AN EVALUATION FRAMEWORK FOR M-LEARNING

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Abstract: We have developed an evaluative framework that can be used to place m-learning projects and technologies within a context that associates a project with a broad learning objective. We do this through the identification of dimensions within the aspects of FRAME, a framework developed by Koole (2009) that looks at three different aspects: device, learning, and social. We have modified this framework to form what we call *Augmented* FRAME. Augmented FRAME refines each of the aspects of FRAME into finer-grained elements in order to gain a better understanding about the degree to which different approaches meet m-learning goals. To illustrate this evaluation framework, we have surveyed a small but representative set of m-learning approaches and discuss initial trends observed from using the framework.

1 INTRODUCTION

In order to help educators address issues related to adopting and using m-learning approaches, we have developed an evaluative framework that can be used to place m-learning projects and technologies within a context that associates a project with a broad learning objective. We do this through the identification of dimensions within the aspects of the Framework for the Rational Analysis of Mobile Education (FRAME), a framework developed by Koole (2009) that looks at three different aspects: *device*, *learning*, and *social*. We have modified this framework to form what we call *Augmented* FRAME, which refines each of the aspects into finer-grained elements in order to gain a better understanding about the degree to which different approaches meet m-learning goals. For instance, we have unpacked the social aspect to account for critical learning activities most often associated with communication, such as reading, writing, speaking, and teaming. To illustrate this evaluation framework we have surveyed a representative set of m-learning approaches and discuss initial trends observed from using the framework.

The remainder of this paper is organized as follows: Section 2 describes background material, including FRAME (Koole, 2009) to provide context for the discussion contained later in the paper. Section 2 also discusses our evaluative framework while Section 3 surveys a number of existing approaches from literature and provides some evaluation of the context of these techniques by placing them into the framework. Finally, Section 4 draws conclusions and suggests future investigations.

2 APPROACH

m-learning brings a promise of extending the learning experience beyond the classroom. Traxler identified three properties that characterize effective m-learning. Specifically, that m-learning has the potential to provide an experience that is personalized, authentic and situated (Traxler, 2007).

As the smart phone becomes the device of choice, more K-12 institutions have begun to explore how the device impacts learning while lowering costs. While the benefits of m-learning are intriguing, the challenges that accompany m-learning pose barriers for adoption (Corbell and Valdes-Corbell, 2007).

2.1 FRAME

FRAME (Koole, 2009) serves as the basis for the work described in this paper. FRAME is a model that describes how social interactions (social aspect), mobile technologies (device aspect), and human learning capacities (learning aspect) all work

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together in forming an ideal m-learning environment.

The device aspect focuses on the physical, technical, and functional characteristics of a mobile device. The learner aspect describes how learners use their knowledge and how they encode, store, and transfer information. Finally, the social aspect of FRAME takes into account the processes of social interaction and cooperation. (Koole, 2009)

In addition to the three aspects above, the FRAME model discusses intersections. The Device Usability (*Device + Learner or DL*) intersection ties characteristics of mobile devices to cognitive tasks related to manipulation and storage of information. The Social Technology (*Device + Social or DS*) aspect describes how mobile devices enable communication and collaboration amongst multiple individuals and systems. The Interaction Learning (*Learning + Social or LS*) intersection focuses on how learning is collaborative with meaning negotiated from multiple aspects. Finally, the Mobile Learning intersection (*Device + Learner + Social or DLS*) refers to the "sweet spot" in the FRAME model where all of the different aspects come together to form a confluence of all of the benefits of each concern (Koole, 2009).

2.2 Augmented FRAME

We found FRAME to be one of the few models that attempts to catalogue different m-learning techniques, but as is proves difficult for analyzing current m-learning trends due to the broadness of the categories. We have augmented FRAME in order to facilitate a more fine-grained analysis of approaches so that identifying where they fall in the framework is more systematic. In particular, we have taken the *device*, *learner*, and *social* aspects of FRAME and identified different dimensions within each as a means for differentiating between different m-learning approaches. In this section, we discuss each of the aspects in detail by introducing the additional properties that we have identified.

Device. In studying different approaches, we identified three additional characteristics that fall under the FRAME category of device; namely *type*, *infrastructure support*, and *mobility*. *Type* refers to the kind of device being used in a particular approach (e.g. netbook, cell phone, etc.). *Infrastructure Support* refers to the kind of network support required to facilitate the devices. *Mobility* refers to the degree to which an approach supports an un-tethered experience.

Learner. For this aspect we identified six different learner-oriented characteristics that differentiate m-learning approaches. In particular, we were interested in whether the given approaches facilitated certain kinds of learning as identified by Traxler (2009) (e.g., personal, authentic, and situated experiences as a form of information transfer). In addition, we identified whether the approaches were meant to facilitate authoring, content delivery (content-oriented), or distance learning.

Social. We identified four characteristics that are commonly associated with communication: reading, writing, speaking/listening, and teaming (or collaboration). In particular, the purpose of these dimensions is to determine whether one form of communication is being used more than others. Since the use of mobile devices is in many ways a visual activity, the use of the devices in the m-learning approaches most often will involve reading, but the more interactive activities of speaking/listening and teaming appear to be more interesting as they provide an ability to connect learners that are not necessarily situated in the same location. In regards to speaking/listening, we have combined these skills into one area to cover forms of one-way verbal or aural communication.

In order to organize and adequately compare different approaches, we use a table to represent all of the different properties described above. Section 3 contains an evaluation of twelve different approaches that we have catalogued, with the purpose being to support not just analysis of these particular approaches, but to provide exemplars of how to use the evaluation framework. In this sense, we believe that our approach has some benefit in that it facilitates:

- Characterization – the evaluation framework provides a high-level view with respect to basic FRAME while also facilitating a deeper look into more specific characteristics that are related to each of the FRAME aspects.
- Adoption – the evaluation framework facilitates a broad understanding of different dimensions that may encourage adoption.
- Comparative – the evaluation framework shows that not all approaches meet different m-learning goals and thus places each approach into discernable contexts.

