A REFERENCE MODEL FOR MOBILE PLAYFUL LEARNING ENVIRONMENTS

Jan Maushagen and Olga De Troyer
WISE Research Group, Department of Computer Science, Vrije Universiteit Brussel
Pleinlaan 2, 1050 Brussel, Belgium

ABSTRACT

We propose a novel model for learning environments to target the characteristics of digital natives and to improve informal learning practices, i.e. the exploration, discovery and self-monitoring of learning content and the reflection on learning activities. The Mobile Playful Learning Environment (MPLE) model is defined as consisting of seven main features (mobile user context, data collection and analysis, learner visualization, self-monitoring, persuasion, playfulness, and micro-learning) intended to encourage continuous usage and self-reflection. As a case study we developed TICKLE, an application that implements the MPLE model to re-activate and re-motivate youngsters at risk for school dropout, for learning by stimulating curiosity and engagement through the recognition of non-formal learning opportunities.

KEYWORDS

Informal Learning, Mobile Learning, Playful Learning, Micro-Learning, Digital Natives, Reference Model

1. INTRODUCTION

In general, the traditional way of learning takes place in a classroom environment. In such an environment, the teacher can explicitly observe interaction and participation of the learners. The advantage is that the teacher can provide the appropriate interventions immediately. However, classic classroom teaching frequently faces difficulties. It might be difficult to gain attention from everyone in a large class due to the "one-size fits everybody" approach usually applied. Some teaching methods (e.g., flipped classroom or problem-based learning) can overcome this but may be challenging with a large class size. On the other hand, the ever-widening accumulation and access to information facilitated by modern communication technologies could lead to a situation of no boundaries to knowledge construction. Wherever we are, we can just take our smartphone and follow up the infinite trails of information. This can be considered as informal learning (Sharples et al., 2009) which is characterized as learning integrated with daily routines, triggered by an internal or external event, not highly conscious, and an inductive process of reflection and action. This way of learning could become an important part of lifelong learning (Sharples, 2000), which is the "ongoing, voluntary, and self-motivated" pursuit of knowledge for either personal or professional reasons.

However, in practice, most people are often overwhelmed by the sheer amount of information faced in the digital world. They may not possess the skills to make sense of all of it. Especially digital literacy skills (Ng, 2012), i.e. the ability to locate, filter, compare and judge digital information, and skills in data analysis, become increasingly important in this kind of learning (Gallardo-Echenique et al., 2015). With a steady stream of information and tools available, it is likely to miss out important information. Moreover, when information is scattered across different sources and in different tools, it is hard for users to create a complete mental model of the environment. Especially the so-called digital native learners (Thompson, 2013), born after the 1980s and grown up with digital technology, have an ambivalent relationship with this overabundance of information and tools. On the one hand they are used to a wide range of information technologies in their daily life: "They use search engines and social networks as a first port of call for knowledge unlike older generations who were used to printed press, radio and television" (Helsper & Eynon, 2010). Because information is received fast, they frequently switch activities. They prefer high visual content, animation and interactivity over static textual content (Dresang, 2005; Prensky, 2003). Digital natives expect information to give answers as well as to be engaging (Radford et al., 2007; Helsper & Eynon,

2010). However, the apparent familiarity and competence with computers disguises some worrying problems in information literacy (Pettenati et al., 2009). Fast switching between activities often results in a superficial view rather than an in-depth understanding of information. The speed of young people's information seeking suggests that little time is spent in evaluating information, neither for relevance, accuracy or authority. While independent learning is an admirable aspiration, many learners will continue to require guidance in their learning process. Leaving them entirely alone in learning activities can result in increased dropout rates and demotivation. Therefore, we argue that even for informal learning, a learning environment could provide added value. Such a learning environment should provide ways and guidance to explore interests freely and exploit them for future opportunities from a personal, professional or educational perspective.

In this paper, we introduce the Mobile Playful Learning Environment model that aims to provide a reference model for such type of learning environment. First, we motivate the main features of the model and present the learning pipeline to indicate how the main features interact with each other. Next, we explain how TICKLE, a mobile playful learning environment for youngsters at risk for school dropout was built based on this model. The paper ends with related work and conclusions.

2. MOBILE PLAYFUL LEARNING ENVIRONMENT

To fulfill the demands of digital natives and guide the future development of learning environments in the context of informal learning, we introduce the **Mobile Playful Learning Environment (MPLE) model** that uses the mobile platform to integrate micro-learning with journaling, persuasion, playfulness and visualization techniques to support self-reflection. The nature of the presented MPLE model is conceptual and architectural and should be considered as a reference model.

This section presents and motivates the main features of a MLPE, as well as its learning pipeline.

