User Experience Evolution of M-Learning Applications

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Abstract: The development of a mobile learning application is associated with many challenges including timely technology, richness of the learning content, pedagogy, usability, and the design of user experience. Users' expectations and requirements on m-learning applications have evolved since the beginning of this millennium. The evolvement is mainly a result of the advancement of mobile technologies, devices, and network services. Users' expectations are based on previous experiences, expertise level, and the context that users have previously worked. The focus of this paper is on mobile learning usability and user experience. We elaborate on m-learning applications' user experience evolution from 2003 to 2016. The results demonstrate that usability needs to be complemented with user experience analysis when developing m-learning applications.

1 INTRODUCTION

Knowledge and educational material has become widely available for anybody with access to internet and desire to pursue it. Wealth of material is available online, free of charge, at any time. Easy access to communication, information, and knowledge has also resulted in social and cultural changes: for instance, people rarely manage a day without a mobile phone or access to the Internet.

This easy access to knowledge creates additional and perhaps even surprising demands for the design of learning content and applications. Learning content and applications need to compete and stay up-to-date with other important and entertaining information and services.

Mobile learning aims to overcome the constraints of traditional educational settings where learning and teaching happen in classrooms behind closed doors. M-learning has been around for almost two decades, but so far it has failed to draw serious attention of educational institutes in comparison with e-learning. Utilizing smart devices for educational purposes is associated with several challenges including the usage of a small device with many limitations on display, keypad, and memory. Mobile learning applications also compete with students' time regarding other applications in the used device, including games.

There have been significant improvements in the technological capabilities of mobile devices during the last decade including mobile application development processes. New gadgets smartphones and tablets have been developed that are equipped with many advanced technologies and capabilities, including WIFI (Henry & Luo, 2002) and NFC (Madlmayr et al., 2008). Furthermore, these devices have become more intelligent than ever before due to the embedded sensors, camera, and high quality audio and video equipment. The challenging drawbacks of these devices, namely the memory space and processing power, have been overcome in many ways. Network operators provide fast data connectivity to their subscribers at a relatively low cost.

Smartphone usage among youth is increasing (Lee et al., 2014) at the expense of PC usage (Sung & Mayer, 2012). Mobile applications including games, social networking, and professional tools, are proliferating in application stores. Mobile learning (m-learning) applications are competing for learners' time and attention, and they must meet learners' educational requirements while also encourage frequent use (Seong, 2006).

M-learning applications require careful design and development considerations as they deal with learning and learners alike. This is particularly true in formal learning settings where m-learning

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applications are meant to be used for long periods of time. In this respect, sustainability plays an important role. A contextual analysis of user's relation to m-learning applications is one way to address such challenges.

Mobile learning applications' usability has initially been applied in the form of usability inspections, although it was soon realized that this was not sufficient (Po et al., 2004). Therefore, alternative solutions, models, and frameworks have been proposed to anticipate these challenges. There have been significant methodological improvements, usability guidelines, and pedagogical development. Kukulska-Hulme (2007) has emphasized that "for broad and long-term adoption the experience really matters".

Seong (2006) formulates three usability evaluation categories for a mobile learning application, namely the user interface, the interaction, and the interface design. Furthermore, Seong (2006) recommends ten usability guidelines to measure the mobile learning application's usability. Simultaneously, researchers have proposed a systematic mobile learning application design and development methodology in order to gain better usability and user experience (UX). This includes recommendations for the learner-centered design and development of m-learning applications (Basaeed et al., 2007; Low et al., 2006; Soloway et al., 1994; Wong, 2012).

In their literature review concerning mobile learning usability assessments, Navarro et al. (2016) present an applied methodology for mobile learning usability assessments. Additionally, they recommend an evaluation framework for m-learning systems that consist of two parts: pedagogical usability and user interface usability. Their proposed set of guidelines for user interface design mainly focus on the usability of m-learning.

Yu and Kong (2016) investigate the mobile web page interface design's impact on ease of use, interactivity, reading time, ease of learning, and perceived user-friendliness in order to predict the users' satisfaction with the mobile browsing experience. Their paper reveals the trend of using usability factors such as ease of use to achieve a better UX. Their attempt to address UX indicates that usability is important in mobile learning, but not sufficient.

