Design Considerations for Mobile Learning 4

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Abstract

For good reasons, the instructional design practices for classroom environments and e-Learning have been largely limited to the cognitive domain. With the increasingly widespread adoption of mobile technology, a paradigm shift is taking place, offering new opportunities for improving performance and augmenting skills (in addition to knowledge transfer). But how is curriculum design and instructional design for mobile learning any different? Traditional course offerings replaced with or augmented by mobile technology may actually follow many of the same instructional design frameworks or processes in alignment with the widely accepted phases of ADDIE (Analysis, Design, Develop, Implement, Evaluate). But what other types of m-Learning can or should be considered during design? What are the current gaps in design knowledge for educators, instructors, and instructional designers? The answer to these important questions requires a solid understanding of mobile device affordances as well as considerations from two key domains of research and

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practice: Learning Sciences and Human-Computer Interaction (HCI). This chapter will cover these considerations with the goal of helping readers establish an informed design strategy for m-Learning, rather than relying solely on prior instructional design experience.

1 Introduction

As with many past technological innovations, instructional designers and educators have quickly adopted mobile technology with the inevitable benefit of understanding its pedagogical merits. With the growing popularity of interactive apps, engaging touchscreen interaction, and immediate access, it's no surprise that mobile technology has ascended as a top priority of many education and training programs around the world. The mobile device and app platform model has undoubtedly created new opportunities for improving education, training, and performance in formal learning settings but has also drastically changed the way many people work and live on a daily basis.

Instructors, educators, and instructional designers are quickly adopting mobile technology in their learning environments, but strategic design considerations and proven pedagogical practices have not been systematically documented. This misfortune can be attributed to the lack of a universal acceptance of what types of devices are agreed to be "mobile" as well as what types of activities are commonly understood and accepted as "mobile learning (m-Learning)."

1.1 What is Mobile?

When a popular technology like mobile receives so much public attention, development teams often begin with focusing too narrowly on the technology itself, rather than the requirements or learning needs. Ideally, the learning outcome should be the primary driver for making design decisions. However, being familiar with the capabilities of the different types of handheld devices that learners use may also introduce new ideas and might even help to appropriately narrow the scope of a mobile learning initiative. For now, there is no right or wrong answer for what types of devices are considered to be truly "mobile" as perceptions and technology will continue to change and evolve. The focus should be on how mobile technology can add the most value to the learning context. If there are no obvious benefits or justification for using mobile technology to enhance learning or performance, then it is conceivable that a business case analysis or cost-benefit analysis could be pursued. A cost savings benefit could possibly serve as a secondary driver for designing and developing a mobile solution.

Mobile device screen sizes as well as several other form factors collectively introduce many considerations and implications for a mobile learning design strategy. Think about the minimum sizes of text and graphics for various mobile-device sizes, preferences for touching or interacting with different device types, designing for keyboard use, dealing with loss of connectivity, screen glare, and behaviors of smartphone users vs. tablet users. All of these concerns may influence how organizations determine what devices they will include or exclude from their list of targeted mobile device types.

While there are success stories that leverage basic features such as text messaging, today's mobile devices that have a touchscreen and advanced hardware capabilities seem to offer the most potential for rich mobile learning experiences. In addition, smartphones and tablets are becoming so prevalent because they are typically more affordable and portable than laptop computers. A survey conducted by the Advanced Distributed Learning (ADL) Initiative in 2013 asked 831 respondents from the education and training community which mobile device they use most often for learning (Berking et al. 2013). The results heavily implied a focus on smartphones and tablets for mobile learning, with the highest responses reported at 61 % for tablets and 29 % for smartphones.

The education and training communities both have internally mixed opinions on whether a laptop should qualify as a mobile device. Laptops were once considered too heavy and not small enough to be truly mobile. However, the recent convergence of laptops with tablets into a hybrid device by some manufacturers could make this concern even more difficult to address. For example, designing learning content for a tablet has much more in common with a laptop or desktop computer than it does for a smartphone. However, the individual usage of these devices is much different. There is also an increasing number of design implications related to hardware expansion capability differences between mobile devices as the market continues to evolve. Nonetheless, the purpose and scope of this chapter will be focused on smartphones and tablets as the preferred types of mobile devices used for mobile learning.

1.2 What is Mobile Learning (mLearning)?

The true potential of mobile learning (hereafter referred to as "mLearning") should not be merely described as learning content delivered or accessed on a mobile device. It should be viewed as a way to augment the learner by providing access to both learning content and support information, anytime and anywhere. Therefore, both the learners and devices of today as well as the future should be considered to provide a more flexible view of mLearning. Unlike other learning technologies, mLearning is unique in that it can accommodate both formal and informal learning in collaborative or individual learning modes, and within almost any context. Consider the following working definition of mLearning:

> Leveraging ubiquitous mobile technology for the adoption or augmentation of knowledge, behaviors, or skills through education, training, or performance support while the mobility of the learner may be independent of time, location, and space.

This definition allows for a growing number of mLearning scenarios as well as future device capabilities and types. This definition also lends itself to support both education and training in traditional learning environments as well as performance support scenarios. Mobile learning should not be merely viewed as a replacement, an alternative, or a new addition to existing education or training delivery methods. It should be thought of as a complementary way to augment or enhance environments that already support learning.

