through examples and case studies with the class once they had an understanding of the course, and with the limited hours of class preferred the class came with the theory and applied it with her assistance.

5.3.3 Objectives

The most useful information to the participant was in understanding Bloom's (1956) taxonomy and the different levels of learning, moving from passive to active learning. The participant found this particularly insightful in understanding how to develop objectives and move the learner "to a point of understanding and applying the knowledge".

The participant stated that "based on the questions in the workshop I had to consider a lot more aspects than I realised which led me to slightly alter how mobile learning was going to support the learning initiative".

5.3.4 Delivery

During the discussion of the mobile learning characteristics and its application to the method, now within a context and amongst objectives, the participant could see the value of the process as the requirements were unfolded. The discussion around the affordances to

mobile learning gave a clearer indication of what requirements needed to be communicated to the designer or developer of the course on the device that could guide the functionality and implementation or development of the mobile learning course.

Using the method assisted the participant in creating a more holistic view of the learner and clarifying the “type of application and delivery method required to successfully engage the learner”. The participant could see how the information laid out could provide sufficient requirements and information to inform the development or design team on what to create.

5.3.5 Structure

With the ten week structure as an initial requirement, using the information that had been created was easily slotted into a Gantt chart that provided deadlines for modules to be completed and certain outcomes to be met within the vision created for the course as a whole.

5.4 Observations

The participant found that using the steps in the methodology gave a better understanding of how to plan for the course and what mobile learning would look like for that course. The participant realised that “the idea I had for implementing mobile learning was not as well thought through as I initially thought”. While a lot of planning had gone into the course content and the timing of the course, the questions raised in the workshop made the participant more aware of the multiple aspects of learning that need to be taken into

account. It was important to explain to the participant the process before heading into the process so that they understood the value of the process.

The participant found the process to be “in a logical structure which allowed me to consider all the aspects of a training course, from the content to method of delivery to assessments”. The sequence of the steps was important in unravelling the course, and as the participant was taken through each step it became clearer why the previous steps were taken. For example, when starting to unpack the styles of learning to be used, the context became an influencer on how to go about it and the objectives guided the outcome required.

As the facilitator of the experiment it was observed that each situation will be very different and that the method needs flexibility to cater for different scenarios.

The method and process followed provided a multi-dimensional view of the mobile learning course to be created. The participant appreciated the questions of each section that allowed them to consider aspects that had not previously been thought through or considered necessary.

The participant would have liked to have covered how to evaluate “if the course was at the appropriate level for the learner” and more on how to know what learning style to use; or to what depth the course should be. Overall, it was a productive experiment that gave the participant further insight into the design of a mobile learning course.

5.5 Summary

Each design cycle brought about changes in the method. The initial cycle being the first attempt of combining the literature assisted in seeing how the different phases came together and influenced each other. This initial stage created the high level method that was proposed at the conference. The feedback from reviewers and conference participants provided additional lenses onto the method, in particular a pedagogical view that extended the method and also questioned the exact implementation of the method.

From the conference the method was further developed into descriptive steps that were tested with a project management professional. The method was received well, with strongly positive feedback from both the academic reviewers at the conference and the participant in the experiment.

From the participant in the workshop, there were gaps identified in that the method did not provide any indication as to whether what was designed would be a ‘good’ design and this indicates that further cycles of this method could be developed.

6 CONCLUSION

6.1 Mobile Learning Design

Mobile learning can be seen as a combination of mobile technology and its affordances that create a unique learning environment and opportunities for learning that can span across time and place. Mobile technology is growing at a rapid rate around the world, and becoming ever more accessible. Technology is emerging and closing the gap towards being a viable tool for mobile learning. It's a social platform that creates environments for communication, understanding, and transfer of information. Its ability to cater for varying learning styles through various features, its link to communication and its social context make it a very attractive tool for learning. The main characteristics that have been identified with mobile technology are nomadicy, ubiquity, context sensitivity, personalisation, and interaction.