These types of frameworks and guidelines demonstrate that the usability of m-learning applications is still evolving and that the existing approaches are not sufficient to result in a successfully deployed and accepted mobile learning application.

2 TWO ERAS OF USER EXPERIENCE

User experience (UX) has been considered to be an important element of a mobile application's success (Roto et al., 2010). UX has become a viable supplement to traditional HCI design, which is indicated in recent practitioner discussions. UX design is a multidimensional phenomenon in which many factors influence success.

Despite the more than a decade-long (Hassenzahl & Tractinsky, 2006) research and definition on user experience, the concept still suffers from vague and broad definition. This is, for instance, reflected in the 27 definitions of user experience reported as a result of the Dagstuhl Seminar on Demarcating User Experience (Roto et al., 2010) (see also http://www.allaboutux.org/ux-definitions).
Application domain (e.g. m-learning) specific definitions of UX are even more scarce. However, Rusu et al. (2015) recognize that there is a tendency to move from usability to user experience, although there is a lack of formal widely-accepted definition of UX among the CS communities.

The importance of UX was raised already in early 2000. **The First Era of UX** may be defined to have taken place during 2000-2006 (Garrett 2000, Roto 2006) and might be entitled as the "technical approach to UX" which still appears as the basis for much of the UX related discussion. Garrett's (2000) model on UX is conceptual model of a development process to ensure the user´s experience of a website. The model consists of five planes: the site objective, the requirements, interaction design, information design, and visual design.

Roto´s (2006) model on UX introduces human responses as part of mobile browsing user experience. The model identifies the different roles of mobile device, browser, connection, and site attributes which have an effect on mobile browsing experience.

The Second Era of UX (ISO, 2010) may be defined to be about "human responses and emotions as UX". It presents a definition of UX that arises from the direction of human responses and emotions. It defines user experience as a "person's perceptions and responses that result from the use or anticipated use of a product, system or service".

Nielsen & Norman (2015) define user experience as simplicity of a product, which comes with elegance

that users enjoy to own and enjoy to use. A similar discussion is also offered by Keinonen (2008) concerning whether the users' needs and UCD are sufficient for mobile application development.

Hassenzahl & Tractinsky (2006) define three facets of UX: beyond instrumental, emotion and affect, and the experiential. The beyond instrumental aims at grasping and describing users' needs to achieve their holistic goals addressing also the hedonic aspects that the product or service fulfils. The affect and emotions deal with user's internal state as a result of the interaction with a product. The third facet of the UX is "the experiental", which deals with the users´ overall experience as a whole.

The importance of user experience in educational media such as e-learning platforms has also been identified (Garaj, 2010; Sutcliffe & Alrayes, 2012). Recently, the importance of user experience in education, especially in m-learning environments, has been noted (Shen, 2014).

Despite the methodological developments related to m-learning applications' usability and design, the importance of the m-learning user experience factors has not yet been researched thoroughly. From the technical perspective, Yousafzai et.al (2016) propose technical guidelines and taxonomy on m-learning environment to overcome the existing multimedia-enabled m-learning applications´ constraints. The taxonomy addresses mobile device heterogeneity, network performance, and content heterogeneity.

Extending the focus from technical characteristics of m-learning, Ali & Arshad (2016) propose an acceptance model that aims to affect the students' intention to adopt an m-learning application. They extend the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al. 2003) with three supplementing factors: mobility, interactivity, and enjoyment. Badwelan et al (2016) reach even more toward non-technical characteristics in determining the factors that influence students' intention to use m-learning. Their results show that the added UTAUT factors personal innovativeness, lecturer's influence, and self-management of the learner had a significant impact on students' intention to use m-learning. Dirin (2016) identifies satisfaction, delightfulness, reliability, and adjustability as important UX factors for m-learning application sustainability in the attempts to move more towards non-technical and "beyond instrumental" (Hassenzahl & Tractinsky, 2006) aspects of m-learning.

The previously presented two "conceptual eras of UX" are used to address the evolvement of m-learning applications over the last decade. In the following sections, we analyse the impact of UX to m-learning applications in respective eras. The aim is to reflect on students' and teachers' evolving expectations towards future m-learning applications.

