

# Facets of Mobile Lifelong Learning Services

Amir Dirin<sup>1</sup>, Teemu H. Laine<sup>2</sup> and Marko Nieminen<sup>3</sup>

<sup>1</sup>*Business Information Technology, Haaga-Helia University of Applied Sciences, Helsinki, Finland*

<sup>2</sup>*Department of Computer Science, Electrical and Space Engineering, Luleå University of Technology, Skellefteå, Sweden*

<sup>3</sup>*Department of Computer Science, Aalto University, Helsinki, Finland*

**Keywords:** Lifelong Learning, Social Media, Learning Media, Emotions, Feelings.

**Abstract:** In the era of digital services and digital connectivity, a massive amount of knowledge has become available and accessible all the time and for all ages. This mandates significant structural changes in the ways in which knowledge are shared and contents are presented. The ways in which knowledge is shared and learners become engaged with that knowledge are crucial in lifelong learning. In lifelong learning the knowledge and the content must be delivered to learners at the right time, without distractions and noise. The traditional educational offering in classrooms is not anymore feasible and supportive as learning happens in a disengaged manner in lifelong learning. In new lifelong learning services, user experience (UX) plays a key role in delivering content appropriately and supporting transition of learning between different contexts with adaptive learning media. The objective of this study is to illustrate and elaborate on the roles of feelings and emotions in engaging students in lifelong learning applications. We have applied systematic literature review (SLR) to identify emotional factors associated with lifelong mobile learning (m-learning) environments. Based on the findings, we propose an application concept as a case study to demonstrate how emotional factors can manifest themselves in lifelong learning applications. Finally, based on the findings of the literature review and the case study evaluation, we propose a model illustrating the facets in lifelong learning applications.

## 1 INTRODUCTION

Technological advancement has significantly impacted traditional educational offerings during last three decades (Halili, 2019). Wireless technologies, Internet, and smart gadgets have enabled lifelong learning design and development to be more feasible than ever. Already for more than two decades E-learning, m-learning, and distance learning have co-existed and provided educational offerings in various forms by educational institutes. These technology-assisted enhancements will continue to support lifelong learning which extends beyond classroom-based curricula. Technology-assisted lifelong learning interventions are the results of the popularity, affordability, and accessibility connected mobile devices. These interventions anticipate and overcome the existing constraints in traditional educational offerings. For example, m-learning overcomes the place and time restrictions of learning which are apparent in traditional classrooms (Mostakhdemin-Hosseini & Tuimala, 2005). Unlike traditional learning where teachers directly interact

with learners, in lifelong learning the learners must be motivated and engaged with the learning platform. With further advancement of technology, m-learning has become more feasible than ever before. Learners in any context are capable of having access to appropriate learning materials just when they are needed. Therefore, learning may happen at any time and any place regardless of age and qualifications of the learner.

In this paper, we define the term lifelong m-learning as self-regulated learning that happens in a context, with help of mobile devices, where users pursue to develop competence or update knowledge. Chen et al (2015) define lifelong learning as a continuous learning for retaining the knowledge. In lifelong learning, learners often utilize unstructured learning approaches. Kukulska-Hulme (2007) emphasized that “for broad and long-term adoption the experience really matters in learning.” Therefore, learners’ engagement plays an important role in any digital learning environment, including also lifelong m-learning environments. Learners’ engagement with digital learning platforms goes into the user experience (UX) domain.

## 2 RESEARCH QUESTIONS AND METHOD

The traditional classroom education is not sufficient for constantly evolving learning demands. M-learning brings learning content to learners whereas classroom training requires learners to go to learning content. Challenges relate to learner engagement with m-learning tools and services; how to motivate and keep the learner connected to learning content continuously?

The aim of this article is to describe the learner's emotional engagement factors to lifelong m-learning applications with help of UX. The approach in this study is based on a systematic literature review, user-centered design, and qualitative analysis (Jabareen, 2009). We pursue to answer the following research questions:

1. How m-learning user experience factors have evolved in research between 2005-2017?
2. What are the potential emotional engagement factors associated with lifelong learning?
3. What are the facets of emerging lifelong learning services?

