A Reference Model for Designing Mobile Learning and Performance Support

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ABSTRACT

During recent years of increased smartphone and tablet adoption there has been a growing interest in how to improve training and performance opportunities with mobile learning and mobile performance support. Increasingly, instructional designers and developers of traditional eLearning are realizing that the design paradigms for mobile learning are significantly different. Results from a needs assessment conducted for the Advanced Distributed Learning (ADL)'s Mobile Training Implementation Framework (MoTIF) project in 2014 identified a strong demand for a mobile learning design model that can effectively inform, situate, and invite consideration of tactical learning approaches, mobile usage patterns, and mobile affordances.

This paper is based on nearly three years of research findings on mobile learning and performance support as part of the MoTIF project. The findings led to the development of a reference model that could improve the design of training and performance support solutions for mobile devices. The reference model components were substantiated by the quantitative and qualitative data collected during the needs assessment and will be iteratively refined and evaluated for improvements in the future. While the model will continue to capture new considerations as an innovative mobile learning design strategy, it can actually be leveraged and adopted by DoD education and training initiatives today as either a conceptual framework or decision support tool.

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INTRODUCTION

The increasingly widespread adoption of mobile technology is creating a paradigm shift in instructional design strategy, offering new opportunities for improving performance and augmenting skills. But how is the instructional design for these new opportunities any different than eLearning? Traditional eLearning course offerings replaced with or augmented by mobile technology may actually follow many of the same instructional design principles in alignment with the widely-accepted phases of ADDIE (Analysis, Design, Develop, Implement, and Evaluate). However, the true potential of mobile learning is best realized by considering a wider palette of learning and performance support opportunities (i.e., "task-based activities and contextual learning experiences," not "forced content"), adaptive and algorithmic approaches (e.g., spaced repetition), and application of appropriate knowledge and learning theories (e.g., Constructivism). When should these opportunities be considered? This overarching question serves as a prelude and will provide a metaphorical lens to magnify the purpose of the reference model presented and discussed in this paper.

An Operational Definition of Mobile Learning

Instructors, educators, and instructional designers alike are quickly adopting mobile technology in their various training and learning environments, but strategic mobile design considerations and proven pedagogical practices have not been systematically documented (ADL, 2013). This misfortune has been compounded by 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." Therefore, it is critical for the authors to first establish an operational definition of mobile learning and identify the types of mobile devices targeted in this paper.

Mobile learning (hereafter referred to as "mLearning") should not be simply perceived as learning content delivered or accessed on a mobile device. Unlike other learning strategies, mLearning is unique, as it can accommodate both formal and informal learning in collaborative or individual learning modes, and within almost any context. ADL (2014) describes mLearning as, "leveraging 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 operational definition of mLearning is used hereafter as it conveys wide coverage for not only education and training types of mLearning activities, but it also includes mobile performance support scenarios that can strengthen mLearning design.

Mobile Devices Targeted

Currently, there is no right or wrong answer for what types of devices are considered to be “mobile”, as both public perception and the technology will continue to evolve. For instance, military training programs have expressed differing 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 several manufacturers makes mobile devices even more difficult to classify. There are also an increasing number of larger screen size variations among smartphones (previously classified as a small tablet size) as the market continues to change.

According to ADL (2012) tablets were used most often for mLearning, reported at 61% compared to 29% for smartphones. Some mLearning studies have also reinforced tablets as being the most popular devices for academic or educational purposes (Chen and Denoyelles, 2013). However, tablets have recently started to decline in sales and adoption while smartphones continue to rise (Gartner, 2015). Recent data from Pew Research (2015) revealed 64% of American adults now own a smartphone of some kind, up from 35% in the spring of 2011. Smartphones are typically more portable and accessible than tablets and naturally offer more opportunities for learning and job performance outside of the classroom (ADL, 2013). Current practices of designing mLearning content for larger-sized tablets and hybrid tablets have much more in common with a laptop or desktop computer than they do with designing content for a smartphone. This commonality is mostly related to how people interact with tablets and their perceived usage patterns, which will be discussed in more detail later. However, the purpose and scope of the research presented in this paper will be generally focused on both smartphones and tablets as the targeted types of mobile devices for mLearning design since both have the potential to support more use cases involving mobile performance support than laptops.