One of the primary tasks when using our evaluation technique is the identification of where a given approach falls within FRAME. Specifically, we are interested in identifying which of the aforementioned intersections an approach falls (e.g., DS, DL, LS, or DLS).

Our taxonomy is meant to assist in providing criterion for identifying how a particular m-learning approach addresses the different FRAME aspects. To do so, we arrange different approaches in a table, with the different aspects (and their respective fine-grained dimensions) in the columns. As an approach is examined, the table is marked with properties that characterize that approach (e.g., serves the *characterization* role).

The information that is used to characterize approaches provides a potential adopter with data about the context of the approach within FRAME and can then facilitate matching the approach with learning goals. For instance, an adopter may be interested in finding an approach that is heavy on the social side (e.g., falls in the DS intersection). By examining a table similar to the one shown in Table 1, an adopter can then view how the approach addresses a particular aspect.

Another potential use of the Augmented FRAME approach is as a *comparative* tool. The obvious comparisons are between different approaches based on the characterizations within the FRAME intersections. However, another comparative use of the framework is in the analysis of which approaches meet certain dimensions within the aspects. That is, as more approaches are catalogued with our technique, identification of interesting areas of investigation can be facilitated. For instance, if we find that a particular dimension within an aspect is not being adequately covered by existing approaches, we can analyze whether that dimension is indeed of interest for m-learning, and if it is, focus attention on developing new methodologies that address that particular area.

3 ANALYSIS

In order to evaluate the effectiveness of the Augmented FRAME evaluation framework, we analyzed a set of twelve approaches that target audiences from K-12 to higher education.

Table 1 contains characterizations based on the dimensions of Augmented FRAME. The *Mobility* column refers to a 5-point scale, where 5 is the most mobile and 1 is the least. In general, mobile applications are typically in the 3-5 range, with kiosks at a 2, and desktop or other fixed devices at a 1. An "X" in the *Learner* and *Social* columns indicate that a particular approach addresses that dimension. The *Frame Intersection* column uses the acronyms of DS, DL, and DLS referred to earlier.

In constructing our table, we have observed some interesting trends. While our analysis is far from being comprehensive, we believe that these trends are interesting enough to determine whether they lead to new research or perhaps the modification of our evaluation framework. One such trend that we have observed is that most of the approaches we have looked at involve *reading* as a

Table 1: Properties of M-Learning Approaches.

		Device			Learner						Social				
Reference	Targeted Age (s=secondary, h=higher-ed)	Type	Infrastructure Support (c = cellular, w = wireless, I = infrared, n = none)	Mobility	Distance Learning	Content-oriented	Authoring	Personal	Authentic	Situated	Teaming & Collaboration	Reading	Writing	Speaking & Listening	Frame Intersection
Cabrera et al., 2005	s	handheld	n	5					X	X		X			DL
Hagen et al., 2005	h	handheld	w	5	X						X	X			DS
Huizenga et al., 2009	s	phones	c	5					X	X	X	X			DLS
Norris & Soloway, 2004	k12	handheld	w, c	5							X	X			DS
Reckles, 2007	k12	tablet	w	5	X				X						DL
Schwabe & Goth, 2005	h	handheld	w	5						X	X	X			DS
Sharples et al., 2002	k5	tablet	w	4		X	X					X	X		DL
Shen et al., 2008	h	phones	c	5	X						X	X			DS
Sung et al., 2008	h	tablet++	n	3					X	X		X			DL
Tatar et al., 2003	k12	PDA	i	5		X				X	X	X			DS
van t' Hooft & McNeal, 2010	k20	phones	c	5					X	X		X			DL
Zurita & Nussbaum, 2004	k5	handheld	w	5		X					X	X		X	DS

primary communication (Social) aspect. On the surface, this would lead us to say that inherently, mobile devices are visual instruments. However, this perhaps leads to wondering about whether other learning modes can be facilitated. For instance, aural learners might be more responsive to audio.

Another trend we observed was that the *personal* dimension within the Learner aspect was not addressed. The fact that mobile devices are considered personal devices means that we have the opportunity to provide experiences that are highly configured to meet the needs of the individual. In addition, writing and speaking/listening found limited support. Considering that these dimensions are related to interactive communication skills, this perhaps means that m-learning approaches are ripe for addressing these skills.

Our primary goal in developing the Augmented FRAME evaluation approach was to assist in understanding the current state of m-learning. We have found other evaluation frameworks to be difficult to use for quickly sizing up approaches as well as for looking at a big picture view of the field. In order to further validate our approach, we intend to expand the number of approaches that we catalogue. In doing so, we hope to identify whether some of the initial trends we have observed are true of the field.

4 CONCLUSIONS

Mobile learning has received an influx of energy with the release of mobile technology that has offered a significant bump in utility. Features such as GPS, cameras, accelerometers, magnetometers, and other capabilities believed to be only wishful thinking during the first generation of PDA in the early 2000's are now commonplace. As more educational institutions move towards using m-learning, effective tools that assist educators in evaluating and selecting appropriate m-learning strategies are needed. In this paper, we described the Augmented FRAME evaluation framework based on the FRAME evaluation model by Koole (2009).

In order to further validate our approach, we will be focusing on building a larger catalogue of m-learning techniques, with the intention of studying trends as well as determining whether the dimensions we have identified are sufficient. Ultimately, our work is focused on using the framework to inform policy makers about methods to use by providing information about potential learning outcomes that are relevant for m-learning.

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