3 SAMPLES ON EVOLVING UX IN M-LEARNING

The following three case applications demonstrate how user experience has evolved over time in m-learning. The analysis of these sample applications indicates how the users´ expectations have changed from *instrumental* to *beyond instrumental* and *experiental* needs, as modelled by Hassenzahl & Tractinsky (2006) over time.

3.1 Java Applet for a Java Course (UX Era 1)

The introduction of m-learning applications relates to the emergence and diffusion of mobile devices and applications in general. The Java-applet-based m-learning application (see Figure 1) helped students to access the resources of a Java programming course including lecture notes, assignments, and other information such as feedback from a teacher using a Java-enabled mobile phone. Additionally, students could submit their laboratory and home assignments through the application if they had access to the network.

The gathered requirements from teachers, courses assistants, and students indicate that users raised only functional demands and needs. For example, teachers and course assistants have concerned about the uploading course related materials while students were concerned about downloading materials. Or, Students asked for possible administrative features such as registering for a course.

The reliability of the application was the only user experience related requirement which highlighted by users for java m-learning application.

The screenshot (Figure 1) presents an example of the application's user interface. The visual design of the java mobile learning application was restricted to the existing development environment (J2ME) on the phone. The user interface ("Main Menu") is divided into the following categories: presentation ("esitys"), activities ("toiminta"), communication ("yhteydenpito"), and administration ("hallinto") according to the virtual course delivery model by Brusilovsky & Miller (2001).

Figure 1: The “Java Course” M-learning application.

The application can be seen to conform to Garrett´s (2000) technology and process focused elements of user experience model. The design and development of the application was done by identifying the users´ needs and defining the technical, structural, and functional requirements accordingly.

However, the development of this application reached towards the model presented by Roto (2006). The human response in relation to the application was evaluated through usability testing. There were many concerns raised by the users regarding connectivity, slow performance of the device, low memory, and short battery life. The slow data transfer connection and high data exchange cost were among major drawbacks in the application´s usage. Connectivity was considered to impact content delivery, usability, and even support for offline usage. These were relevant concerns but the technology and the development environments at the time prevented the finding of a proper workaround to overcome the technical constraints.

3.2 Adaptive M-Learning Application (UX Era 2)

The adaptive m-learning application for driving licence candidates (see Figure 2) was a joint project between Haaga-Helia University of Applied Sciences and Haaga Driving School in Helsinki. This application helps the driving school candidates to study and access the compulsory driving school theory lessons on their smartphones. Furthermore, the administration tool helps the instructors to trace students’ theory progress and driving experiences.

The main goal of the project was to design a functional m-learning application as a proof of concept. The design, development, and assessment of this case study application is published in (Dirin & Casarini, 2014).

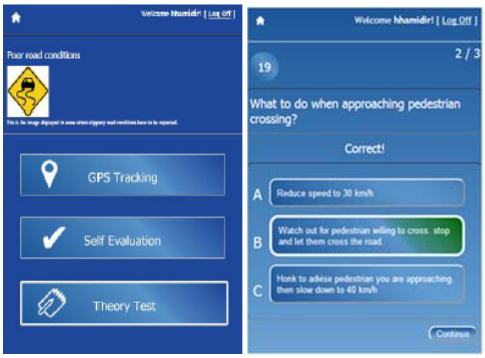

Figure 2: The “Driving School” M-learning application.

This m-learning application assists driving school students and instructors in their daily teaching and learning activities. The application helps the driving school candidates to study and access the compulsory driving school theory lessons on their smartphones. The administration tool helps the instructors to trace students’ theory progress and driving experiences.

In contrast to the Java Applet mobile learning application, the user expectations for this application were much more than just the mere functionalities of the application or just extending the uses of the mobile devices. The users’ needs and requirements of the potential application included many non-functional requirements which Hassenzahl & Tractinsky (2006) refer to as “beyond instrumental” characteristics. The following are examples of non-functional requirements that users raised during the elicitation phase: 1. Customization of the potential application based on users´ preferences 2. The resources provided to users based on the context and user competences 3. Instructors follow students´ progress reliably. Figure 2 reveals that the above non-functional requirements were tackled through 1. The user is able to customize application feel and look at any time. 2. Through color-coding, the adaptive m-learning application provides instance feedback to users on the context. 3. Instructors follow the students’ progress through the color-coded interface.