To answer the first research question, we conducted a systematic literature review (SLR) which analyses research on mobile learning user experience in 2005-2017. We have utilized Kitchenham (2004) guidelines on conducting systematic literature review and Prisma reporting (Tricco et al., 2018) to report the findings of the SLR and the search results. The objective is to survey the scholarly articles, journals, and conference proceedings relevant to m-learning application design, usability, and user experience. The main inclusion criteria in literature search were as follows: articles that were published between 2005-2017, articles that were written in English, and articles that focus in m-learning user experience. The primary keywords / phrases which were used and combined in the search were "mobile learning", "development framework", "usability", and "user experience". The process of the identifying the emotional words in the SLR were as follows: first we searched with the keywords in the selected journals and conferences. If the article contains the emotional words, then that article is selected for reading in details. Next, we update the excel sheet which keep tracts of the emotional words and the article details such as journal name, publication year, and authors details. For answering the research question 2, we applied user centered design (UCD) (Norman & Draper, 1986) method to design and develop an

application concept. In the UCD process, semi-structured interviews were used for eliciting the requirements. Finally, based on the findings of research questions 1, 2 and related research we used Jabareen's (2009) qualitative method for building conceptual frameworks to create a conceptual model that presents the core facets of emerging lifelong learning services.

## 3 RELATED RESEARCH

### 3.1 User Experience and m-Learning

A number of diverse definitions has been proposed for UX. Nielsen and Norman (2015) defined UX as the simplicity of a product, which is accompanied by elegance, that users enjoy owning and using. According to ISO (2010), UX is a "person's perceptions and responses that result from the use or anticipated use of a product, system or service." Hassenzahl and Tractinsky (2006) defined three facets of UX: beyond instrumental, emotion and affect, and experiential. The beyond instrumental facet mainly concerns humans' non-functional needs to achieve their goals, such as hedonic aspects that the product or service fulfils. Hassenzahl and Tractinsky (2006) suggested that the advancement of technology has caused interactive products to become not only useful and usable but also trendy and fashionable.

The UX research field has been divided into three distinct eras (Dirin & Nieminen, 2017). The first era, which took place during 2000–2006 was characterized by technical approaches to UX. The second era, which spanned 2006–2010, was defined as the usability of mobile applications. Finally, the third era, which commenced after 2010, focuses on human responses and emotions as UX, where UX arises from the direction of human responses and emotions. Shen (2014) tackled the importance of UX in m-learning through three priorities: (1) content, which involves improving the quality of delivered learning materials; (2) teaching and learning processes, which involves live and synchronized learning; and (3) learners themselves, which involves detecting their emotional states during m-learning. Recent advances in m-learning are aimed at developing applications that are based on users' emotional states, as indicated in the work of Kuderna-Iulian et al., (2015). They developed a multimodal monitoring tool capable of detecting the learner's behavior and emotional state. Furthermore, Zatarain-Cabada et al., (2014) addressed emotional recognition in their system for intelligent tutoring on Android-

based mobile devices. These studies demonstrate that the importance of emotional aspects of UX has already captured the attention of m-learning researchers.

### 3.2 Beyond Functionality and Usability

Mobile devices' coexistence with learners as a supportive tool for learning activities has also changed learners' expectations. Learners now seek a multi-tasking medium that can carry out complex instructions, as discussed regarding the second era of M-learning UX, which was characterized by the requirement to go beyond the device's functionality and applications. Learners' objectives for using a mobile device are more closely related to learning outcomes than to the features and functionality of the device and its applications. The usage of mobile devices and applications is constantly evolving. For instance, the concept of "gamification" (Huotari & Hamari, 2012) is intended to motivate (Deterding, 2012) students to learn through playing games. Hamari et al. (2014) demonstrated that gamification delivers positive effects, although the effects greatly depend on the context in which the gamification is implemented. An example of this is the application of Angry Birds in education (Rodrigues & Carvalho, 2013).

