Framework for the Rational Analysis of Mobile Education (FRAME) Model: Revising the ABCs of Educational Practices

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Abstract

The Framework for the Rational Analysis of Mobile Education (FRAME) model was originally developed as a basis for assessing the effectiveness of mobile devices for distance learning [1]. The FRAME model is the first comprehensive theoretical model to describe mobile learning 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 collaborative learning. It is hoped that this model will help to guide the development of future mobile devices, the development of learning materials destined for mobile learning, and the specification of teaching and learning strategies for mobile education.

1. Introduction

"Information library researchers say that by the year 2010, the world's codified knowledge will double every 11 hours" [2]. Educators need to prepare learners to navigate within an information rich world with unknown limits and endless potential. Mobile learning may offer advantages such as access to information when and where it is needed. As well, through the use of networked mobile devices, learners may be able to contact experts and peers who can help them assess the importance, relevance, and trustworthiness of information. The Framework for the Rational Analysis of Mobile Education (FRAME) model not only outlines the relationship between mobile learning, human learning capacities, and social interaction, but it also addresses contemporary pedagogical issues of information overload, knowledge navigation, and collaborative learning. The FRAME model also has practical implications. An in-depth understanding of the process of mobile learning permits researchers and practitioners to develop more efficient and practical mobile devices, design appropriate learning materials, and select effective teaching and learning strategies for mobile learning.

The FRAME model was originally developed in order to understand the process of mobile learning. In particular, it was developed to facilitate the understanding of various mobile devices as distance learning tools [1]. While it would be possible to evaluate mobile devices, themselves, strictly on the basis of their hardware and software characteristics, such an evaluation would not effectively address the relationship between technology and the phenomena of learning and interaction. Human learning is inherently related to cognition and social interaction. This standpoint is mirrored in the name for the FRAME model. In particular, the word *rational* refers to the "belief that reason is the primary source of knowledge and that reality is constructed rather than discovered" [3]. Further, the FRAME model describes a mode of learning in which learners may participate and interact with each other although physically and temporally separated. As Tella [4] notes, the *m* in *mLearning* may refer to both *mobile* and *mediated*. It is a form of learning that allows learners to move to different physical or virtual locations using networked, mobile devices.

The context for the FRAME model is *information*. Information may be internal or external to the learner; that is, it can be derived from personal, social, technological, or environmental stimuli. All such stimuli constitute the learning environment. Within this context, the FRAME model is represented by a Venn diagram (Figure 1).

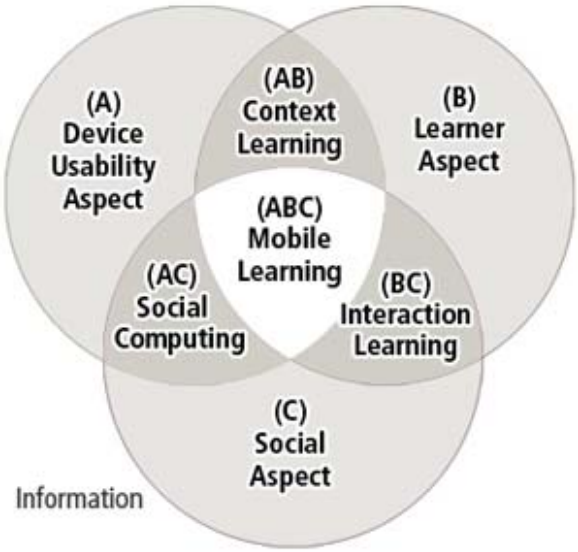

Figure 1. The FRAME Model

The three circles represent the device usability (A), learner (B), and social (C) aspects. The regions where two circles overlap, the secondary intersections, contain attributes that belong to both aspects. The attributes located inside the secondary intersections of context learning (AB) and social computing (AC) describe the capabilities of true mobile devices. The secondary intersection labeled interaction learning (BC) contains instructional and learning theories. Hypothetically, the primary intersection (ABC), a convergence of all three aspects, represents and defines the mobile learning process.