There are many other macro-level implications and considerations for mLearning from a development, implementation, or evaluation perspective. It is beyond the scope of this chapter to describe or cover these. In this chapter, the focus is on answering the question, *What unique considerations are relevant to the instructional design of mLearning?* The chapter will begin with how the traditional views of curriculum and instructional design can be rethought to support the performance of the learner. Readers will learn about these critical considerations for mLearning design based on the aforementioned distinctions and descriptions the authors candidly provided for the terms "mobile" and "mobile learning (mLearning)."

2 Performance Support in Curriculum and Instructional Design

In formal learning environments around the world, the key tenets of "what should be learned" and "how it should be organized" are traditionally addressed through the processes of curriculum and instructional design. However, a prevailing uncertainty among educational technology researchers today is whether or not mLearning introduces a discontinuity in traditional design principles for curriculum and instructional designers. The 2013 ADL mLearning survey (Berking et al. 2013) of education and training professionals inquired whether the instructional design process for mLearning is any different from the instructional design process for traditional eLearning. Sixty-six percent of the respondents from this study agreed that it does offer some discontinuity.

Perhaps the most significant impact of mLearning on overall curriculum and instructional design is a paradigm shift from planned instruction to performance support. Performance support is the discipline that harnesses informal learning and makes it intentional (Gottfredson and Mosher 2011). This is simply due to the "anytime, anywhere" nature of the mobile platform, where users can access information and support materials at the point of need. As MIT professor and artificial intelligence pioneer Seymour Papert (Motivateus.com 2014) said, "*You can't teach people everything they need to know. The best you can do is position them where they can find what they need to know when they need to know it.*"

Learners are no longer constantly tethered to their desktop or portable laptop computer to support learning but are more frequently turning to leveraging mobile devices for support and self-directed learning. A 2012 Pew Research survey (PEW 2012) found that 86 % of smartphone owners have used their devices in the previous 30 days to perform at least one "just-in-time" or performance support activity. Performance support is now often used in education, training, and workplace settings when learning is complemented or enhanced by on-demand information assets and electronic aids. The previously mentioned survey on mLearning (Berking et al. 2013) revealed a high level of confidence in performance support as an optimal approach for delivering mLearning. Towards Maturity (2014) found in their 2013 survey that "accessing support at the point of need" was the top driver for mLearning (80 % of respondents listed it as such, above such factors as "improving employee engagement"(79 %) and "improving communication between individuals"(77 %)).

Mobile device use inherently increases the tendency for learners to engage in self-directed learning and stimulate their cognitive curiosity beyond classroom walls (Traxler 2007). Self-directed learning is commonly understood as a universal goal of higher education. Determining the most effective conditions for improving the performance of the learners in both higher education and training environments is often considered by instructional designers and educators as one of the most critical yet challenging undertakings.

The role and focus of performance support in education and training is generally increasing, and there is also a clear distinction in education when compared to its purpose in a training environment. The distinction is directly related to the intended outcome and whether it is supporting a workplace task or a formal learning task. Typical learning outcomes are commonly aligned with memorization, understanding principles or concepts, applying rules, or acquiring high-order cognitive skills or problem-solving abilities. These types of learning outcomes all require different forms of instructional support and strategic planning. There are two distinct types of performance support: one is designed to offer support for workplace tasks at the point of need (defined by time, place, and context); the other is designed to support the learning process itself, usually in an academic setting (i.e., electronic study aids for a class). The former is often blended with instruction (classroom or eLearning), and the latter is inherently blended.

Performance support alone, or a blended version of it, has the potential to significantly alter curriculum design; what were once sequences of formal courses or modules can now be catalogs of performance support materials; what were once sequences of classroom activities can now be self-directed learning activities guided by on-demand information. In some cases, the classroom or online portion of a blended learning module is relegated to merely training on what performance support resources are available and how and when to use them. Assuming there is a clear value proposition for incorporating mobile technology, the teachers, instructors, or instructional designers need to determine if the learning activity is truly dependent upon the learner and device being mobile. If it is not, and the activity is only minimally enhanced by mobile technology, then it may not be necessary to tie it too closely to the learning objectives.

3 Learner-Centered Design

A key factor in determining the utility and success of an mLearning solution is the ability of that solution to adequately satisfy its users. Instructional designers should consider establishing user experience goals for their solutions so the learners find them usable, engaging, and motivating. In both the mobile and web development professions, experience design and interaction design are often closely aligned to a usability philosophy of considering the quality of touchpoints and user engagement within a software application experience.

Ironically, designers of interfaces for learning are often not instructional designers, but they should be encouraged to work closely together. User experience and interaction designers often apply principles of usability whereas the instructional designers apply theories of learning. These theories of learning should be conveyed to the interaction designer before they can be leveraged for mLearning design. Consequently, the principles of user experience and interaction design should be equally conveyed to the instructional designer. Often, the focus of a user-centered design is to support task completion, whereas effective learner-centered design will help to reconstruct the experience around the learner. Combinations of both user-centered and learner-centered practices are often required in order to design and develop a useful mLearning solution.