By combining the various aspects of mobile learning and the research in these areas, this paper has proposed a method for mobile learning that does not prescribe the content and structure but rather facilitates the process of planning and creating a course while ensuring that the various aspects such as technology, context, usability, and pedagogy are considered along with the objectives of the course. It is hoped that this research can create a central point of reference to more detailed and focused research around mobile learning, allowing for improved mobile learning courses.

6.2 Design Science Research

A design science research methodology was selected as a research approach that allows for the research artefact – a method – to be developed and evaluated in multiple iterations, such that the method can be improved upon constructively. In following a design science research methodology, the seven guidelines were followed (Hevner et al., 2004) as follows:

6.2.1 Design as an Artefact

The artefact designed is that of a method. The method consolidates existing theories and optimises the approach to designing mobile learning. The method was developed and evaluated using experiments and an iterative process from literature, conferences and experiments. This method was novel in that the literature contains very specific aspects of mobile learning design, and does not combine them as has been done in this research.

6.2.2 Problem Relevance

The artefact developed in this research addressed the problem that mobile learning, being a relatively new area has had very few attempts at combining and providing a way for a practitioner to use the available information and research in a relevant and holistic manner to design mobile learning. One of the driving forces of this research area is the increase in mobile devices, and access to these devices to all populations of the world. This research has provided a reference point for different areas of research relating to mobile learning from context sensitivity, technological abilities and pedagogical expectations.

6.2.3 Design Evaluation

The artefact was evaluated with academics peers through a conference paper and with a practitioner in conducting an experiment, while using the artefact in its relevant environment. The literature used to develop this method provides grounding for the artefact after which the cycles of testing have provided a largely positive reaction from the initial feedback of the academic community and practitioner.

6.2.4 Research Contributions

This research contributed through the identification of the research problem. From the literature the gap was identified that a holistic method to assist in designing mobile learning had not been addressed. This research contributes further in highlighting the relevance of this research and the need for further research on this topic, due to its increasing demand and opportunity for accessibility and mobility of learning.

The literature review and method explained in this research was submitted to the Informing Science and IT Education Conference for review, where it was published under the title “Towards a method for mobile learning design” (Stanton & Ophoff, 2013).The paper underwent blind-review by eight academic peers who found the research to be relevant and to be at least a 'modest contribution', with two reviewers that found the research to be a 'unique contribution'. The reviewers placed the contribution as being either a 'validation of theory/knowledge' or an 'enhanced understanding of the subject matter'.

This research has provided a central and holistic view of the mobile learning design area; that provides a reference point for further research.

6.2.5 Research Rigour

This research was conducted in a rigorous manner, through the extensive review of literature in developing and forming the artefact proposed, in gaining input from the academic community into its design, including suggestions from these reviews and conducting an experiment with an educational practitioner.

The rigour was maintained by using design cycles as proposed in the design science research approach. This research contained three cycles of design for the artefact: the initial cycle being the first attempt of combining the literature assisted in seeing how the different phases came together and influenced each other; the second cycle was in developing more descriptive steps to the method from presenting at an international conference; the third cycle was an experiment of the method in a workshop environment to test the practical implementation of the method proposed. Each cycle contributed to the research and the rigour of the research.

Further rigour was shown through the detailed description of how to implement the method proposed throughout Chapter 4.

6.2.6 Design as a Search Process

This research was conducted through multiple cycles as described in Section 6.2.5. The intention of these cycles was to constantly find the problem areas and provide solutions

towards continuous improvement of the method, from its initial stages to its detailed description. Each cycle provided improvements to the method.

The first steps in developing the process came from applying the artefact conceptually to develop the steps that would be used. The initial stage being the first high level method proposed which resulted in a problem arising of how to actually implement the method.

In the next cycle the artefact developed was proposed to the academic community through a conference, and from presenting these ideas further areas of application were applied to the research. One of the main contributions from the comments from the conference reviewers was Bloom's Taxonomy (1956), which gave strong input into how to form objectives. Further to that, more visual representations of the method were added following reviewer comments.