### 3.3 Definition of Lifelong Learning

The term lifelong learning has become popular in research communities with the advancement of technologies and accessibility of knowledge at any time and place. This sounds like a m-learning definition (Mostakhdemin-Hosseini & Tuimala, 2005) which overcomes the traditional education constrain on content accessibility at any time any places. UNESCO (Lee & Tom, 2011) has significant impacts on the life learning over the last four decades. There have been recommendations, frameworks, and conceptual proposals on applying mobile technologies for lifelong learning such as Nordin et al.. Kay (2008) applied the concept of personalized and pervasive computing to assist learners in their learning throughout their lives. The concept has also been promoted by the European Commission (Field, 2010) and (Volles, 2016). The term mobile lifelong learning refers to learning that happens in a context where users pursue to develop competence or update information. This definition indicates that learning happens everywhere and can happen continuously. There have been many initiatives to anticipate solutions for lifelong learning,

such as Nordin et al.'s (2010) m-learning framework that supports systematic lifelong learning experience design. They explored the design factors that focused on mobile environments, basing the factors on the learning theories, mobile environment, m-learning context, and learning experience. The term lifelong learning also appears in artificial intelligence learning algorithm design and development, such as lifelong machine learning (Silver et al.2013), (Ruvolo & Eaton, 2013) and (Chen & Liu, 2016). However, in this article the focus is on lifelong learning from the UX perspective.

### 3.4 Emotions and Feelings

The recognition of emotions and other affective factors have become important in human-computer interaction (Calvo, 2010). Emotional experiences are feelings that inform people about the states and state changes in their belief-desire systems (Reisenzein, 2009). In other words, people have various beliefs and desires that they aim to fulfill (e.g., by engaging in learning activities), their emotional experiences or the emotions been met through the interaction with their surroundings.

Emotions have a subjective, behavioral (arousal), and physiological (bodily) components (Scherer, 2005) that must be analyzed separately (Dirin et al., 2017). Emotions have direct effects on our physical and mental health as well as our attention, memory, learning, judgment, and decision-making for example (Lerner et al. 2015). Therefore, by recognizing emotions, arousing emotions, and regulating emotions, we can properly adapt learning application to match the learner's emotion state.

### 3.5 Learning Awareness and Cognition

We define learning awareness as gaining of knowledge and development of competence whenever and wherever needs on the context and environment where the knowledge is demanded. Learning awareness is not a constrain in the contemporary world where learning contents are available anywhere and anytime. However, acquiring knowledge for competence development in a lifelong m-learning setting requires more than just the availability of knowledge; intrinsic motivations (Rainer Reisenzein, 2009) are essential in order to engage the learner in lifelong learning activities that are typically not governed or facilitated by a formal education system. Intrinsic motivations according to Ryan and Deci (2000) are the natural human tendency to learn and adopt. In a virtual world, also the

learner’s curiosity (Litman, 2005) raise awareness of the learning needs and competence development. Oudeyer et al. (Oudeyer, et al. 2016) findings demonstrate that the curiosity, surprise, and the experience of novelty lead to learning and memory retentions.

Furthermore, learning cognition is important in lifelong learning. Okrigwe (2010) states that the cognitive view of learning depends on the individual’s way of thinking, memorizing or solving problems as their ways of learning and demonstrating the knowledge are different. The cognitive learning theory for multimedia learning, as Mayer (2014) studied, has five cognitive processes: first, selecting the proper words; second, selecting proper images; third, organizing the selected words into coherent verbal presentations; fourth, selecting the images into coherent pictorial representations; and five, emerging the pictorial and verbal representations with prior knowledge. The cognitive load theory provides guidelines to help in presentation of information so that it encourages the learner to optimize their learning based on their individual capacity since the cognitive capacity of the working memory is limited (de Jong, 2010).

### 3.6 Learning Content, Learning Media and Tools

The way a lifelong learning system presents learning contents impacts learners’ motivation to continue learning. Social media, as Dabbagh and Kitsantas (2012) stated, creates a personal learning environment (PLE) which integrates formal and informal learning that supports students’ self-regulated learning. Furthermore, Balakrishnan and Gan (2016) reveal that social media supports various learning approaches, such as participatory, collaborative, and independent learning. Dede (2009) demonstrate that comprehensive and realistic experiences engage learners in immersive interactive digital learning media.