2. Aspects

The three key ingredients of the FRAME model are the device usability (A), learner (B), and social (C) aspects. The device usability aspect describes characteristics unique to electronic, networked mobile technologies; the learner aspect describes characteristics of individual learners; and the social aspect describes the mechanisms of interaction among individuals.

2.1. Device Usability Aspect (A)

The device usability aspect refers to the physical, technical, and functional description of mobile devices. It describes the medium through which mobile learners and mobile community members interact. Kommers suggests that the user interface bridges "the gap between user interest and the target task" [5]. The physical characteristics as well as input and output capabilities of the interface are affected by other processes internal to the machine such as storage capabilities, power, processor speed, compatibility, and expandability. These characteristics result from the hardware and software design of the devices and have a significant impact on the physical and psychological comfort levels of the users. Learners equipped with well-designed mobile devices should be able to focus more effectively on cognitive tasks such as those described in the learner aspect (B).

2.2. Learner Aspect (B)

The learner aspect refers to the situations and tasks in which the learner wishes or needs to succeed. It takes into account an individual's cognitive abilities, memory, and prior knowledge. Prior knowledge refers to how learners use what they already know. Memory is dependent on how human learners encode, store, and transfer information. Learning may also be affected by environmental characteristics which, in turn, affect advanced cognitive processes related to situated cognition (learning in situ), knowledge transfer, and learning by discovery. Actively selecting or designing learning activities rooted in authentic situations and encouraging learners to discover laws within physical and cultural environments are powerful pedagogical techniques. Clearly, human interaction among individual learners is an important part of human learning. Therefore, a discussion of human learning would be incomplete without a discussion of social and cultural factors. To facilitate this discussion, the social aspect (C) describes communication and social interaction processes.

2.3. Social Aspect (C)

The social aspect takes into account the processes of interaction and cooperation. In order to understand social interaction in learning, it is necessary to understand how people communicate. The way individuals exchange information through discrete combinations of speech acts affects the way groups of people develop knowledge and sustain cultural practices. Mobile learning practitioners must consider how to develop "media spaces" or computer-mediated communications environments that will assist learners to communicate even though they are physically and temporally separated [6]. The acquisition of culturally meaningful signs, symbols, customs, behaviours, and information moves the learner into the interaction learning intersection (BC). Hence the social aspect has an important role in both the interaction learning (BC) intersection and the mobile-learning process (ABC) itself.

3. Intersections

Moving inward from the outer circles of the Venn diagram, it becomes apparent how the aspects converge to produce interesting synergies. The device usability aspect (A) combines with the learner aspect (B) to produce a flexible learning environment described in the context learning intersection (AB). The device usability aspect (A) also combines with the social aspect (C) to provide new virtual communications opportunities as described in the social computing intersection (AC). And, the learner aspect (B) combines with the social aspect (C) to create the interaction learning intersection (BC) in which learners can experience enhanced interactive learning situations with more opportunities for negotiation of meaning.

3.1. Context Learning (AB)

The context learning intersection contains elements that belong to both the device usability and learner aspects. The context learning intersection connects the needs and activities of learners to the hardware and software characteristics of their mobile devices. The ease of use, portability, and ability to provide anywhere, anytime access to information help to characterize *mobile* learning devices. Highly portable devices permit learners to move with their mobile tools to more relevant or more comfortable locations. The context learning intersection relates characteristics of mobile devices to cognitive tasks such as the acquisition of information as well as effective manipulation and storage of information.

A well-designed mobile device will reduce cognitive load by performing mundane and repetitive tasks thereby permitting the learner to concentrate on higher-level learning tasks [7]. In addition to accessing information when and where it is needed, a well-designed device should also permit the learner to move physically to different locations. These processes can affect the user's sense of psychological comfort and satisfaction by reducing cognitive load and increasing access to information. The context learning intersection (AB) describes the relationship between one learner and a device. The social computing intersection (AC), on the other hand, moves beyond individuals and describes how mobile devices enable communication and collaboration among multiple individuals.