Learner-centered strategies also usually target independent learners with a need to think critically and solve problems. As mentioned earlier, performance support is emerging as a key design strategy for mLearning but also supports learner-centered design strategies. In the higher education setting, this might take the form of the scenario mentioned in the previous section, where it complements the classroom experience or, in some cases, guides self-directed learning. For classrooms augmented by mobile technology, the design of the mLearning solution must integrate closely with the core texts, curriculum guide, class objectives, and other materials related to the class. Similarly, workplace performance support materials should align with existing training or workplace tasks. Ideally, a learner-centered design strategy must give the users a compelling reason to access the support materials. Quinn (2011), an author of several books and articles on mLearning design, presents performance support as a form of learning augmentation and provided the following items for consideration in a learner-centered design:

1. Motivational examples – presented before and after a formal course to reinforce the need to learn the material
2. Extending learning processes
   - Reconceptualization – providing new concept representations
   - Recontextualization – new contexts of application as examples
   - Reapplication – more practice
3. Connecting with feedback
4. Supporting learner preferences – presenting material in the medium, time, format, etc. preferred by the learner
5. Contextual opportunities – adding value by tailoring learning to specific locations or times

What other factors could influence a learner-centered design strategy? To answer this question, consider thinking about how people touch, hold, perceive, and interact with their mobile devices. A deep understanding and analysis of the target audience's usage patterns and the device affordances will heavily inform the design. These factors will be examined next.

3.1 The Sense of Touch and Mobile Behaviors

Mobile devices provide a context in which haptic interfaces are playing an increasingly important role (MacLean 2008). The emotional and social significance of touch for humans is undeniable. It is deeply rooted in early human physiological and psychological development from the time of embryo development all the way through adulthood (Nicholas 2010). Today's mobile user typically expects full control over a mobile interface and receives sensory information prompts in a manner that is usable in his or her current context. Touchscreen and sensor-based inputs such as swipes, taps, pinches, screen rotation, and vibrations seem to increase motivation, engagement, and the authenticity of a simulated environment on mobile devices. However, there is little research on exactly why mobile touchscreen interfaces are so engaging and motivating in both collaborative and individual learning environments. According to the 2013 survey on mobile learning from ADL (Berking et al. 2013), touchscreen interaction was also selected as the top area of mLearning design that educators and training professionals were most interested in better understanding.

What role does touch interaction play in tactile cognition and learning on mobile devices? Tactile learning is the process of acquiring new information through tactile exploration (Nicholas 2010). Research studies on tactile information processing in humans have revealed that people can actually be trained to absorb a large amount of information by using their sense of touch. There are also obvious benefits inherent in mobile apps that provide an optimized-for-touch experience. According to research on mLearning in the classroom (Ciampa 2014), materials, quizzes, and games made available via mobile apps also provide opportunities for exploration, repeated self-assessment, and instant feedback. The instant feedback to student responses was an appealing form of incentive compared to prior classroom practices of grading and providing feedback by hand, long after a concept had been taught and possibly forgotten.

Neglecting to consider HCI and touch interaction behaviors when designing mLearning can actually lead to missed learning opportunities if users are subjected to poor interface and interaction design decisions. While high-quality content and instructional design are important, clean graphics and visual design help attract learners to interact with the interface and content. Fortunately, for the most part users are at the mercy of the mobile device manufacturers and operating systems (OS). They have already made many of the inherent user interface design decisions for apps to work within their mobile OS. However, there is still some responsibility for graphic design and interface elements in mLearning, leaving room for error, and even more so if mobile user behaviors are also not taken into consideration or tested for in advance.

Past research on mobile behaviors has focused primarily on smartphones while educators and instructional designers have directed much of their focus to delivering mobile learning on tablets without a deep understanding of the ergonomics and

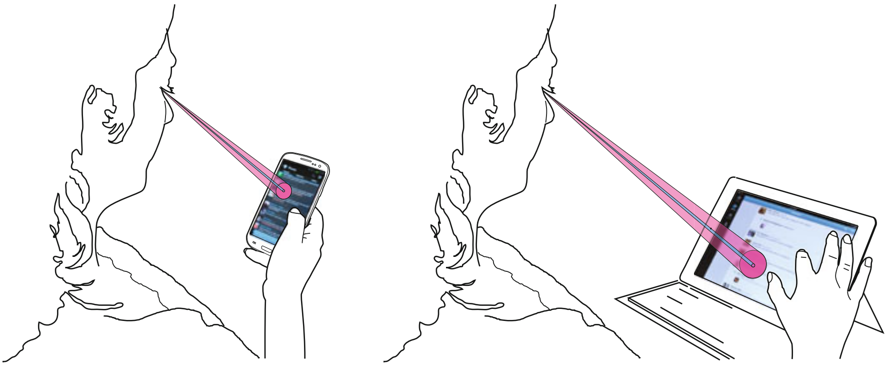

Fig. 1 A tablet on a surface is much further from the user than smartphone in the hand so text and graphics must be much larger from Hoober and Shank (2014)

behaviors of use. A recent survey report published by (Hoober and Shank 2014) titled "Making mLearning Usable: How We Use Mobile Devices" revealed how people hold and when they use mobile devices. The survey revealed the ways people use smartphones and large tablets are substantially different. People use phones almost entirely in several possible hand combinations, and largely on the move while standing or walking. People use tablets much more often while sitting, and with the device in a stand, attached to a keyboard, or set on a table. Users also often change the way they hold their smartphone or tablet, switching from one to two hands and changing the orientation, different for typing vs. reading. These findings have huge implications for readability and mLearning design (Fig. 1).