## 4 A LIFELONG M-LEARNING APPLICATION CONCEPT

As an example of potential life lifelong m-learning applications, we present the concept of a basketball shooting application, which helps basketball players and coaches learn and teach, respectively, how to shoot efficiently (Figure 1). Learning awareness must be based on a natural approach; in other words,

learning happens while doing, and here, learning happens in the context of a basketball court. Through the use of contemporary learning tools and media, this can be accomplished without the need to learn a frustrating theory lesson in a classroom.



Figure 1: Lifelong m-learning concept: basketball learning application.

Every basketball player and coach know that the best way to keep improving shooting is to track how experts perform in comparison with the player. By designing an application for a smartwatch that can be worn while shooting, the player can input shot results after every “spot” without having to leave the court to write them down. The smartwatch application is meant purely for inserting results, which are then automatically synchronized to the smartphone application, where the player can see advanced statistics and graphs based on the information from the watch. This application concept was designed and developed in a user experience design course by a group of students.

## 5 RESULTS

### 5.1 Emotional Factors in Lifelong m-Learning

We identified emotional factors in lifelong m-learning by going through the selected articles and publications and categorized the findings in an Excel document. Table 1 presents the journals and conferences and the respective number of articles identified for the analysis.



Table 1: Source forums and publication counts.

No	Journal / Conference	Publication Count
1	World Conference on Mobile and Contextual Learning (mLearn)	21
2	International Journal of Interactive Mobile Technologies (IJIM)	29
3	European Journal of Open Distance and E-Learning (EURODL)	4
5	International Journal of Emerging Technologies in Learning (JET)	9
6	International Journal of Teaching and Learning in Higher Education (IJTLHE)	3
7	Journal of Computer Assisted Learning (JCAL)	17
8	Journal of Online Learning and Teaching (JOLT)	3
9	Computers & Education. An International Journal (Computer & Education)	15
Total		102

We conclude the findings of the SLR in Figure 2 which presents the fluctuation of articles on emotion factors that have been recognized for m-learning applications to improve the user learning experience.

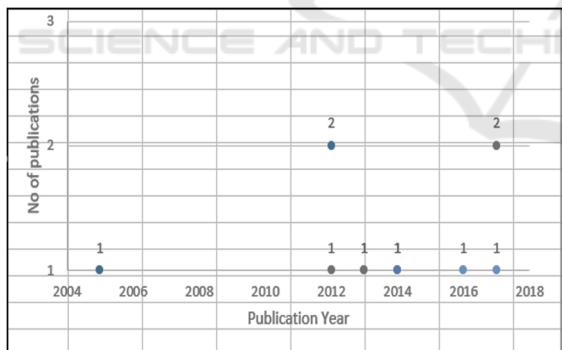


Figure 2: Number of articles identified in the literature review that discuss emotional factors that improve the user experience.

The findings indicate that already at the rise of m-learning applications in 2005 the emotional user experience factors have been recognized as important in application design and development. The development reached its peak point in 2011. The fluctuations continue until 2017. The feelings of trust and security were the researchers’ concerned already during 2005-2007. As soon as m-learning applications became more complex, the feelings of

excitement, empowerment, and effectiveness become evident. In the following, the list of identified emotional factors are presented:

- *Feeling of trust* means “I do not lose my data”. Kim and Moon (1998) identified that the feeling of trust in systems with utility is considered an important part of “emotional usability” .
- Feeling of *reliability* translates to “redundancy, overlapping functionality”. Wixom and Todd (2005) identified that the information accuracy and system reliability results user satisfaction
- Feeling of *security* means “Others do not see my data”, “My information will not be exposed to others”, “I can do mistakes when learning without fearing/being improperly monitored”. The feeling of safety and security during early childhood is a key to pleasurable learning experience (Perry, 2017).
- Feeling of *empowerment* means “The service enables/persuades me to use my full capacity”, and even “I can exceed my skills and abilities”. Bradbury-Jones et al. (2011) identified that empowerment is an important element in nursing education for self-control and self-efficacy.
- Feeling of *being effective and efficient* means “The service helps me learn new knowledge/skill efficiently and effectively”. Marksteiner et al. (2019) demonstrate that student who do not feel belonging has higher risk of dropping out of school, or university and earning poor grade.
- Feeling of *excitement* means “I am delighted when using the service/app”. Reeve et al., (Reeve et al. 1986) demonstrate that excitement has a significant impact on the intrinsic motivation