2.1 The Main features a MPLE

Mobile User Context. The learner's mobile context characterizes the situation of the learner. In e-learning, it is common to use a user profile containing information about the learner (such as personal information, goals, knowledge, interests, preferences, learning history, and possibly also the information about the user's context (such as location, time and device)) (Zhou & Rechert, 2008). We prefer to use the term Mobile User Context because in a MPLE, the mobile aspect is very important. With a mobile Internet-enabled device the user can connect to the MPLE from everywhere at any time. Information can be associated with locations and a wide field of topic areas such as history, culture, and sports to extend excursions or informal strolling through the neighborhood with up-to-date content. Therefore, the mobile user context includes information about the current position of the learner, as well as of relevant objects, like point of interests, in the public space. We distinguish the following dimensions for the mobile user context:

- The **personal context** contains personal information such as past learning behavior, current progress in learning activities, learning styles, cognitive abilities and learning goals.
- The **location context** includes learner's current location and previous location history.
- The **social context** includes information about peers in the learning communities.
- The **technology context** contains information about technology used or available (mobile, desktop or wearables) and their characteristics (e.g., GPS precision, touch input, screen size).

Data Collection and Analysis. To construct and keep the mobile user context up to date, but also to support the self-reflection, data needs to be collected and analyzed. Hence the need for data collection and analysis. Static user data can be collected in the traditional way (e.g., by questionnaires or from external sources), but the dynamic data needs to be collected by the MPLE. This data collection involves recording the interaction of the learner with the MPLE, stored as so-called learning traces. These are granular snapshots of student activity. The most basic kind is a "page-visit" trail in the environment (Clemens et al., 2018). Other learning traces include moving to a point of interest, performing a learning activity, or adding an interest to one's profile. These traces should be logged for later analysis, e.g. to create a historical log of the user's actions across time.

Learner Visualization. Information visualization has been proven to be a powerful means to present large amounts of information and give people insight and is thus a perfect choice to make various types of context information and learning traces visible to the learner, in order to provide structure, awareness and guidance. Visualizations can provide support for improving awareness on learning, for instance along a timeline. Moreover, they can aggregate data, such as participation rates in events and message reply delays, into a set of high-level indicators that can be displayed to learners (Govaerts et al., 2010).

Self-Monitoring. It is important that a MPLE offers resources for self-reflection on activities, learner context and peers to gain awareness of learning behavior. We propose to do this by providing journaling, which means automatically journal keeping by gathering learning traces and augmenting them with additional information. This can offer advice and guidance for future learning such as highlighting missed learning opportunities or recommending new learning material. In this process, also narration could be used as a mode of presenting events within a context. Many people perceive information as unrelated facts if they do not find personal value in them, but when it is placed in the context of a story, it is easier to find connections of personal interest and thereby improve recall, interpretation and synthesis of knowledge (Lambert & Hessler, 2018). These principles should be combined with an adaptive and personalized approach, meaning that what will be offered, how and when, should be adapted to the needs of the individual learner and be dynamically responsive to the learner's behavior.

Persuasion. To stimulate continuous use of the learning environment, persuasion strategies (Cialdini, 2001) are recommended. Mobile technologies create special opportunities for persuasive strategies, because they are closer to the human than any other device and used ubiquitous and pervasive throughout life; people have them with them all the time. Mobile platforms can more easily motivate people to achieve their own personal goals. According to (Fogg, 2002), it can layer information into our lives in a way that changes our behavior. This persuasion power has been shown in many domains, including marketing, healthcare education and environmental sustainability (Thieme et al., 2012). Mobile devices enable access to location, personal photos, movement acceleration or document access history. By exploiting these capabilities, they can use the personal data flows coming from mobile devices to persuade the user to change behavior positively.

Micro-Learning. We propose to use the concept of Micro-Learning which assumes that people can learn better and more effectively when the content is broken down into digestible parts (Kovachev et al., 2011). Learning in small steps better fits the way people consume information today on the Web, i.e. in terms of small text or status updates (Bruck et al., 2012). Following this approach, the role of the content creator is to create small learning activities that can be interwoven into the daily life of the learner. MPLE should deliver them in small self-contained context-related learning activities and provide users with instant feedback.

Playfulness. Next to the use of persuasion, the integration of game-based concepts familiar to youngsters, such as obtaining rewards, could be a way to motivate learners to use the environment. This is known as gamification. Game mechanics, such as points, badges, leaderboards, avatars or stories, can be integrated into the environment to scaffold playfulness. However, note that playfulness is not the same as gamification. Adding game elements can make a system more fun but it is by no means sufficient. It is not because one can earn points or badges with a learning activity that the activity will be perceived as fun. Moreover, some people may perceive some game elements such as points, badges and leaderboards, as annoying or childish. Play is an activity engaged in for enjoyment and is often a voluntary activity (Plass et al., 2015).