These findings also point to the fact that the larger tablets with 9–11 in. screens are being used very similarly to laptops. In addition, the wide range of hand combinations when using smartphones is further increased if left-handed vs. right-handed use is taken into consideration. These insights reinforce the importance of HCI and learner-centered design considerations in an mLearning design strategy (Fig. 2).

It may not be possible to address all of the attributes of both tablets and smartphones without encountering a substantial amount of distinct differences such as accommodating user interaction preferences, screen sizes, and user behaviors. These differences alone would require exponentially complex considerations for each device type and form factor. Therefore, it is imperative that organizations wisely decide on which devices should be part of their mobile strategy, and this decision should be informed by their learners' behaviors but also by their access to and expectations of mobile technology.

3.2 Device Capabilities and Affordances

As a result of the excitement surrounding mLearning in recent years, many educators and instructional designers mistakenly ask "where do I start in deciding which mobile technology to use?" Faced with the overwhelming array of choices, many

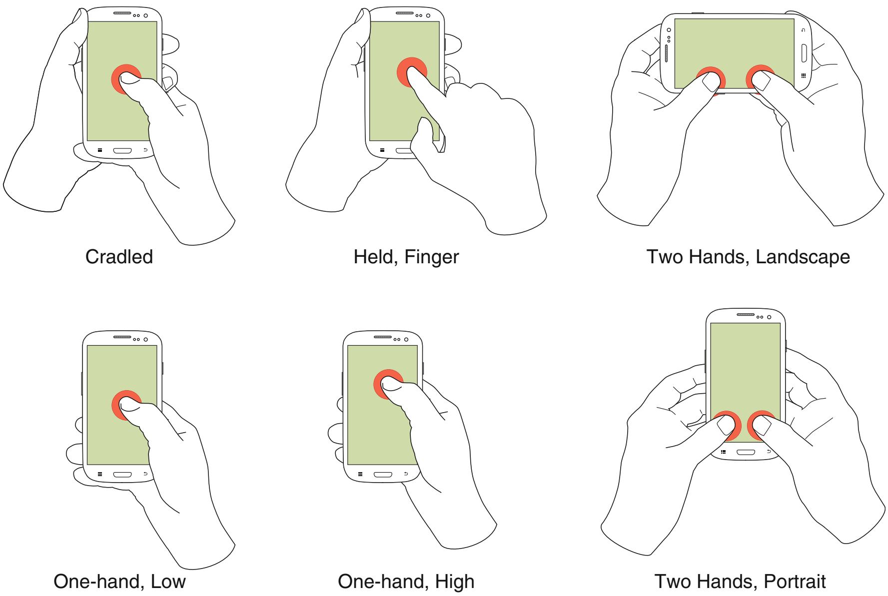

Fig. 2 The way we hold our mobile devices from Hoober and Shank (2014)

start in an arbitrary way, selecting a technology (especially a new one that has emerged as the flavor of the month) that seems to be a fit for their need and finding a way to make it work for them (e.g., augmented reality). A less risky approach is to define the problem to be solved and then examine mobile technologies systematically, pointing to specific device capabilities and affordances. This can be tricky, because most mobile technologies were not invented solely for learning and do not come with a manual of how to use them explicitly for learning.

Psychologist James J. Gibson in his 1977 article "The Theory of Affordances" first introduced the term "affordance." Gibson (1977) defined affordances as all "action possibilities" latent in the environment, objectively measurable and independent of the individual's ability to recognize them but always in relation to agents and therefore dependent on their capabilities. An affordance in general terms is therefore a quality of an object, or an environment, which allows an individual to perform a specific action or ability. The term has been further evolved by Norman (1988) for use in the context of HCI to indicate the easy discoverability of perceived action possibilities. The key to understanding affordances is to identify the underlying capabilities and then describe the affordances those capabilities provide for learning applications, as an intermediary step to eventually identify the learning strategy to be employed. Raw capabilities of the device are therefore the enablers for affordances. However, learners may not always have equal access to the same capabilities depending upon their device type, connectivity, security, privacy, and other technological or environmental challenges. Equal access to specific device capabilities is a critical factor and consideration influencing the flexibility and richness of mLearning design options. These types of considerations should be identified during the analysis phase of an mLearning project so that they might be appropriately addressed during the design phase.

Affordances are important to recognize for the design of mLearning because smartphones and tablets exhibit unique features and qualities that allow individuals to perform a specific action. Each affordance is enabled by the portability of the device, coupled with a specific capability of the device. In many cases the affordance is based on the combination of both hardware and software capabilities. For example, the camera is a capability of many smartphones and tablets. The hardware for the camera alone does not provide a unique capability. When the camera hardware is combined with a software application (App), then such affordances as capturing video and images, augmented reality, Quick Response (QR) code reading, or content image analysis are made possible. When thinking more deeply about capabilities and affordances for mLearning, consider the following table in Fig. 3 below.

Augmenting and Contextualizing

Instructional designers and educators often lack clarity regarding the impact that a learner's physical location has on his or her learning. An analysis of what parts of context are important for effective mLearning practices and how they can be used is of major importance. *Augmenting* and *Contextualizing* might possibly be two of the most powerful affordances to be considered for mLearning design.