## 5.2 Evaluation of the Basketball Learning Application

The results of the emotional analysis of the basketball learning application were acquired by the concept developer group of four students at Haaga-Helia University of Applied Sciences who evaluated the usability of the application at the Media Lab. The details of the emotional factors’ evaluation are presented in Table 2. The table comprises the assessed feelings and a description for each feeling in the context of the basketball learning application. Table 2 is the result of the concept designers’ feedback on the given evaluation form which the first and third authors summarized. However, the actual impact of these emotional factors on user experience required additional studies with the real users and real environment. Feelings of security, effectiveness, and

Table 2: Emotional factors associated with the basketball learning application.

<b>Emotional factors</b>
<p><b>Trust:</b>                      Definition: I do not lose my data                      Users' thoughts and feelings: "I believe that my information is saved automatically and can be accessed reliably whenever I want from all my devices."                      Features: The device saves and backup the data regularly in the device and cloud.</p>
<p><b>Excitement:</b>                      Definition: The service thrills me when I explore unexpected features and functions                      Users' thoughts and feelings: "when I throw the ball I can feel the new smart watch captures my shoot – and other players recognize my watch, too. It makes me a professional and dedicated player"                      Features: Vibrations and bright blink when the shoot has been recorded.</p>
<p><b>Empowerment:</b>                      Definition: The service enables/makes/persuades me to use my full capacity. It allows for pushing boundaries and offers easy editing and presentation in various contexts.                      Users' thoughts and feelings: "I am able to follow up my competence development myself and with my peers. I feel that I have develop my techniques this week better than before. The instance feedback keeps my performance and progress to the maximum all the time."                      Features: The service presents positive steps to exceed previous achievements and share the results with peers.</p>
<p><b>Effectiveness:</b>                      Definition: I can find all the necessary functions and services. I can review my performance whenever is needed                      This is faster and more effective than the traditional learning method. The information is retrievable anytime, anywhere.                      Features: I can trace my performance during, after and while practicing with the different devices.</p>
<p><b>Security:</b>                      Definition: My personal information and data is secure and no unauthorized third party may access the information                      The data are encrypted to ensure privacy, but it can still be accessed by the creator easily.                      Features: My information save in a secure environment. I can access the information when I need it.</p>

empowerment are particularly evident. The feeling of empowerment boosts the player's learning and allows the player to reach their full capacity. Effectiveness is the feeling that emerges because the device allows the user to obtain information without having to exert much effort. Since retrieving information is less time consuming, this allows for devoting more time to learning. The feeling of security is addressed through

the provision of valid content to learners, through the integrity of user data, and through the accessibility in the context where the data is needed.

## 6 DISCUSSION

Learning happens in varying, even surprising, locations and situations. Demands for lifelong learning emphasize that learning may happen anytime and anywhere. In addition to the fit to physical and temporal surroundings, appropriateness of the learning experience to the learner's emotional context also affects learning. We know that emotions have powerful and predictable drives for our decision-making (Lerner et al., 2015) and learning outcomes (Trigwell et al., 2012). Trigwell et al. (2012) demonstrated that the experience of positive emotions and a deep approach result in higher achievement, with negative emotions resulting in lower achievement. Therefore, determining how to use emotions effectively to ensure correct judgment is important. Emotional decisions are often spontaneous and fast. Emotions impact our cognitive ability; for example, when the learner is emotionally under stress, cognitive performance decreases. In the following, we revisit the research questions and summarize our answers to the questions. How m-learning user experience factors have evolved in research between 2005-2017?

We identified 102 articles that recommend or explore user experience factors in m-learning applications. Most of the emotional factors were recommended by researchers after 2010, as Table 1 demonstrates. However, contributions specific to m-learning applications are still vague as we do not yet have clear emotional engagement guidelines for m-learning application design and development. This is also the definition of the m-learning that the learning happens in smart phones or tablets. Therefore, the m-learning emotional factors, which identified during SLR also apply to lifelong learning. The case study example can be interpreted as real lifelong learning scenario.

What are the potential emotional engagement factors associated with lifelong learning?