The application was designed to allow users to combine external services to the application including, for instance, the search for information through their preferred internet search engine.

The responsive design of the application makes the mobile device adaptive to users’ contextual requirements. This is an “affect mechanism” to depict the negative emotions. Furthermore, the application makes use of colors, visual symbols, and familiar icons to raise positive emotions during the use of the service.

This adaptive m-learning application also helped

the user to receive feedback on learning instantly. During the driving experiment the application notifies the instructor on candidate's performance. Additionally, the application delivers pop-up messages as notifications on occurred mistakes and provides guidance to fix them.

3.3 Business Game Application (UX Era 2)

This mobile learning application helps users to become familiar with the complex premises and the offices in different buildings. In the "Business Game" (see Figure 3) application (Dirin & Vainio, 2015) the user study was performed to learn about the target users' application preferences. The qualitative data from the user study was analyzed and categorized to produce the requirements. The designer focused on designing the product concept to be most appealing to users. User scenarios were applied and various application concepts were assessed by the users. The low-fidelity paper-based prototype created using Balsamiq Mockups helped to obtain more specific feedback from users.

Users' expectations on presenting the content as a game illustrate the "beyond instrumental" requirements. This non-functional requirement was raised in the concept design phase of the application. Furthermore, users' demand on having different game characters to play the game indicated that users strive for an emotional relation towards the application. Figure 3 presents sample of a character that we proposed in the business game application. Engagement with the application and communication with other peers are considered as important complementing non-functional requirements that reflect the "beyond instrumental" needs.

The desired increasing complexity in playing the game was raised by users in the usability test reflecting the hedonic aspects towards the application. Emotion appeared to provide a basis for the selection of the characters and affect was detected while analyzing achievements after playing each game. The "game appeal" appeared to increase learners' motivation to complete the game and go through the whole learning content.

Figure 3: Sample of role character for the "Business Game" m-learning application.

4 DISCUSSION

The usability evaluation of the initial Java m-learning application (UX era 1) indicated that users do value high the utilization of their mobile device for educational purposes despite their initial mental model on m-learning as an "upgraded text messaging service". The more recent applications' (UX era 2) design and development reveals that students´ demands and expectations were more than just "usable" consisting only of effective and efficient performance with the application. Users of the Java m-learning application desired to use their mobile devices solely for educational purposes which Hassenzahl & Tractinsky (2006) present as "instrumental". This approach emphasizes that the developers need to create a usable application which, according to ISO 9241, ends up being effective, efficient, and satisfying.

One may argue that the users' motivations to use the mobile devices for educational purposes has significantly changed. The users of the latest mobile learning applications have already learnt to use mobile devices for a multitude of purposes including the educational. These include using Google to search, online dictionaries, emails, calendars, etc.

In our case descriptions, the users in the first group (the "Java Course" m-learning application) did not have prior experience with mobile learning and, therefore, were eager to enhance the uses and functionality of the device towards educational activities. In the "Java Course" m-learning application, the main requirements were focused on task-related and functional aspects. The second group, however, had already extensively used their

mobile devices for a multitude of purposes including the educational process. The users of the new mobile learning applications expect usability (efficiency, effectiveness, and satisfaction) as a "de-facto characteristic" for any mobile learning application. The work by Yu and Kong (2016) justifies the importance of moving from usability toward user experience in web browsing on a small screen. They demonstrate the importance of design in facilitating the ease of use and ease of interactivity in order to achieve the ease of learning and reading.

The two latter cases from "UX era 2" go beyond the "usability" boundaries reaching towards the hedonic aspects. The users of these m-learning applications emphasized the responsive and subjective experience on the use of the application. The feelings of joy and ownership affect users´ emotional engagement with the application. The "beyond instrumental" and "experiential" requirements have become more important for m-learning application acceptance and continuing utilization.

In addition to technology, changes have also occurred in students' and teachers' social lives and cultural surroundings. Over the years, people have become more dependent on their mobile devices. Hence, smartphones and their use have a significant impact on m-learning applications' concept, design, and development.

Alongside the maturing of mobile technology in general, users' attitudes and expectations regarding the m-learning applications' design and performance have also altered. Unlike the situation in 2003, smart devices are now equipped with extensive in-device applications to meet users' various daily needs. Additionally, millions of third-party applications are available for download in the different platform stores. Almost all these applications are competing for users', including students', time and dedication. These changes have resulted in additional expectations for m-learning applications' design, features, application performance, and user experience.