METHODOLOGY

The authors explored multiple design and research methods and determined that a unique approach was required. The authors followed a Design-based Research (DBR) approach developed by Bannan-Ritland (2009) in order to embark on a systematic analysis of theories, requirements and best practices of mLearning. DBR is a modern approach suitable to address complex problems for which no clear guidelines or solutions are available such as in the case of mLearning design. DBR can produce both theories and practical design interventions. The interventions can include such things as strategies, materials, products, and systems (as solutions to the problems), but will also advance the researchers’ knowledge about the characteristics of these interventions and the processes involved in designing and developing them (Bannan-Ritland, 2009). Since DBR is intended to both solve real world problems and to generate design principles, it is well suited to help develop a reference model for mLearning design. Following a DBR approach helped the authors to realize the scope of the research effort, from initial conceptualization to future adoption. In addition, as a result of following this approach a needs assessment was conducted to justify the development of an mLearning reference model as a possible design intervention.

The authors employed a mixed method approach to include surveys, interviews, and a focus group to collect both quantitative and qualitative data. The target audience included education or training professionals with a potential interest in implementing mLearning. The target audience included educators, instructional designers, instructors/trainers, content developers, managers, researchers, and students. The authors administered the survey and conducted the focus group and interviews with the largest possible international audience in order to increase the likelihood of a rich and diverse data set. Based on the target audience and objectives of the needs assessment it was not feasible, practical or theoretically sensible to conduct random sampling. Therefore, ADL followed multiple non-probability sampling approaches to attract the most representative responses of the target audience. The authors received 831 responses to survey, interviewed 11 different experts and researchers of mLearning, and facilitated a focus group study consisting of 5 mLearning practitioners.

RESEARCH NEED

The needs assessment identified requirements that were prioritized based on the strength of the responses aligned to each research objective. The guiding research objectives were as follows:

1. Determine if there is a perceived need for an mLearning-optimized design model.
2. Determine if there is a perceived need to identify alternative learning approaches that are appropriate for the mobile platform.
3. Determine if there is a perceived need to identify and document the unique capabilities of the mobile platforms and their affordances for learning.

The results of the survey, interviews, and focus group revealed all of the aforementioned objectives could benefit from an intervention that would reference and incorporate a multitude of principles and practices for various types of mLearning. Figure 1 (below) shows the results of asking respondents if a modified process or model optimized for mLearning design would improve their ability to contribute to education and training projects. A majority of the survey respondents (69%) either strongly agreed or agreed that an mLearning-optimized design model would improve their ability. In comparison, the input received from the focus group and interviews also reinforced this need, but emphasized that there is a need for both theoretical models as well as process models. These findings and others from the needs assessment process ultimately influenced the requirement for the intervention.

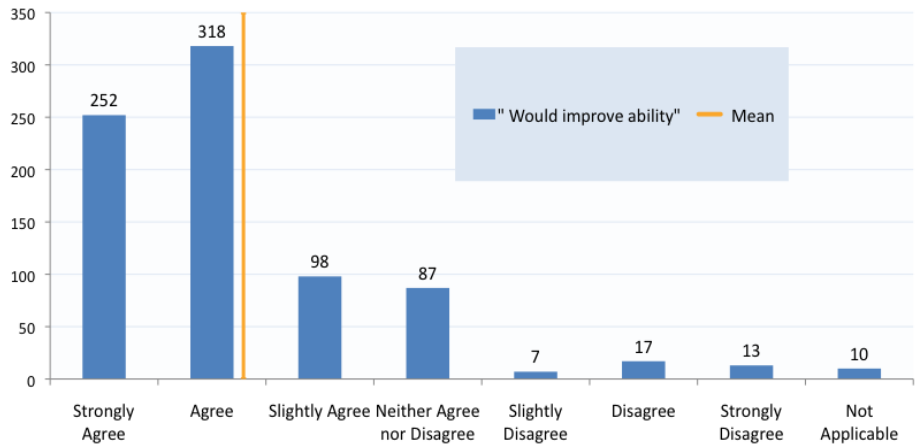

Figure 1. Survey question: "An mLearning-optimized design model would improve my ability to contribute to education and training projects."