Lifelong learning has become a reality in contemporary life. Therefore, investigating on the motivational factors to engage learners has become self-evident. Emotional engagement is a form of motivational factor that encourages learners for a continuous usage.

Our SLR revealed six emotional factors (i.e. trust, reliability, excitement, empowerment, effectiveness

and security) that previous studies have identified in the context of m-learning. These feelings are recognized to be important in m-learning and hence applicable in lifelong learning application design and development. It is obvious that these feelings are not enough for robust lifelong learning. There are still room for further research and study to identify additional factors.

What are the facets of emerging lifelong learning services?

UX in lifelong learning contributes to a synthesis consisting of situated, emerging learning possibilities that are enabled by pervasive, connected technologies. Furthermore, in learning service development, addressing emotions and feelings complements the compilation of learning materials with learning awareness and cognition, and the learning tools and media. The awareness of the learner's learning profile and strategies (structures for "lifelong learning") enables them to turn emerging situations into learning moments. Positive feelings resulting from a motivating situation and context boost learning outcomes and make it easier for the learner to comprehend and recall the learned content (see Figure 3).

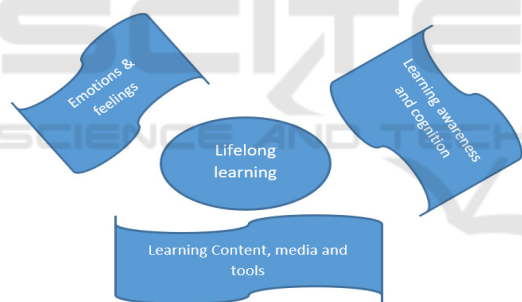


Figure 3. Synthesis of elements contributing to emerging lifelong learning situations.

Jabareen (2009) proposed that the conceptual framework is the network of linked concepts. Accordingly, we define the lifelong learning conceptual model which has three facets. Lifelong learning offerings must consist of the learning awareness which may happen based on the learner's curiosities or other motivational factors. The learning media and the methods provide means to convey content to users. At top of these facets the emotions and feelings ensure the learner's engagement to the lifelong learning offerings.

## 7 CONCLUSION AND FUTURE WORK

Technology advancement and smart gadgets' popularity along with availability of vast amounts of knowledge have made lifelong learning a reality. Moreover, lifelong learners' emotional engagement plays an important role in continuous use. Our literature review revealed that emotional engagement has been a concern of m-learning application research. Therefore, in addition to usability user engagement become more evident that's why we have seen more emotional factors being emphasis. The main justification is that m-learning applications have become more complex and have been capable to deliver independent learning subjects. In addition to emotional factors, learning awareness to trigger learners plays an important role. Furthermore, the learning content and how it is presented to users is another facet of emerging lifelong m-learning platforms.

As a future work we aim to identify more feelings associated with lifelong m-learning and develop sample applications to validate the findings in real lifelong learning contexts.

## REFERENCES

- Balakrishnan, V., & Gan, C. L. (2016). Students' learning styles and their effects on the use of social media technology for learning. *Telematics and Informatics*. <https://doi.org/10.1016/j.tele.2015.12.004>
- Bradbury-Jones, C., Sambrook, S., & Irvine, F. (2011). Empowerment and being valued: A phenomenological study of nursing students' experiences of clinical practice. *Nurse Education Today*. <https://doi.org/10.1016/j.nedt.2010.07.008>
- Calvo, R. a. (2010). Latent and Emergent Models in Affective Computing. *Emotion Review*, 2(3), 288–289. <https://doi.org/10.1177/1754073910368735>
- Chen, Z., & Liu, B. (2016). Lifelong Machine Learning. *Synthesis Lectures on Artificial Intelligence and Machine Learning*. <https://doi.org/10.2200/S00737ED1V01Y201610AIM033>
- Chen, Z., Ma, N., & Liu, B. (2015). Lifelong learning for sentiment classification. *ACL-IJCNLP 2015 - 53rd Annual Meeting of the Association for Computational Linguistics and the 7th International Joint Conference on Natural Language Processing of the Asian Federation of Natural Language Processing, Proceedings of the Conference*. <https://doi.org/10.3115/v1/p15-2123>
- Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and