Mobile device capabilities such as the Global Positioning System (GPS) sensors, geolocation, and camera scanning provide mLearning designers with the ability to know the real-world geographic position as well as the physical place where learning can occur. Augmenting provides an enhanced view of the real world by overlaying sound, graphics, text, video, and GPS information. Contextualizing provides opportunities to improve learning through adding more meaning or contextual support. How can this impact mLearning design strategy? Consider situated learning (Lave and Wenger 1991), where such learning is situated in a specific context or takes place within a particular social and location-based environment. Situated learning is possible in mLearning today through the affordance of contextualizing. For example, consider the following examples: field trips, location-based guides, nature studies, museum tours, collaborative field activities, on-the-job training, and performance support. All of these types of learning scenarios are especially enhanced by improving nearby context information because they may depend on a specific location.

Mobile augmented reality is one example of mLearning that sometimes combines the affordances of *Augmenting* and *Contextualizing*, providing designers with a way to enhance both the user's context and real-world situation at the same time. This combination of augmenting and contextualizing might explain why augmented reality has grown substantially in recent years and penetrated other markets outside of the learning space.

Affordance for Mobile Learning	Device Capabilities
Accessing: On-demand access to information, courses, performance support or refresher knowledge. Examples: search knowledgebases, job aids, reference, dictionary, Wikipedia, courses, voice search, social media	• touch screen • internet browser • connectivity • microphone
Augmenting: Overlaying still imagery, audio, or video over real world objects or setting in support of or during a contextual learning activity. Example(s): augmented reality, scavenger hunt, museum tours, language learning	• camera • GPS • internet connectivity
Capturing (audio): Documenting or recording auditory content in support of or during a learning activity.	• microphone • speakers • digital storage
Capturing (imagery or video): Documenting or recording visual content relevant to learning activity.	• camera • microphone • digital storage
Communicating (messaging): One-way, two-way or group messaging as part of an informal or formal learning activity. Examples: group collaboration, instructor/student discussion and chat	• SMS • MMS • chat apps • microphone
Communicating (voice): Two-way, or group discussion as part of an informal or formal learning activity. Examples: group conference, meeting, focus group	• voice call • voicemail • speaker • microphone
Contextualizing: Notifications and linked interactions sent by transmitters or tags attached to objects using proximity or location sensors to provide a context-aware or location-aware content in support of or as part of a learning activity. Examples: iBeacons, QR Codes, scavenger hunt, mobile tours, games, and interactive stories	• Bluetooth • GPS • NFC • RFID • Wi-Fi • camera
eReading: Accessing and reading documents on multiple devices anytime, anywhere in support of or as part of a learning activity.	• text zoom • text highlighting • notes
Media Playing: Accessing media anytime, anywhere in support of or as part of a learning activity. Example(s): YouTube, Kahn Academy, Webinars	• image • video • audio • internet connectivity
Notifying / Reminding: Event triggers, instant reminders, and alerts that illicit immediate responses or deeper engagement with a learning activity. Examples: spaced repetition/learning, flash cards, language learning	• connectivity • touch screen • push notification service • calendar

Fig. 3 Affordances for mobile learning

Spaced Learning

In addition to providing contextually relevant information or augmentation, mLearning is ideal for providing enhanced retention by leveraging Spaced Learning (aka spaced repetition). Spaced Learning is a learning technique that incorporates increasing intervals of time between subsequent reviews of previously learned material in order to exploit the psychological spacing effect. Spacing can involve a few repetitions or many repetitions. This is one of the examples provided in Fig. 3 above as a result of the notification/reminder affordance. Providing only textual and general information in mLearning without repetition, no matter how elegantly it is presented, will usually not result in long-term knowledge transfer or performance improvement for most learners. While repetitions are good for retention in learning, spaced repetitions have been proven to be the most effective. And longer spacings tend to produce more long-term retention than shorter ones (Thalheimer 2006).

This spacing is effective both on the level of the initial content presentation as well as refresher/reminder education or training (to prevent knowledge decay of information that one seldom uses). Findings from Thalheimer (2006) reveal that the amount of practice and intervals in between depend on a number of factors including how complex is the skill, how often the opportunity occurs, and how important is competence or performance. Thalheimer, W. (2006) reports that

> The spacing effect is one of the most reliable findings in the learning research, but it is, unfortunately, one of the least utilized learning methods in the learning field.

Instructional designers have had this information for a long time – over 100 years, in fact. Hermann Ebbinghaus proved it in 1885 with what he called The Forgetting Curve. Figure 4 below is an adaptation of Spaced Learning to include practice and test depictions by Quinn, C. (2011).

This effect suggests that "cramming" (intense, last-minute studying) the night before an exam is not likely to be as effective as studying at intervals in a longer time frame. Repetitions at increased time intervals strengthen connections in the brain and counteract the process of forgetting. For improved retention, an mLearning solution could optionally provide repetitive practice to mastery to ensure that the facts, processes, and concepts are internalized for later recollection and use. Consider how spaced or timed, relevant learning could be beneficial to your learners. Mobile devices provide the capabilities that easily leverage the affordances of notifications and reminders that can harness the power of Spaced Learning.