3.2. Social Computing (AC)

The device usability (A) and social (C) aspects form the basis of the social computing intersection. This intersection refers to the ability of users to communicate with each other and to gain access to other networked systems and information. Device hardware and software can provide connectivity through telephone lines, Ethernet systems, Wireless Fidelity, CDMA, GPRS, Bluetooth, and other technologies. What is of practical importance to learners, however, is the means of information exchange and collaboration between people with varying goals and purposes. When people are able to exchange relevant information at appropriate times, they can participate in a variety of community and collaborative situations that normally would be difficult at a distance. This intersection contributes to the FRAME model by providing the foundational description of electronic social collaboration for mobile activity. As will be seen in the discussion of the interaction learning intersection (BC), the ability to interact is a significant characteristic of learning according to social constructivist philosophy.

3.3. Interaction Learning (BC)

The interaction learning intersection (BC) represents a synthesis of learning and instructional theories, but relies heavily on the philosophy of social constructivism. In this view, "[learning] is collaborative with meaning negotiated from multiple aspects" [3]. Adherents of social constructivist philosophy vary in the degree to which they place emphasis on social interaction. Some support the idea that learners indirectly negotiate the meaning of materials by comparing their interpretation with that of the author. Others contend that learners interact and *negotiate* meaning with other individuals directly [3]. It seems clear that individuals do both, depending on circumstances, and the interaction learning intersection presented here is balanced between these viewpoints. In this context, it is important to note that not all interaction takes place between people. Distance education began primarily as correspondence education in which the students interacted with written course materials. As the nature of technology changed, students could also interact with audio tapes, video tapes, television, video disc, or other media. Sharples argues that "the minimum requirement for any person, or any system, to learn [is the ability] to converse with itself about what it knows" [8]. Computer based learning, however, lacks the depth of information to provide sufficiently flexible and appropriate interaction nor does it adequately stimulate metacognitive skills necessary for decision making, information selection, and self-regulation [5].

This intersection takes into account the needs of distance learners as individuals who are situated within unique cultures and environments. Cultural settings affect a learner's ability to understand, integrate, interpret, and use new ideas as needed in both formal and informal instruction. Participation in learning communities and cognitive apprenticeships can provide socially based learning environments in which learners can acquire information and negotiate the meaning of such information. Combining these socially grounded learning practices with the affordances of networked mobile devices completes the FRAME model. The definition of the mobile learning process (ABC) emerges through the combination of all three aspects and of the characteristics defined by their intersections.

4. Centre: The Mobile Learning Process (ABC)

Effective mobile learning is defined by the integration of the device usability, learner, and social aspects. In addition, the learner context, social computing, and learner interaction intersections each describe additional qualities of the mobile learning process. This convergence enables the three individual aspects to extend their impact beyond their natural boundaries. Mobile learning provides enhanced collaboration among learners, access to information, and a deeper contextualization of learning. Collaboration can reduce search time and improve efforts to evaluate information. Hypothetically, effective mobile learning can empower learners by enabling them to select and assess relevant information, redefine their goals, and reconsider their understanding of concepts within a shifting and growing frame of reference.

4.1. Information Access and Selection

As the amount of information available on the Internet grows, it is becoming increasingly important for learners to be able to identify relevant and accurate information. Learners must be able to identify patterns and relationships between facts. In addition, both the relevance and the accuracy of the information may shift as other information becomes available. Mobile learning can help learners gain immediate and ongoing access to information, peers, and experts who can help them determine the value of information found on both the Internet and in their real-world environments. This kind of access to other learners and experts can also help to mitigate the negative effects of information noise and assimilation bias (prior-knowledge that prevents the assimilation of new information) [7]. Brown documents the transition from a knowledge production paradigm to a knowledge navigation paradigm [9]. In the previous paradigm of knowledge production, teachers determined what and how information should be learned. In knowledge navigation, teachers help learners understand how to navigate through knowledge in order to select and manipulate already existing information. In this shift, teachers move from acting as facilitators to acting as coaches and mentors.

4.2. Device Development

Central to the integration of the three aspects of the FRAME model is the idea of *mediation*. According to Vygotsky, the nature of the interaction itself changes as learners interact with each other, their contexts, tools, and information, and that this occurs in an iterative fashion [10]. Similarly the *task-artifact cycle* posits that the artifacts themselves introduce possibilities and constraints that, in effect, redefine the uses for which the artifact was originally intended [11]. Therefore, as learners interact with mobile learning devices, they reshape what defines the devices as well as what they, in turn, need to learn. They also expect devices to be developed to meet their needs as learners. Therefore, companies developing mobile devices should to consider learning and communication theory in device development. The FRAME model illustrates these dependencies.