- informal learning. *Internet and Higher Education*. <https://doi.org/10.1016/j.iheduc.2011.06.002>
- de Jong, T. (2010). Cognitive load theory, educational research, and instructional design: Some food for thought. *Instructional Science*. <https://doi.org/10.1007/s11251-009-9110-0>
- Dede, C. (2009). Immersive interfaces for engagement and learning. *Science*. <https://doi.org/10.1126/science.1167311>
- Deterding, S. (2012). Gamification: Designing for motivation. *Interactions*, 19(4), 14–17. <https://doi.org/10.1145/2212877.2212883>
- Dirin, A., Laine, T. H., & Nieminen, M. (2017). Sustainable Usage through Emotional Engagement: A User Experience Analysis of an Adaptive Driving School Application. *Cognition Technology & Work*, 25.
- Dirin, A., & Nieminen, M. (2017). User Experience Evolution of M-Learning Applications. *9th International Conference on Computer Supported Education 21-23 April*, 9. Porto, Portugal.
- Field, J. (2010). Lifelong learning. In *International Encyclopedia of Education*. <https://doi.org/10.1016/B978-0-08-044894-7.00016-6>
- Halili, S. H. (2019). Technological Advancements In Education 4.0. *The Online Journal of Distance Education and E-Learning*.
- Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? - A literature review of empirical studies on gamification. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 3025–3034. <https://doi.org/10.1109/HICSS.2014.377>
- Hassenzahl, M., & Tractinsky, N. (2006). User experience - a research agenda. *Behaviour & Information Technology*, Vol. 25, pp. 91–97. <https://doi.org/10.1080/01449290500330331>
- Huotari, K., & Hamari, J. (2012). Defining gamification. *Proceeding of the 16th International Academic MindTrek Conference on - MindTrek '12*, 17. <https://doi.org/10.1145/2393132.2393137>
- ISO. (2010). Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems (ISO 9241-210:2010(E)). *ISO*, pp. 1–32. <https://doi.org/10.1039/c0dt90114h>
- Jabareen, Y. (2009). Building a Conceptual Framework: Philosophy, Definitions, and Procedure. *International Journal of Qualitative Methods*, 8(4), 49–62. <https://doi.org/10.1177/160940690900800406>
- Kay, J. (2008). Lifelong Learner Modeling for Lifelong Personalized Pervasive Learning. *IEEE Transactions on Learning Technologies*. <https://doi.org/10.1109/TLT.2009.9>
- Khderna-Julian, B., Marcel, C., & Mireca, V. (2015). A multimodal affective monitoring tool for mobile learning. *14th RoEduNet International Conference – Networking in Education and Research (RoEduNet NER)*, 34–38. <https://doi.org/10.1109/RoEduNet.2015.7311824>
- Kim, J., & Moon, J. Y. (1998). Designing towards emotional usability in customer interfaces—trustworthiness of cyber-banking system interfaces. *Interacting with Computers*, 10(97), 1–29. [https://doi.org/10.1016/S0953-5438\(97\)00037-4](https://doi.org/10.1016/S0953-5438(97)00037-4)
- Kitchenham, B. (2004). Procedures for performing systematic reviews. *Keele, UK, Keele University*, 33(TR/SE-0401), 28. <https://doi.org/10.1.1.122.3308>
- Kuderna-Julian, B., Marcel, C., & Mireca, V. (2015). A multimodal affective monitoring tool for mobile learning. *14th RoEduNet International Conference – Networking in Education and Research (RoEduNet NER)*, 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, M., & Tom, F. (2011). Continuously reaffirmed, subtly accommodated, obviously missing and fallaciously critiqued: Ideologies in UNESCO's lifelong learning policy. *International Journal of Lifelong Education*. <https://doi.org/10.1080/02601370.2010.547619>
- Lerner, J. S., Li, Y., Valdesolo, P., & Kassam, K. S. (2015). Emotion and Decision Making. *Annual Review of Psychology*, 66(1), 799–823. <https://doi.org/10.1146/annurev-psych-010213-115043>
- Litman, J. A. (2005). Curiosity and the pleasures of learning: Wanting and liking new information. *Cognition and Emotion*. <https://doi.org/10.1080/02699930541000101>
- Marksteiner, T., Janke, S., & Dickhäuser, O. (2019). Effects of a brief psychological intervention on students' sense of belonging and educational outcomes: The role of students' migration and educational background. *Journal of School Psychology*. <https://doi.org/10.1016/j.jsp.2019.06.002>
- Mayer, R. E. (2014). Cognitive theory of multimedia learning. In *The Cambridge Handbook of Multimedia Learning, Second Edition*. <https://doi.org/10.1017/CBO9781139547369.005>
- Mostakhdemin-Hosseini, A., & Tuimala, J. (2005). Mobile learning framework. *Proceedings IADIS International Conference Mobile Learning 2005*, 3, 203–207. Malta.
- Nielsen, J., & Norman, D. (2015). The Definition of User Experience.
- Nordin, N., Embi, M. A., & Yunus, M. M. (2010). Mobile learning framework for lifelong learning. *Procedia - Social and Behavioral Sciences*, 7, 130–138. <https://doi.org/10.1016/j.sbspro.2010.10.019>
- Okrigwe, B. N. (2010). Cognition and learning. In *Handbook of Research on Human Cognition and Assistive Technology: Design, Accessibility and Transdisciplinary Perspectives*. <https://doi.org/10.4018/978-1-61520-817-3.ch027>
- Oudeyer, P. Y., Gottlieb, J., & Lopes, M. (2016). Intrinsic motivation, curiosity, and learning: Theory and applications in educational technologies. In *Progress in Brain Research*. <https://doi.org/10.1016/bs.pbr.2016.05.005>
- Perry, B. (2017). Creating an emotionally safe classroom. Retrieved from Scholastic website: <http://teacher>.