Nonetheless, the technological advancements in smart devices and in networks have not impacted the identity of m-learning stakeholders or their overall roles and contributions. Consequently, the technological advancements and social changes mandate and emphasize the importance of m-learning-related pedagogical, usability, and user experience considerations during design and development. At the time of the "Java Course" m-learning application contemporary technology was used to deliver timely user experience. This meant better functionality and usability of the application. More recent implementations need to go beyond that.

Aligned with the smart gadgets´ technological advancement, many solutions aim at anticipating the technical changes. This may not be sufficient anymore. Mere technology-oriented solutions are not sufficient to result in continuous usage of mobile learning application. Instead, the changing social and cultural surroundings provide a source of analysis for the "beyond instrumental" aspects that may be crucial for the acceptance of the applications.

These aspects are visible in the presented cases. In 2004 the users only wanted to have the Java course content as an application on their mobile phones while in 2013, having only the content in the phone was not sufficient. Users demand the application to be fun to use, adaptable, and adjustable.

As the focus of mobile learning application design appears to move from technical to experiential, the success of mobile learning applications depends on the "experiential design". In their recent research, Kuderna-Iulian et al. (2015) recognize the importance of behavior and emotions in learning and the acceptance of a software product. Their multimodal monitoring tool for collecting emotional feedback through mobile devices' sensors provides interesting ways forward in analysing such impacts in using an m-learning application.

The technological developments have also had an impact on educational institutes' attitudes toward m-learning application utilization and, most of all, on students' expectations of m-learning applications' enhancement (Dirin & Nieminen, 2014) of their educational process. Therefore, in contemporary educational institutes (Collins & Halverson, 2010) with current social setups (Vannoy & Palvia, 2010), m-learning applications have become a response to student and staff demands regarding their educational activities.

5 CONCLUSIONS

This paper aims at illustrating the changing landscape of user experience in m-learning. User experience in educational context plays an important role as the applications need to motivate learners for sustainable usage. Initially, the focus has been on technical solutions. However, there is potential to focus more on the emotional and experiental side in m-learning application development. Mobile gadgets and the applications have become ubiquitous daily tools. They provide context-independent sharing, transferring or receiving educational material,

information, and knowledge. Hence, m-learning is ubiquitously merging knowledge with smart devices, which means learning and teaching are not restricted by place and time constraints as in traditional educational institutes where knowledge sharing happens in only one context.

Our analysis of the UX evolvement of mobile learning applications indicates that mere technological solutions are not anymore enough to attract users to use mobile learning applications. This study reveals that user experience in m-learning is still emerging and has room for further study and development. The research demonstrates that user experience challenges with m-learning applications have mainly been tackled technically according to technology and process focused models on UX. Contributions on user experience factors addressing emotional needs in m-learning are vague. Users' demands for sufficient usability and user experience have significantly increased in line with mobile penetration among students and m-learning adoption by educational institutes. As users' expectations and requirements have evolved over the time, traditional application design and development approaches are not sufficient in developing m-learning applications. Applying the latest technology to come up with a mobile learning application is important; however, it is not sufficient for engaging users emotionally for continuous usage.

In the future, mobile learning applications need additional justification than just satisfying the practical needs impacting the effectiveness and efficiency of the application. User experience plays an important role in motivating users for continuing and sustainable usage of m-learning applications through added emotional engagement.

Proper addressing of user experience increases the possibilities for the m-learning applications to compete on students' time with other entertaining and engaging applications in their device. We suggest that special attention should be put to the "beyond instrumental" and "the experiential" aspects when designing engaging mobile learning applications for continuous and sustainable use.

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REFERENCES

Ali, R. A., & Arshad, M. R. M. (2016). Perspectives of Students' Behavior Towards Mobile Learning (M-learning) in Egypt: an Extension of the UTAUT Model. *Engineering, Technology & Applied Science Research*, *6*(4), 1109–1114.

Badwelan, A., Drew, S., & Bahaddad, A. A. (2016). Towards Acceptance M-Learning Approach in Higher Education in Saudi Arabia. *International Journal of Business and Management*, *11*(8), 12–30. http://doi.org/10.5539/ijbm.v11n8p12.