Although eLearning paved the way for mLearning, evolution from one paradigm to the next does not imply that instructional designers should simply transfer those same design principles and practices. Designers should not convert existing eLearning materials and courses to fit on a smaller screen without first considering alternative options for addressing learning and performance objectives based on the mobility of the learner. At the highest level, designers need guidance to determine whether mLearning is even appropriate for a given solution. The results of the needs assessment research ultimately helped the authors to identify new design options and best practices for mLearning design. These options are highlighted in the form of a reference model intervention that can optionally serve as a decision support tool for designing future mLearning solutions.

Intervention Design

Following the needs assessment, the authors formed a community of 533 members, and an active working group of 15 people focused on incorporating several considerations impacting the mLearning design process. The needs assessment findings and working group feedback revealed the following high-level requirements for the design of the intervention:

- There is a need for integrating theoretical, conceptual, and process models with the collective intelligence of the mLearning community. The elements of learning theory and learning technology are often not completely separate, and are often co-constructing each other.
- mLearning solutions should drive consideration of performance support solutions instead of or in combination with training.
- Mobile design should always consider:

  - Human-computer Interaction (HCI) and mobile usage patterns
  - The opportunity to add context to the experience
- There is a need to integrate existing mLearning theory and best practices in one place that is usable both conceptually to spur thought, and a practical tool to aid practitioners in the process of design.
- A mobile-optimized model should identify the unique capabilities and affordances of the mobile platform that can be used for mLearning.

These intervention design requirements and other related themes were incorporated into a baseline version of the Reference Model. Similar to the Sharable Content Object Reference Model (SCORM), the mLearning Design Reference Model is a "reference model" rather than a native model because it is mostly an integration of existing models and best practices. In comparison, a native model is one that is created anew from the very beginning. The ADL Mobile Learning Research Team determined there were already enough quality materials published on mLearning theories and best practices such that it was not necessary to completely reinvent the wheel to try to publish a new model from scratch. A working group was convened in the Fall of 2014 to validate these design assumptions and refine the Reference Model product, using the collective wisdom of members of the learning, education, and training community who have a stake in designing mLearning.

The foundation of the Reference Model is the Dick, Carey, and Carey (2014) instructional design model. This model was chosen as the primary organizing principle and starting point for the Reference Model, since it is a well-established model used as a standard in instructional design degree programs and by practitioners. Some portions of the Reference Model are reproduced as they appear in the author's published work (as flowcharts). Most portions, however, do not appear as flowcharts in the Dick, Carey, and Carey (2014) textbook; instead, they are abstracted from text-based publications and converted into flowchart form. This is particularly evident for performance support elements derived from Gottfredson and Mosher (2011) and Rossett and Schafer (2007). The ADL Mobile Learning Research Team connected these concepts and augmented them in logical order. A decision-tree flowchart was determined to be the initial format for representing the Reference Model, both conceptually and in draft form as a design tool. Mobile performance support is treated as a separate approach that branches off from the instructional design model early on in the analysis phase, once it is determined that the solution (or at least part of the solution) will be provided as performance support.

The authors further refined the Reference Model by integrating the research findings and feedback from the MoTIF project (Berking et al, 2014) with existing practices and models from the global mLearning community. The first round of working group meetings was completed January 12, 2015, producing the beta version. Since then, the Reference Model has been iteratively improved by the working group over several months. In mid April, 2015, version 1.0 of the Reference Model was published.

COMPONENTS OF THE MODEL

The Reference Model is both an academic research exercise that integrates many different theoretical concepts, and a decision support tool that makes the designer aware of critical factors to be considered in the design process and provides an array of relevant theoretical and practical alternatives.

It is currently rendered as a set of interlinked flowcharts in Microsoft PowerPoint ® presentation software, but with many text explanations, resources, and checklists providing further detail about steps and decisions represented by flowchart icons. It is essentially a guide to the order and nature of steps to follow in the design process, with supporting details available for the user to drill down into where needed.