4 Learning Theories and Conceptual Frameworks

As previously mentioned, mLearning does not simply amount to a different mechanism for delivering content to learners; it represents an emergent way of thinking that implies a paradigm shift and requires new design strategies informed by sound underlying learning theories. Although mLearning design does not necessarily require new models, the mobile devices and the learning theories they support are

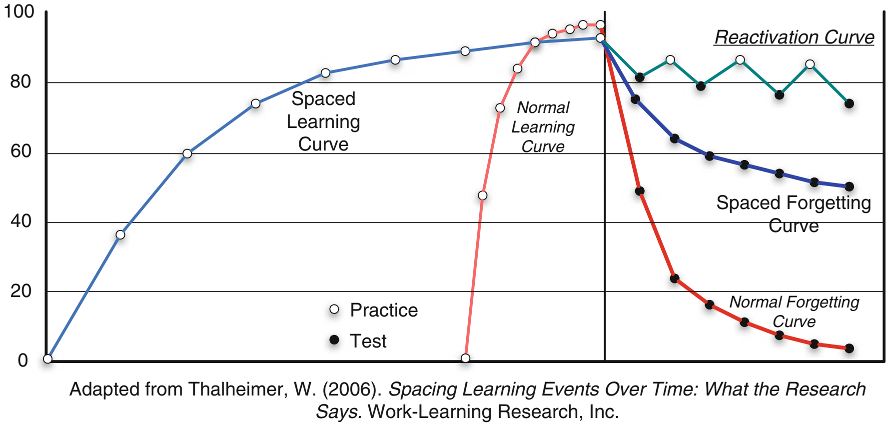

Fig. 4 Spaced practice by Quinn, C. (2011) (Adapted from Thalheimer 2006)

sufficiently unique that special considerations are warranted during the design process. Conceptual frameworks can also provide opportunities for these considerations by providing guidance for thinking about new concepts and approaches in the design context. Instructional design models such as ADDIE are generally focused on helping lead the designer, objectively, without premature bias toward a particular solution, to choosing the appropriate learning technology and instructional strategy. Robust ID models are intended to stand the test of time and are agnostic to particular technologies and design strategies. However, it is not unusual for instructional designers to combine existing process models with other models, frameworks, or theories.

Learning theories are critical to mLearning design because they directly inform choices of learning strategies and can ultimately influence other steps in the ID process. Constructivism is generally recognized as one of three main schools of thought in learning theory, based on the work of Piaget and philosophers like Vygotsky. In the past, it has been underutilized in learning experience design because of limitations of the learning environment or technology. However, it is now enabled significantly by the mobile platform, occupying a potentially equal seat at the learning design table along with the two other traditionally relied-on learning theory schools of thought, Cognitivism and Behaviorism.

Constructivism holds that learners "construct" knowledge and meaning from interactions with other people and their environment; meaning is therefore unique to each individual. New information is assimilated into the learner's mental schema filtered through existing knowledge and experiences. Constructivist learning focuses on creating appropriate learning environments, with authentic representations of real challenges and tasks that learners can interact with and construct meaning from. This learning theory is especially relevant because mLearning enables learners to communicate, analyze problems, and participate in learning activities in a real-world context. In fact, learners can analyze problems on the spot in real time without having to return to the classroom.

Constructivism is also often equated with informal learning. Depending on the definition of the latter, there is significant overlap, but they can be differentiated by the fact that informal learning connotes freedom of choice on the part of the learner to determine what activities they are going to engage in to meet the learning objectives; by contrast, constructivist learning environments (CLEs) may be constrained to a finite range of choices (i.e., learners "discover" the solution to a problem by examining the given options that are engineered into the system). There are no unique design considerations for mobile CLEs except that the affordances of the mobile device need to be taken into account; CLEs, more than behaviorist or cognitivist experiences, really can benefit the most from mobile technology, since they are often conducted in the field, leveraging the many different data capture and communication features of mobile devices.

Conceptual mLearning design frameworks (as opposed to learning theories) might also be investigated during the analysis phase while developing an instructional strategy. However, they can inform mLearning design mostly only in indirect ways; they are meant to suggest a heuristically based intellectual orientation when approaching design problems. They are on the opposite end of the spectrum of algorithmic, cookbook-style design process models such as Dick et al. (2014). Although abstract and high level, these models can be used as an evaluation rubric for a given design, in terms of determining whether it adequately accounts for all aspects shown in the model. MLearning content and applications should be designed with special consideration for existing learning theories, and conceptual frameworks can be leveraged for stimulating creative thinking and planning. Several mLearning frameworks have been proposed, but many are uniquely aligned with a specific use case. The following frameworks are more generalized and might serve as a starting point for designers new to approaching design challenges in mLearning.

4.1 A Framework for M-Learning Design Requirements

This conceptual framework by Parsons et al. (2007) was conceived prior to the advent of modern smartphones and tablets, but it still provides a valuable resource on the systematic planning for mLearning experience design. The framework addresses generic mobile environment issues, context issues, learning experiences, and their individual or collective learning objectives (Fig. 5).