2.2 The Learning Pipeline of a MPLE

A pipeline (see Figure 1) is used to show how the user's mobile context and the micro learning can generate learning traces that can be visualized to turn awareness into insight. The figure shows how a MPLE's components, realizing the features mentioned above, interact and contribute to the final goal.

The Mobile User Context and Micro-Learning components contain all information needed for the extraction of learning traces, which happens in the Data Collection and Cleaning component. This data is further analyzed in the Data Analysis component. The Learner Visualization component is responsible to make the learning traces and analysis results visible. For instance, in this way, the learner can realize that (s)he crossed each week a famous monument with a long history in the city that can nurture her or his interest in that topic. These events are narrated with the help of Journaling Techniques to help generate awareness of the learning activities, which is needed to trigger the Self-Reflection, i.e. a cognitive process where insight is

formed about learning problems and opportunities. The goal of this phase is to reinforce learning behavior by having the learner returning to the Micro-Learning component and perform more learning activities. For example, by revisiting all informal learning activities of the past week (which included several trips to museums of city planning) the learner can realize that (s)he has a deeper interest in the history of architecture and could decide to perform more learning activities related to this topic. The Persuasion component is used along the process to persuade the learner to keep using the MPLE. For this, persuasive techniques such as notifications, recommendations, rewarding, investments or tunneling can be used. For instance, recommendations can propose trips to related museums or monuments. To increase engagement of the MPLE, the Playfulness component is used to enrich the interaction with the system in a playful manner.

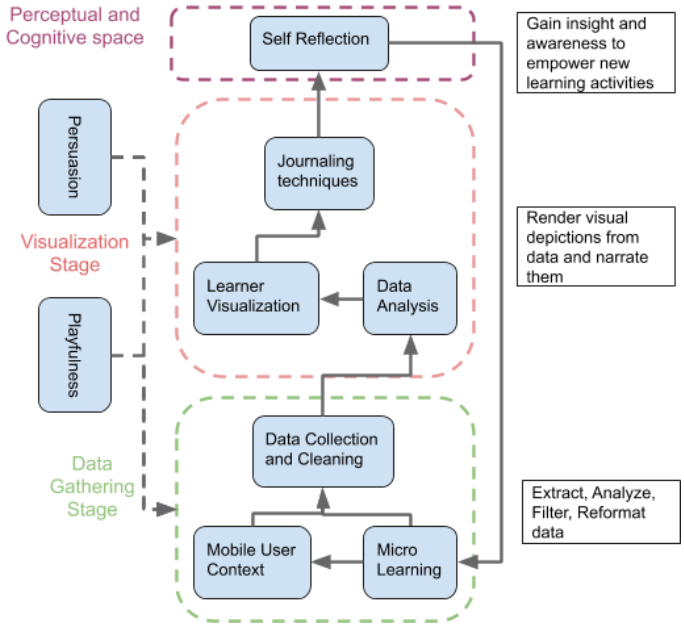

Figure 1. Learning Pipeline for the MPLE Model

3. AN EXAMPLE MOBILE PLAYFUL LEARNING ENVIRONMENT

TICKLE is a MPLE developed in the context of a project dealing with school burnout (https://wise.vub.ac.be/tickle/). School burnout refers to exhaustion at school, a cynical and detached attitude towards school, and feelings of inadequacy as a student. It often precedes school dropout, which has a great impact on further life (Walburg, 2014). The goal of TICKLE is to re-activate and re-motivate youngsters for learning through the recognition of non-formal learning opportunities. TICKLE, including its evaluations, is described in detail in (De Troyer et al., 2019) and (De Troyer et al., 2020). Here, we focus on how the main features of a MPLE are realized in TICKLE.

Micro-Learning & Mobile User Context. Micro Learning Activities (LAs) are the core unit of interaction to provide playful learning experiences. They are formed around new media (text, voice, music, graphics, photos, video) and situated in the personal context and interests of a youngster. The youngster's mobile context plays an important role, e.g. based on a youngster's personal interest in racing cars and current location, the platform could recommend a LA which can take place in a museum nearby. The LA could utilize augmented reality to exemplify the workings of an engine of a racing car. In principle, LAs can be located anywhere and performed anytime and they are explicitly not bound to a school context. LAs are embedded in cards, called ChallengeCards (see Figure 2a for an example). These cards provide an intuitive way to provide and access background information needed to successfully perform the challenge (i.e., the LA). ChallengeCards can be presented either purely digital (on a mobile device) or in mixed reality. For instance, the virtual card can be accessed by a youngster on his/her mobile device while standing relatively

close to the physical location associated with the ChallengeCard. Or a real physical card (e.g., made from cardboard) can be placed on a physical location and the attached QR code can be scanned to reveal the corresponding ChallengeCard on the mobile device. Figure 2b shows the map view of the app providing the youngster an overview of ChallengeCards and their location in the environment.