Perhaps the most unique attribute of the Reference Model is the fact that, true to its name, it is a comprehensive attempt to integrate a curated collection of existing models and practices. Several mLearning industry experts, practitioners, and researchers heavily influence the collective knowledge represented in the Reference Model. The key contributions from these people (listed by last name) are associated with each category in Figure 2 (below). This diagram represents the high-level component theories, models, and disciplines included in the Reference Model, with each component sized in proportion to its relative contributions to the whole. The Instructional Design Process Model is shown in the middle because each of the outer components appear within a specific part of this overall model framework.

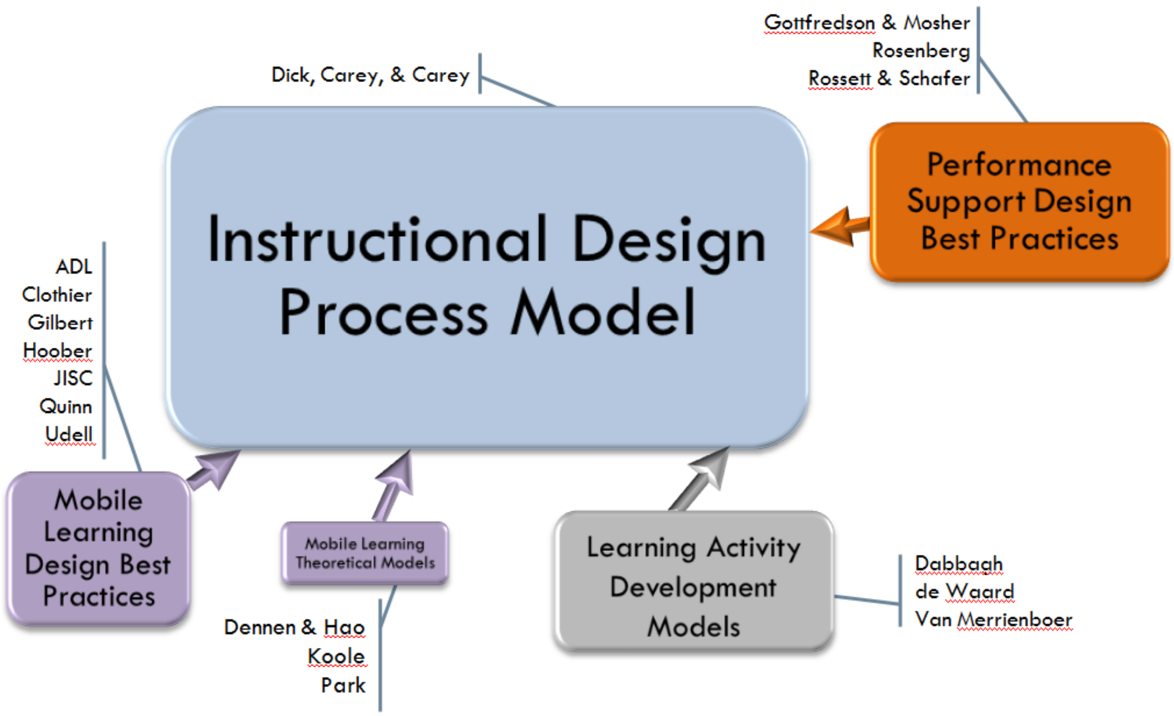

Figure 2: Components of the Reference Model

As a tool for designers, the Reference Model is highly heuristic in nature. It is designed to invite consideration of many different questions and decisions that may impact mLearning design. See Figure 3 (below) for an example of a flowchart from the Reference Model that is part of the "Mobile Learning Designer Best Practices" component.