5. Implications for Designing Mobile Learning Materials

The FRAME model explains how mobile technology, human learning capacities, and socio-cultural factors mutually influence each other. It describes the processes involved in mobile learning. Understanding these processes can assist practitioners in designing course materials for mobile learners. But how content is designed and organized is only one consideration. Learning styles, mental processing, and motivational factors must also be considered.

5.1. Content Development for Mobile Devices

Content for mobile devices must be designed in the form of learning objects to allow for flexibility in course development and delivery and to cater to students' individual needs. There are many definitions for a learning object. Ally defines a learning object as any digital resource that can be used to achieve a specific learning outcome [12]. Wiley

describes a learning object as any digital resource that can be reused to support learning [13]. Each learning object should be tied to a learning outcome so that on completion of the lesson, students get a sense of achievement.

Designing content in the form of learning objects will benefit both the learner and the instructor. If learning objects are developed, tagged, and stored properly, this could help instructors by automating the assembly of lessons for mobile delivery. Hence, instructors can instantly prepare a lesson by assembling learning objects from one or more repositories. If created and tagged properly, learning objects have the potential to significantly change the way instruction is designed and assembled for delivery. Also, by placing learning objects in repositories, students and instructors can access learning objects anytime and from anywhere using their mobile devices.

5.2. Design for Different Learning Styles

Designers of mobile learning must develop learning activities to cater to different learning styles since different students perceive, interact with, and respond to a given learning situation in different ways. In addition, adequate social interaction systems must be developed for students with different learning styles since they may require different levels of support [14].

5.3. Design for Efficient Mental Processing in Mobile Learning

When designing learning materials for mobile devices, proper learning theories must be followed to promote success. Good pedagogy is critical for mobile learning since the student and the instructor may be in different locations. Below are guidelines for designing instruction for mobile devices based on learning theories.

- Because of the limited display capacity of mobile devices, information should be chunked into categories to prevent overload during processing in working memory.
- The level of the learning material must match the cognitive ability level of the student. Therefore, the use of self-tests or placement tests may help students receive appropriate content for their comprehension levels.
- To facilitate processing, learning materials must use strategies such as advance organizers to activate existing cognitive structures or to establish the structure to incorporate the details of the lesson.
- Strategies that require students to apply, analyze, synthesize, and evaluate should be included help promote higher-level learning for transfer to long-term memory.
- Learning strategies to allow students to apply the information in real life should also be included to contextualize learning and to make learning more meaningful. Practitioners can design activities that require the students to draw upon their social and cultural contexts.

5.4. Design to Maintain Motivation

When using mobile devices, students may be in different locations. As a result, the learners may feel disconnected from the learning activities thereby diminishing their motivation. Keller proposed a motivational model that could be used when developing learning materials for mobile devices [15]. Practitioners need to consider strategies to stimulate student attention at the start of the lesson and maintain it throughout the lesson. Students should be informed of the importance of the lesson and how taking the lesson could benefit them. Learning materials must be designed in manageable chunks so that students can get a sense of completion after successfully completing each chunk. Students should be provided with ongoing feedback indicating their progress. If they are not progressing well, they would be able to use their metacognitive skills to adjust their learning strategy. To facilitate transfer and contextual learning, strategies that encourage real life applications should be used in mobile learning. Good pedagogical strategies that keep learners active should be used to allow learner to process information at a high level and to promote meaningful learning.

6. Conclusions

The major advantages of mobile learning include greater access to appropriate and timely information, reduced cognitive load during learning tasks, and increased interaction with other people and systems. It may be argued that networked mobile devices can help shape a culturally sensitive learning experience that can offer additional and, possibly, more powerful means of encoding, recall, and transfer. In addition, it is very important to consider the development of learning objects as well as the recognition of learning styles, cognitive processing, and motivation of learners.