Basaeed, E., Member, S., Berri, J., Member, S., & Zemerly, M. J. (2007). Learner-Centric Context-Aware Mobile Learning. *Engineering Education*, *2*(2), 30–33. Retrieved from http://ewh.ieee.org/soc/e/sac/meem/public/old_issue/vol02iss02/MEEM020206.pdf.

Brusilovsky, P., & Miller, P. (2001). Course Delivery System for Virtual University. *Access to Knowledge: New Information Technologies and the Emergence of the Virtual University*, 167–206.

Collins, A., & Halverson, R. (2010). The second educational revolution: Rethinking education in the age of technology. *Journal of Computer Assisted Learning*, *26*, 18–27. http://doi.org/10.1111/j.1365-2729.2009.00339.x.

Dirin, A. (2016). *Toward Enhancing User Experience in Mobile Learning Applications*. Aalto University.

Dirin, A., & Casarini, M. (2014). Adaptive M-Learning Application for Driving Liceness Candidates Based on UCD Framework for M- Learning Application Development. In *6th International Conference on Computer Supported Education*.

Dirin, A., & Nieminen, M. (2014). State-of-the-Art of M-Learning Usability and User Experience. *The Fourth International Conference on E-Learning (ICEL)*.

Dirin, A., & Vainio, V. (2015). Case Study: From Requirements List to an Educational Game. In *Computer Supported in Education*. Lisbon, Portugal. Retrieved from http://www.csedu.org/

Garaj, V. (2010). M-learning in the education of multimedia technologists and designers at the University level: A user requirements study. *IEEE Transactions on Learning Technologies*, *3*(1), 24–32. http://doi.org/10.1109/TLT.2009.38.

Garrett, J. J. (2000). The Elements of User Experience, 2000. Retrieved from http://uxdesign.com/assets/Elements-of-User-Experience.pdf.

Hassenzahl, M., & Tractinsky, N. (2006a). User experience - a research agenda. *Behaviour & Information Technology*. http://doi.org/10.1080/01449290500330331.

Hassenzahl, M., & Tractinsky, N. (2006b). User experience - a research agenda. *Behaviour & Information Technology*, *25*(2), 91–97.

Henry, P. S., & Luo, H. (2002). WiFi: What's next? *IEEE Communications Magazine*, *40*, 66–72. http://doi.org/10.1109/MCOM.2002.1106162.

ISO. (2010). ISO 9241 Part 210: Human-centred design for interactive systems. In *ISO 9241 Ergonomics of humansystem interaction*.

Keinonen, T. (2008). User-centered design and fundamental need. *Proceedings of the 5th Nordic Conference on Human-Computer Interaction Building Bridges - NordiCHI '08*, 211. http://doi.org/10.1145/1463160.1463183.

Kuderna-Iulian, B., Marcel, C., & Mireca, V. (2015). A multimodal affective monitoring tool for mobile learning. In *14th RoEduNet International Conference – Networking in Education and Research (RoEduNet NER)* (pp. 34–38). Craiova, Romania: ASL Publication.

Kukulska-Hulme, A. (2007). Mobile usability in educational contexts: What have we learnt? *International Review of Research in Open and Distance Learning*, *8*.

Lee, U., Lee, J., Ko, M., Lee, C., Kim, Y., Yang, S., … Song, J. (2014). Hooked on smartphones: an exploratory study on smartphone overuse among college students. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2327–2336). http://doi.org/10.1145/2556288.2557366.

Low, L., Connell, M. O., & Connellcitacteduau, M. O. (2006). Learner-Centric Design Of Digital Mobile Learning. In *Framework* (pp. 1–13).

Madlmayr, G., Langer, J., & Scharinger, J. (2008). Managing an NFC Ecosystem. In *Proceedings - 7th International Conference on Mobile Business, ICMB 2008, Creativity and Convergence* (pp. 95–101). http://doi.org/10.1109/ICMB.2008.30.

Navarro, C. X., Molina, A. ., Redondo, M. A., & Reyes, J.-R. (2016). Framework to Evaluate M-Learning Systems: A Technological and Pedagogical Approach. *IEEE Revista Iberoamericana de Tecnologias Del Aprendizaje*, *11*(1), 33–40. http://doi.org/10.1109/RITA.2016.2518459.