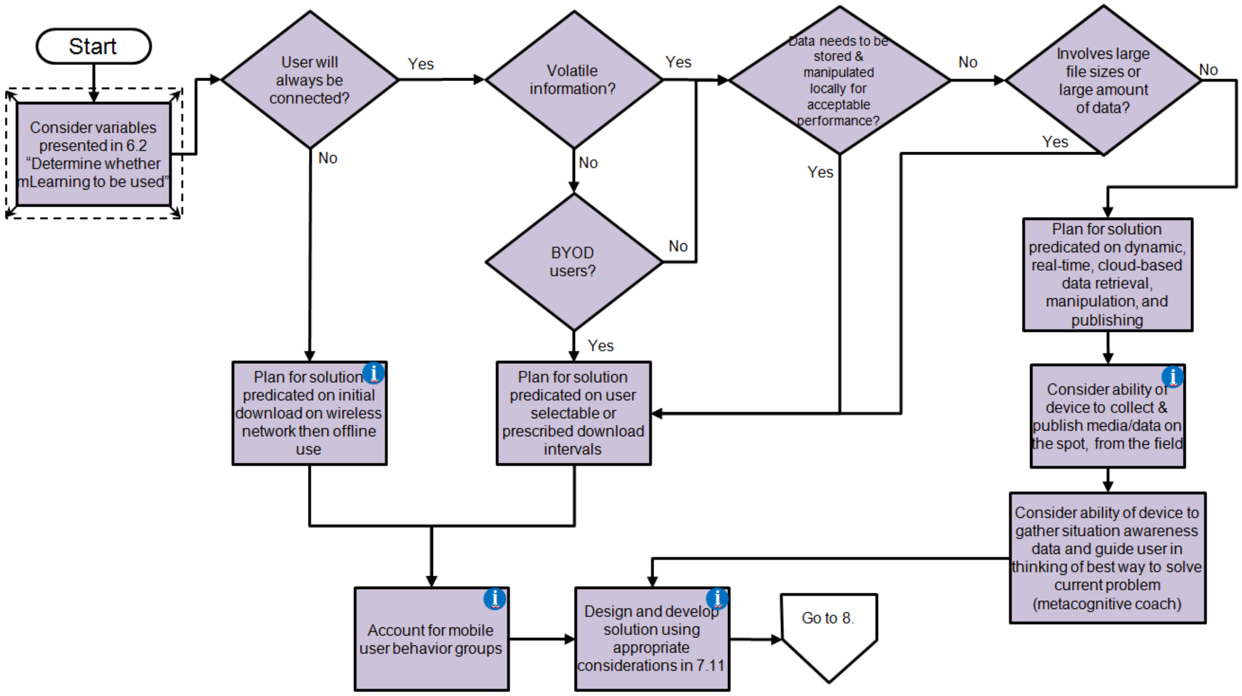

Figure 3: Example of flowchart from Reference Model

Above all, it is not intended to be followed in a linear, lock-step manner, with prescriptive steps followed in a standard way to ensure a quality result every time. That is simply not the nature of the process of design, especially in regard to an evolving discipline like mLearning where creativity and agility are often required, in ways that resemble art more than science. The high-level components of the Reference Model are further described in the following subsections: Alternative Learning Approaches and Tactics, Performance Support and Design Strategy, Mobile Usage Patterns & HCI, and Mobile Affordances.

Alternative Learning Approaches and Tactics

The second research objective, as stated earlier, is "Determine if there is a perceived need to identify alternative learning approaches that are appropriate for the mobile platform." Constructivism is a relatively unexplored (at least on a mass scale) learning approach that is well supported by research (Newmann, Bryk, and Nagaoka, 2001 in Brookhart, 2010). Constructivism implies construction of knowledge using disciplined inquiry to produce discourse, products, or performances that have value beyond the immediate learning need. Most alternative learning approaches for mLearning fall under the broad umbrella of constructivist learning theory, which is often served well by mobile technology.

Constructivist approaches often translate into learning activities that involve:

- Problem solving, reasoning, active & reflective use of knowledge, and critical thinking
- Complex, realistic, and relevant environments
- Social negotiation as an integral part of learning
- Multiple perspectives and the use of multiple modes of representation
- Ownership in learning (student-centered, relevant)

The mobile platform supports these well because of its contextual nature, and because of the many affordances that support collaboration and communication. The Reference Model has been designed to explicitly invite consideration of constructivist learning approaches by including it in the first top level "Identify Instructional Goals" flowchart and including a list of specific tactics associated with it later on. The two other main learning theories, Behaviorism and Cognitivism, have been the foundation of training and education for many years, and tactics associated with these are also categorized in the lists of tactics in the Reference Model.