4.2 The Framework for the Rational Analysis of Mobile Education (FRAME) Model

Koole (2009) presents a model for describing mLearning as "a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction." It addresses contemporary pedagogical issues of information overload, knowledge navigation, and collaboration in learning." Using this Venn diagram and

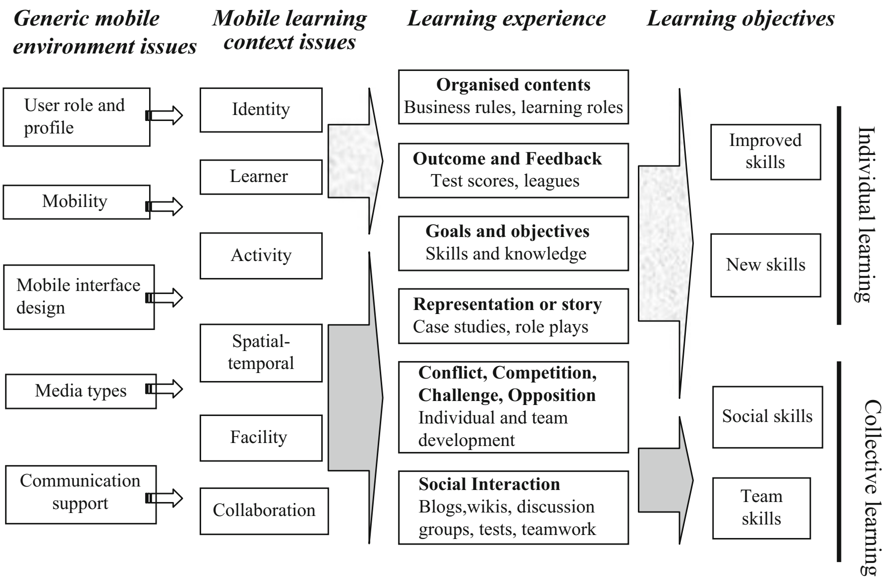

Fig. 5 A framework for M-learning design requirements

the explanation Koole provides on each circle and intersection area, a high-level informal checklist can be generated to comprehensively guide one's design thinking in these particular areas (Fig. 6).

4.3 Park's Pedagogical Framework

Park (2011) used Moore's (2007) transactional distance (TD) theory as the basis for a conceptual framework for mLearning. Transactional distance refers to the immediacy and structure of communication between instructors and learners. This led to his categorization of four types of mLearning by Park (2011):

1. High–transactional distance socialized m-learning
2. High–transactional distance individualized m-learning
3. Low–transactional distance socialized m-learning
4. Low–transactional distance individualized m-learning (Fig. 7)

Park (2011) also discusses how this framework can be leveraged by instructional designers to understand how mobile technologies can be incorporated into their design strategy more effectively. The framework's practical use would rely on categorizing the characteristics of desired learning activities as well as the inherent properties of a particular mobile technology and matching them to one of the four types.

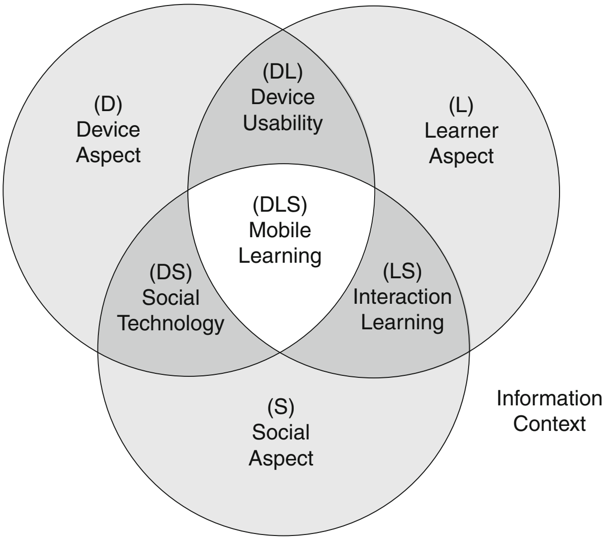

Fig. 6 The FRAME model

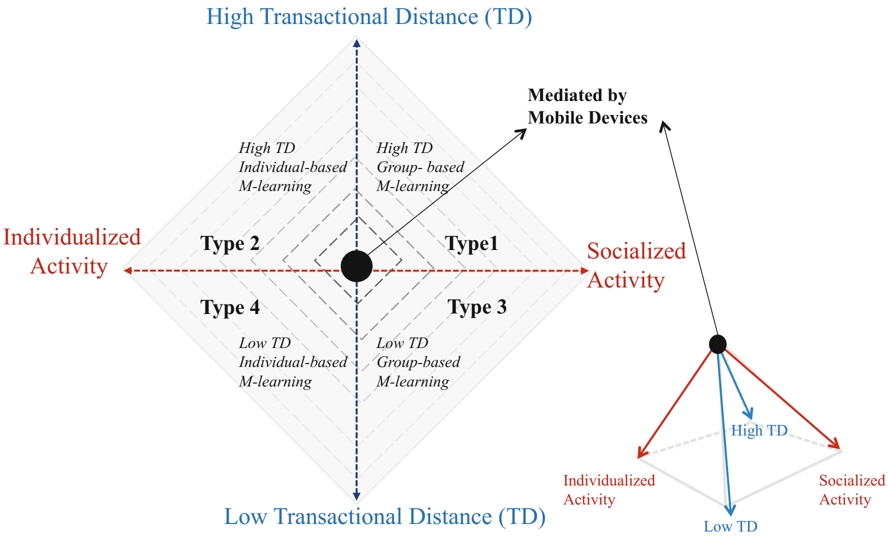

Fig. 7 Park's pedagogical framework

4.4 The M-COPE Framework

This framework by Dennen and Hao (2014) provides a useful tool for encouraging educators to consider the requirements for incorporating mLearning into their instructional strategy. The M-COPE framework consists of five key elements:

Mobile, Conditions, Outcomes, Pedagogy, and Ethics. Each of these elements provides a set of considerations to be made about a particular learning context. It was developed to help instructors make informed decisions during the design process when creating both new learning activities and applications or when incorporating mobile resources into existing nonmobile activities. The authors of this framework believe that instructors will benefit from this framework by prompting them to recognize learning needs and constraints while following established ID process models.