- scholastic.com/professional/bruceperry/safety\_wonder.htm
- Reeve, J., Cole, S. G., & Olson, B. C. (1986). Adding excitement to intrinsic motivation research. *Journal of Social Behavior & Personality*.
- Reisenzein, Rainer. (2009). Emotional experience in the computational belief-desire theory of emotion. *Emotion Review*. <https://doi.org/10.1177/1754073909103589>
- Rodrigues, M., & Carvalho, P. S. (2013). Teaching physics with Angry Birds: exploring the kinematics and dynamics of the game. *Physics Education*, 48(4), 431. <https://doi.org/10.1088/0031-9120/48/4/431>
- Ruvolo, P., & Eaton, E. (2013). ELLA: An efficient lifelong learning algorithm. *30th International Conference on Machine Learning, ICML 2013*.
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*. <https://doi.org/10.1006/ceps.1999.1020>
- Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information*, 44(4), 695–729. <https://doi.org/10.1177/0539018405058216>
- Shen, R. (2014). *Constructing a user experience-based mobile learning environment: problems and solutions* (Fernuniversität, Hagen Germany). Retrieved from [http://deposit.fernuni-hagen.de/2984/1/Diss\\_Shen.pdf](http://deposit.fernuni-hagen.de/2984/1/Diss_Shen.pdf)
- Silver, D. L., Yang, Q., & Li, L. (2013). Lifelong machine learning systems: Beyond learning algorithms. *AAAI Spring Symposium - Technical Report*.
- Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., ... Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*. <https://doi.org/10.7326/M18-0850>
- Trigwell, K., Ellis, R. A., & Han, F. (2012). Relations between students' approaches to learning, experienced emotions and outcomes of learning. *Studies in Higher Education*, 37(7), 811–824. <https://doi.org/10.1080/03075079.2010.549220>
- Volles, N. (2016). Lifelong learning in the EU: changing conceptualisations, actors, and policies. *Studies in Higher Education*. <https://doi.org/10.1080/03075079.2014.927852>
- Wixom, B. H., & Todd, P. a. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information Systems Research*, 16(1), 85–102. <https://doi.org/10.1287/isre.1050.0042>
- Zatarain-Cabada, R., Barrón-Estrada, M. L., Alor-Hernández, G., & Reyes-García, C. A. (2014). Emotion Recognition in Intelligent Tutoring Systems for Android-Based Mobile Devices. *Human-Inspired Computing and Its Applications*, 494–504. [https://doi.org/10.1007/978-3-319-13647-9\\_44](https://doi.org/10.1007/978-3-319-13647-9_44)