An important learning tactic that can be layered onto any one of the three learning theories mentioned above is spaced learning. The mobile platform is ideal for providing enhanced retention by leveraging spaced learning (aka spaced repetition). Spaced learning involves designing increasing intervals of time between subsequent reviews of previously learned material, or presenting new material in increments at specific intervals. Spacing can involve either a few spaced intervals or many intervals. According to Thalheimer (2006), "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." The notifications feature on mobile devices can be used to remind users of content to be consumed at the appropriate time, and deliver the content on the spot, in keeping with the precise, prescribed interval. The Reference Model incorporates considerations for when and how to use this tactic as well.

Performance Support and Design Strategy

What is performance support? There are several working definitions based on the initial movement started by Gloria Gery in 1991. However, according to Rosenberg (2013) common to all performance support definitions is the focus on tools and resources, the emphasis on application, and the timing "at the moment of need." The purpose of performance support is to deliver the right information, to the right people; at precisely the right time they need it. Learners are no longer constantly tethered to their desktop or portable laptop computer to access learning materials, but are more frequently turning to leveraging mobile devices for performance 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 type of 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. Prior research by ADL (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%]).

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 mobile performance support; one is designed to offer support for workplace tasks at the point of need (defined by time, place, and context). One is designed to support the learning process itself, usually in an academic setting (e.g., electronic study aids for a class).

Learner-centered strategies 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 education settings, this might take the form of a scenario where performance support complements the classroom experience or, in some cases, guides self-directed learning. For classrooms augmented by mobile technology, the design of the performance support solution must integrate closely with the core texts, curriculum guide, class objectives, and other materials related to the class. Similarly, job performance support materials should align with existing training or workplace tasks. Ideally, a learner-centered design strategy for mLearning must give the users a compelling reason to access the support materials.

What other factors could influence design strategy? To answer this question, instructional designers should 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 discussed next as critical components of the Reference Model.

Mobile Usage Patterns and HCI

According to the 2013 survey on mLearning from ADL (Berking et al., 2013), touchscreen interaction was selected as the top area of mLearning design that educators and training professionals were most interested in better understanding. 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.

Research on mobile usage patterns often focus on smartphones while educators and instructional designers have directed much of their focus to delivering mLearning on tablets without a deep understanding of the ergonomics and behaviors of use. A survey report published by Hoober & Shank (2014) titled, "Making mLearning Usable: How We Use Mobile Devices," revealed when people use mobile devices and how they hold them. The survey revealed that the way people use smartphones and large tablets are substantially different. People use smartphones in several possible hand combinations (see Figure 4 below), and largely on the move while standing or walking. In comparison, people use tablets at a further eye distance and much more often while sitting and with the device in a stand, attached to a keyboard, or set on a table (see Figure 4 below). Users also often change the way they hold their smartphone or tablet, switching from one to two hands and changing the orientation differently for typing vs. reading.

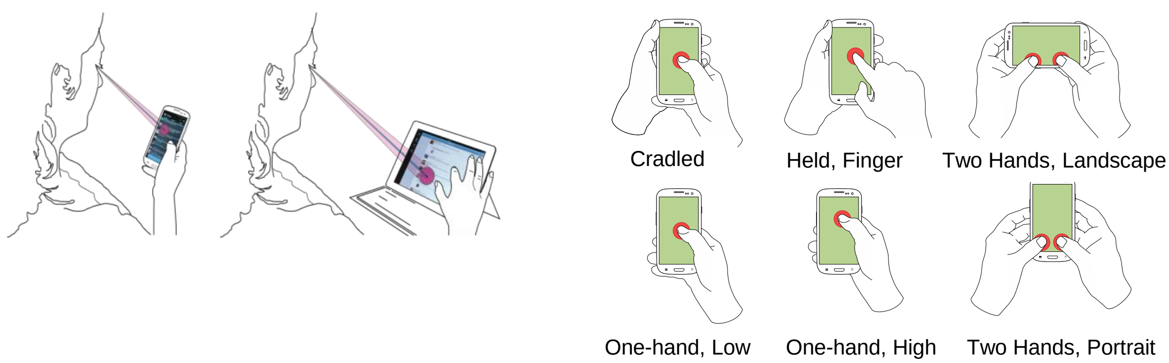

Figure 4. Mobile usage patterns. Artwork by Stephen Hoober (2014)

These findings have important implications for readability and mLearning design. These findings also point to the fact that the larger tablets with 9-11 inch 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 both HCI and learner-centered design considerations in an mLearning design strategy.