The final cycle was implementing the method in its detailed steps, with the additional pedagogical understandings from the previous cycle, and seeing the practical use of the modifications to the method. The method with its steps was put to test with a practitioner; where further feedback was captured. Following this test the method was further clarified and defined to the method as described throughout Chapter 4. This shows that the design of this method was a process of continuous improvement.

6.2.7 Communication of Research

The initial method of this research was published as "Towards a method for mobile learning design" (Stanton & Ophoff, 2013). The paper was presented at the Informing Science and

IT Education International Conference 2013, where the audience that was presented to included professionals and academics from all areas of education. It was important in this presentation to explain the concepts in a way that was meaningful to the audience and that the theory and method proposed were easy to understand using examples and answering questions about the method. The conference paper reviews marked the method and literature as being relevant and a valid contribution to the mobile learning research.

6.3 Research Questions

The research objectives stated in Section 1.2 were met as follows:

- *How can the technical aspect of mobile learning research and educational research be combined to get a holistic and effective approach to designing mobile learning?*

The different aspects of the mobile learning design were catered for by simplifying the artefact into phases and further into steps that could be followed sequentially and still influenced each other in creating a holistic view of mobile learning.

- *What would a framework for mobile learning design look like, and what are the steps to follow this method?*

The artefact, a method, proposed throughout Chapter 4 is the result of the question being asked and provides a visual representation of how the method works with clear steps to navigate the phases of design considerations.

- *How can an understanding of a mobile user's as-lived mobile experience be used to maximise the potential of mobile learning?*

The as-lived experience became relevant as part of the context phase, where it reached further into the requirements and objectives of the course. Its consideration of anticipation of breakdown, domains of understanding and blindness in design create an awareness for the designer in continuing with the steps of mobile learning design.

6.4 Results of Research

The experiment conducted displayed promise in this method. The sequence of the steps came up as being important to the participant and in gathering the right information to influence the next steps of the method and avoid having to back track too much.

The high-level areas or modules in the methodology allow for other frameworks and theories to be brought into the method without having to fundamentally change the method, ensuring that each area is covered if only using a different theory within that area.

6.5 Contribution

The method proposed has made effort contribution in combining research from mobile learning and pedagogical research into format that is more readily applicable and usable; it is by no means an extensive study but it does provide a starting point. The method includes a focus on mobile learning characteristics that provides a guideline for educators to decide how they will use and deliver their teachings through a mobile device. In this way this paper

has addressed its objective to create a method that facilitates the process of planning and creating a course while ensuring various aspects such as technology, context, usability and pedagogy are considered along with the objectives of the course.

6.6 Further Research

Further investigation into this method, its applicability, generalisability and improvement is necessary. To get the most value from this method it needs to be continually reviewed so that it is taking into account the latest theories and technological abilities. It is recommended that this method and its process be more rigorously tested in more experiment cycles in future and further theories integrated into the process succinctly so that it remains accessible and useable.

Areas such as the device hardware, that is being improved at a rapid rate, can be considered along with the new features and abilities that are being afforded to phones. It may be necessary to also consider how different size devices (phones vs. tablets) might affect the method.

APPENDIX A: SEMI-STRUCTURED INTERVIEW

The following questions were used following the third cycle of the design, implementing the method in a workshop environment, as an evaluation tool. The questions were asked in an informal feedback session following the workshop.

- From the information gathered and mapped in this experiment, would you have enough information to create your mobile learning course? Please explain.
- Did the experiment help to clarify the context of the learner and was this useful to the design of the course? Please explain.
- In what way did you find the objectives outlined in the experiment useful for designing the course?
- What worked well for you in this experiment that you would use again?
- What would you have liked to have covered that was not covered in this experiment?
- Did using this methodology change or influence your original idea of how to implement mobile learning in your course?

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