4.5 Mobile Training Implementation Framework (MoTIF)

This framework is focused on exploring the intersection of multiple design and research methods by following a Design-Based Research (DBR) approach. The framework suggests using an integrated master flowchart of processes, decisions, and considerations for the entire instructional design process, specifically including and highlighting elements that optimize it for mobile learning. The objective to define and refine a design decision support framework includes consideration of the motivational, contextual, pedagogical, and performance support aspects of mobile learning.

5 Create, Convert, or Capitalize?

Perhaps one of the least complicated mLearning decisions for educators and instructional designers is determining whether they need create something entirely new, convert existing learning materials, or capitalize on current mobile apps. Creating a new mLearning solution can quickly become costly and time consuming, and there are significant technical concerns when it comes to cross-platform development. Before rushing to create a new mLearning solution, designers might consider capitalizing on the popularity current App Store catalogs from Apple, Google, and Microsoft. The popular “there’s an App for that” slogan trademarked by Apple holds true for the other mobile platforms as well. Often, the mLearning need can be addressed by an existing app or a combination of apps. For example, several augmented reality browser apps are freely available today and are already being used to meet mLearning needs in education, training, and performance support. If existing apps or mLearning solutions can be leveraged, it might also be more cost effective to utilize them rather than creating a new capability from scratch. If existing apps don’t completely fulfill the mLearning requirements, then reviewing them might at least help expose educators and instructional designers to new design ideas.

Alternatively, leveraging HTML and the web might provide another option for mLearning design for situations where learners might not have access to the same mobile platforms or apps. The one thing every mobile device has in common is that they all have web browsers that support HTML. While targeting a mobile web approach might address concerns with cross-platform access, it will limit mLearning design strategies that wish to target the advanced capabilities of mobile devices (e.g., sensors, camera, push notifications).

In the case of revisiting instructional strategy due to a mobile conversion requirement, conceptual frameworks from Park (2011), Koole (2009), and Berking et al. (2014) that emphasize the analysis phase might also be considered. If the analysis phase is ignored, the learning or performance problem may never be addressed and money and resources might be wasted either on a problem that doesn't exist or the wrong problem altogether. It is at this point in the process when appropriateness of mLearning as a solution should be justified.

If existing learning materials are being converted to mLearning, the Analysis phase has presumably already been completed. However, in light of the unique design considerations for mLearning, an audit would be needed of the existing content and strategy, to ensure that the content and approach is still appropriate for mobile. Mobile conversion usually requires more than chunking the content down into much smaller units, accounting for the reduced screen size, etc. In fact, it often requires a careful analysis of existing learning materials or courses before converting them to a mobile format. It has been proposed that many designers and developers are creating new mobile content and converting existing courses by only resizing them to account for the smaller screen and user interface differences. Survey and interview respondents from ADL's mobile learning survey report (Berking et al. 2013) agreed that this is often the case and results in poor usability and learning outcomes.

An important consideration when addressing conversion to a mobile format is that the learning content should be reduced to much smaller discrete units than in a classroom or desktop eLearning course, with preferably 2–3 min for each unit or module. The attention span, readability (on a small screen), and previously mentioned mobile behaviors reinforce this advice. Where and how these design changes are to occur is also a primary concern in the analysis phase when following an instructional design model. Such questions as the following should be considered:

- Can the information be made more concise?
- Should information be sequenced in the same way?
- Should the students be assessed differently?
- Should objectives be reevaluated?
- Is the seat time too long for mobile instructional materials?

6 Future Directions

This chapter provides key considerations for the design of mLearning. It is difficult to design for all of the different characteristics of both smartphones and tablets. However, the scope was specifically limited to these devices as they offer the most potential for the rich, contextual, and contemporary mLearning design opportunities today. The contents of this chapter heavily relied on both the Learning Science and Human-Computer Interaction (HCI) domains in order to identify the unique considerations applicable to the instructional design of mLearning as well as describe potential gaps in general mobile design knowledge.

When possible, it can be a powerful mLearning design strategy to incorporate performance support materials in both education and training settings. However, the most effective mLearning solutions often take both practice to mastery and performance support into account while focusing on how mobile technology can add the most value to the learning context. Learner-centered design considerations should be at the top of the list of any mLearning strategy. These considerations are often deeply connected to deeper aspects of user experience design, mobile behaviors, and access to mobile device affordances.

The existence of learning theories and conceptual frameworks provides guidance and opportunities for leveraging mLearning epistemologies. Finally, most mLearning design decisions will eventually lead into production considerations of creating, converting, or leveraging existing materials. All of these aforementioned considerations are relevant to and will ultimately result in an informed set of design requirements for any mLearning strategy, whether it is for education, training, or human performance purposes.

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