While these tools are relatively new to education, there will be some unforeseen impacts on the traditional roles of teachers and learners. In the mobile

environment, teachers and learners must move away from knowledge production and into a knowledge navigation paradigm in which teachers become more like tutors who help learners to select and manipulate pre-existing information [9, 16]. Successful transition in roles and responsibilities in mobile learning can move education towards a truly learner-centred model in which "They have to construct knowledge and reflect on thoughts and experiences constantly" [16]. According to Erstad in "student-centred environments . . . the learner defines how to proceed, based on individual needs, and that learning is highly tuned to the situation in which it takes place . . . [learning is] deepened through exploration, interpretation and negotiation" [17].

10. References

[1] M. Koole, "Framework for the rational analysis of mobile education (FRAME): A model for evaluating mobile learning devices," M.D.E. thesis. Athabasca University, Athabasca, AB, Canada, in progress.

[2] N. Bontis, "The rising star of the chief knowledge officer," *Ivey Business Journal*, vol. March/April, pp. 20-25, 2002, [Cited 2005 June 10], Available HTTP: http://www.iveybusinessjournal.com/article.asp?intArticle_ID=370

[3] P. L. Smith and T. J. Regan, *Instructional Design*, 2nd ed. Toronto, Ontario: John Wiley & Sons, Inc., 1999, pp. 14-15.

[4] S. Tella, "Chapter one: M-learning-cybertextual traveling or a herald of post-modern education?" in *Mobile Learning*, H. Kynäslahti and P. Seppälä, Eds. Helsinki, Finland: Edita Publishing Inc., 2003, pp. 7-21.

[5] P. Kommers, "Chapter 3: Research on the use of hypermedia," in *Hypermedia learning environments*, P. Kommers, S. Grabinger, and J. Dunlap, Eds. Mahwah, NJ.: Lawrence Erlbaum Associates, 1996, pp. 33-75.

[6] J. Preece, Y. Rogers, and H. Sharp, *Interaction Design: Beyond Human-Computer Interaction*. New York: John Wiley & Sons, 2002.

[7] R. Marra, "Chapter 6: Human-computer interface design," in *Hypermedia Learning Environments*, P. Kommers, S. Grabinger, and J. Dunlap, Eds. Mahwah, NJ.: Lawrence Erlbaum Associates, 1996, pp. 115-136.

[8] M. Sharples, "The design of personal mobile technologies for lifelong learning," *Computers & Education*, vol. 34, pp. 177-193, 2000.

[9] T. Brown, "Beyond constructivism: Exploring future learning paradigms," [Online document], 2005, [Cited 2005 June 10], Available HTTP: http://www.dreamland.co.nz/educationtoday/Tom_Brown_Beyond_Constructivism.pdf.

[10] L. Vygotsky, *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press, 1978.

[11] J. Caroll and M. Rosson, "Paradox of the active user." [Online document], 1985 [Cited 2005 June 15], Available HTTP: http://www.winterspeak.com/columns/paradox.html.

[12] M. Ally, "Designing effective learning objects for distance education," in *Online Education Using Learning Objects*, R. McGreal, Ed. London: Routledge Falmer, 2004, pp. 87-97.

[13] D. A. Wiley, "Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy," in *The Instructional Use of Learning Objects*, D. A. Wiley, Ed. Bloomington, Indiana: Agency for Instructional Technology, 2002, pp. 1-35.

[14] M. Ally and P. Fahy, "Using students' learning styles to provide support in distance education," presented at The Eighteenth Annual Conference on Distance Education Teaching and Learning, Madison, Wisconsin, 2002.

[15] J. M. Keller, "Motivational design of instruction," in *Instructional Design Theories and Instruction: An Overview of their Current Status*, C. M. Reigeluth, Ed. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1983, pp. 383-429.

[16] M. Ahonen, B. Joyce, and H. Turunen, "Chapter three: Mobile learning - a different viewpoint." in *Mobile Learning*, H. Kynäslahti and P. Seppälä, Eds. Helsinki, Finland: Edita Publishing Inc., 2003, pp. 29-39.

[17] O. Erstad, "Norwegian students using digital artifacts in project-based learning," *Journal of Computer Assisted Learning*, vol. 18, pp. 427-437, 2002.