It may not be possible to address all of the attributes of both tablets and smartphones without encountering a substantial number 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 designers wisely decide on which devices should be part of their mobile strategy, and this decision should be informed by their learners' behaviors, and by their context and expectations of mobile technology. A list of guiding design principles based on mobile usage patterns is included as a vital component in the Reference Model.

Mobile 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 start in an arbitrary way, selecting a popular technology that seems to be a fit for their need and find a way to make it work for them (e.g., augmented reality). A more logical approach is to define the learning, training, or performance problem to be solved, and then examine mobile technologies systematically, aligning them with 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.

Research objective 3 from the needs assessment stated, "Determine if there is a perceived need to identify and document the unique capabilities of the mobile platform and their affordances for learning." This drove the authors to ask a number of questions in the survey and interviews pertaining to mobile capabilities and affordances and the need for interventions to educate learning professionals about them. Very few respondents (2.6%) reported that they had not seen any of the capabilities used for learning. However, 37% indicated that they had not designed or implemented any of the capabilities mentioned. Most respondents selected multiple items when asked which device capabilities they would like to have a better understanding of in regard to their applicability for mLearning. The Reference Model was further enhanced to incorporate the systematic examination of mobile capabilities for learning, based on 13 identified affordances published by the ADL Research Team (Haag, 2014).

An affordance in general terms is a quality of an object or an environment, which allows an individual to perform a specific action or ability. According to Gibson (1977), affordances are "objectively measurable and independent of the individual's ability to recognize them, but always in relation to agents and therefore dependent on their capabilities." The term "affordance" was further evolved by Norman (1988) for use in the context of HCI to indicate the easy discoverability of perceived action possibilities.

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 then such affordances as capturing video and images, Augmented Reality, Quick Response (QR) code reading, or content image analysis are made possible.

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 restrictions. Equal access to specific device capabilities is a critical factor and consideration influencing the flexibility and richness of mLearning design options. Using the Reference Model, these types of considerations could be identified during the analysis phase of an mLearning project so that they might be appropriately addressed during the design phase.

CONCLUSION AND FUTURE DIRECTION

The Reference Model presented in this paper is available now at http://www.adlnet.gov/downloads/mlearning.pptx, and will continue to be iteratively refined through participant and stakeholder feedback during 2015 field testing phases of the intervention. Field testing opportunities are currently being solicited throughout the DoD Services and ADL partner organizations. The field testing may be conducted by applying the Reference Model to existing training projects as well as new mLearning projects. Since the current format is a Microsoft PowerPoint ® file, the Reference Model can be easily modified so new additions and refinements can be incorporated iteratively during the feedback and evaluation process. Once a milestone is reached in terms of significant changes to the Reference Model, the working group will convene to review and discuss the changed version. Once consensus is reached, these changes will be finalized as a new baseline product.

Assuming there is a clear value proposition for incorporating mobile technology, instructional designers ultimately need to determine if the activity is truly dependent upon the user being mobile. If it is not, and the activity is only minimally enhanced by mobile technology, then it may be feasible to tie it more closely to the learning objectives rather than a performance support strategy. Performance support alone, or a blended version of it, has the potential to significantly improve mLearning design. What were once sequences of course modules can now be catalogs of performance support materials, and what were once sequences of classroom activities can now be self-directed learning activities guided by on-demand information.

As with many past technological innovations, instructional designers and educators have rapidly adopted mobile technology before realizing its pedagogical merits and limitations. Ideally, the learning or performance outcome should be the primary driver for making mobile design decisions. The true potential of mLearning is best realized by considering a wider palette of learning and performance support opportunities. But when should be these opportunities be considered and what are the gaps in mLearning design knowledge? The answer to these important questions is now provided as a reference model for mLearning design and performance support. It heavily relies on both the Learning Sciences and HCI domains in order to identify the unique considerations applicable to the instructional design of mLearning. It also can help to identify potential gaps in general mobile design knowledge. The mLearning Reference Model highlights considerations from these domains with the goal of helping designers establish an informed strategy for mLearning, rather than relying solely on prior instructional design experience.

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