Nicolás, O., Carlos, J., & Aurisicchio, M. (2011). The Scenario of User Experience. In *DS 68-7: Proceedings of the 18th International Conference on Engineering Design (ICED 11), Impacting Society through Engineering Design,* (pp. 1–12). Copenhagen, Denmarik.

Nielsen, J., & Norman, D. (2015). The Definition of User Experience.

Po, S., Howard, S., Vetere, F., & Skov, M. B. (2004). Heuristic evaluation and mobile usability: Bridging the realism gap. *Mobile Human-Computer Interaction–MobileHCI 2004*, *3160*, 591–592. http://doi.org/10.1007/b100594.

Roto, V. (2006). *WEB BROWSING ON MOBILE PHONES - CHARACTERISTICS OF USER EXPERIENCE (Dissertation)*. Retrieved from https://aaltodoc.aalto.fi/bitstream/handle/123456789/2784/isbn9512284707.pdf.

Roto, V., Law, E., Vermeeren, A., & Hoonhout, J. (2010). User Experience White Paper: Bringing clarity to the concept of user experience. *Seminar on Demarcating User Experience*, 12.

Rusu, C., Rusu, V., Roncagliolo, S., & Carina, G. (2015). Usability and User Experience: What Should We Care About. *International Journal of Information Technologies and Systems Approach*, 12. http://doi.org/10.4018/IJITSA.2015070101.

Seong, D. S. K. (2006a). Usability guidelines for designing mobile learning portals. *Proceedings of the 3rd International Conference on Mobile Technology, Applications & Systems - Mobility '06*, 25. http://doi.org/10.1145/1292331.1292359.

Seong, D. S. K. (2006b). Usability Guidelines for Designing Mobile Learning Portals. *ACM International Conference Proceeding Series; Vol. 270 Proceedings of the 3rd International Conference on Mobile Technology, Applications & Systems*, 25. http://doi.org/http://doi.acm.org/10.1145/1292331.1292359.

Shen, R. (2014). *Constructing a user experience-based mobile learning environment : problems and solutions*. Fernuniversitä, Hagen Germany. Retrieved from http://deposit.fernuni-hagen.de/2984/1/Diss_Shen.pdf.

Soloway, E., Guzdial, M., & Hay, K. E. (1994). Learner-centered design: the challenge for HCI in the 21st century. *Interactions*. http://doi.org/10.1145/174809.174813.

Sung, E., & Mayer, R. E. (2012). Students' beliefs about mobile devices Vs. desktop computers in South Korea and the United States. *Computers and Education*, *59*(4), 1328–1338. http://doi.org/10.1016/j.compedu.2012.05.005.

Sutcliffe, A., & Alrayes, A. (2012). Investigating user experience in Second Life for collaborative learning. *International Journal of Human Computer Studies*. http://doi.org/10.1016/j.ijhcs.2012.01.005.

Vannoy, S. A., & Palvia, P. (2010). The social influence model of technology adoption. *Communications of the ACM*. http://doi.org/10.1145/1743546.1743585.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). USER ACCEPTANCE OF INFORMATION TECHNOLOGY: TOWARD A UNIFIED VIEW. *MIS Quarterly*, *27*(3), 425–478. http://doi.org/10.2307/30036540.

Wong, L. H. (2012). A learner-centric view of mobile seamless learning. *British Journal of Educational Technology*, *43*(1). http://doi.org/10.1111/j.1467-8535.2011.01245.x.

Yousafzai, A., Chang, V., Gani, A., & Noor, R. M. (2016). Multimedia augmented m-learning: Issues, trends and open challenges. *International Journal of Information Management*, *36*(5), 784–792. http://doi.org/10.1016/j.ijinfomgt.2016.05.010.

Yu, N., & Kong, J. (2016a). User experience with web browsing on small screens: Experimental investigations of mobile-page interface design and homepage design for news websites. *Information Sciences*, *330*, 427–443. http://doi.org/10.1016/j.ins.2015.06.004.

Yu, N., & Kong, J. (2016b). User experience with web browsing on small screens: Experimental investigations of mobile-page interface design and homepage design for news websites. *Information Sciences*, *330*, 427–443. http://doi.org/10.1016/j.ins.2015.06.004.