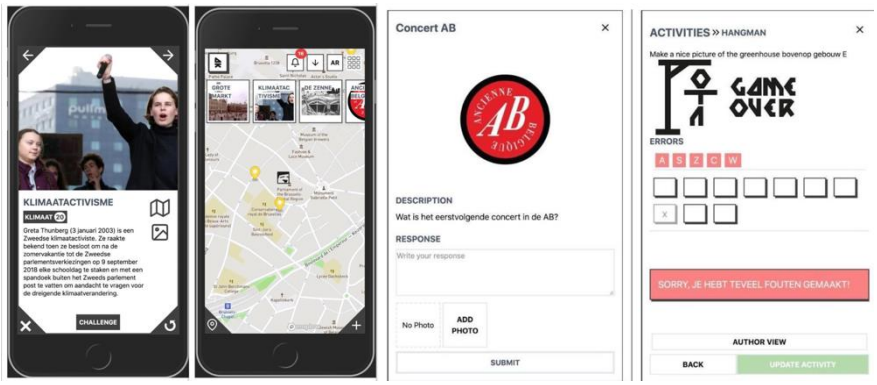

Figure 2. a) Front side of a ChallengeCard; b) Map View of the TICKLE App: c) Photo Challenge d) Hangman

Playfulness. Playfulness is achieved by a combination of gamification and story elements. First, ChallengeCards can be collected, i.e. by succeeding in the challenge. Challenges can, for instance, include mini games, such as a Photo Challenge (i.e. the user must find a certain artifact and take a photo of it) (see Figure 2c) or a Hangman (i.e. the user must guess letters of a word. When too many mistakes are made a hangman is shown) (see Figure 2d). The architecture of TICKLE allows the integration of third-party LAs, such as the widgets from BookWidgets (BookWidgets, 2020), which range from timelines to 'fill the gaps' texts.

Moreover, each ChallengeCard is associated with some topics and a certain number of points (called Experience Points (XP)) (per topic) that can be collected by successfully performing the challenge. The XPs are saved in a wallet and can be used to buy rewards, such as badges, cinema tickets, or reduction coupons, or to unlock more content. Story elements are realized with the use of notifications and the Diary. The Diary keeps track of assessed and collected ChallengeCards and highlights special events, e.g. a streak of collected cards without failure; the completion of a card set; the exploring of a new neighborhood; etc.

Persuasion. Re-activating youngsters with school burnout implies a behavior change. To achieve this, we followed the Hook Model (Eyal, 2014). The principle of the Hook Model is to gradually replace external triggers to provoke a certain behavior, by an internal trigger, such as emotions of joy, fear or boredom. When the external trigger is not needed anymore to trigger the desired behavior, the new behavior has become a habit. We realized the Hook Model as follows. At the start, there are external triggers which prompt the user what to do next. In this phase, TICKLE takes the hand of the youngster by providing guided tours and notifications. To make it easy, the app also provides exact routing on how to find the physical location of these ChallengeCards. With more progress in terms of collected ChallengeCards and explored areas of interests, the app becomes more open and provides more freedom to the youngster, but notifications are still used to point the user to interesting opportunities. The notifications use persuasive messages tailored towards the personality of the youngster (currently using the Big Five taxonomy (Jia et al., 2016) and HeXad (Tondello et al., 2016)). The persuasive principles used in the notifications and feedback are derived from the literature, e.g. (Cialdini, 2001; Kaptein et al., 2011).

Learner Visualization & Self-Monitoring. As mentioned above, the Diary is keeping track of the youngster's activities. The diary is presented in a visual format to facilitate revisiting collected ChallengeCards, exploring related ChallengeCards, or perform the challenges not done yet. To create a coherent user story, the diary couples the presentation of the in-app events with personal data. For instance, GPS data is used to determine visited places or participation in social events such as concerts or museum visits. Figure 3 shows four important parts of the TICKLE Diary (from left to right):

A. Collected XPs are visualized in form of bar charts to give an overview of strengths and weaknesses.
B. Radial visualization showing nearby ChallengeCards by their distance to the youngster's location.
C. The topics associated with the ChallengeCards are visualized by Bubble Sets (Collins et al., 2009).
D. The timeline view shows ChallengeCards based on the point in time when they have been collected/accessed. By opening a context menu, the user can access related ChallengeCards.

Figure 3. Screenshots of four important functionalities of the TICKLE Diary

Furthermore, when the user has collected a fair amount of ChallengeCards, (s)he also gains access to the card authoring system. From then on, the youngster is not a bare consumer of information anymore, (s)he is also encouraged to become a producer of ChallengeCards and to create new ChallengeCards for his/her peers. This card creation activity is an important part of the reactivation process because it demands creativity and imagination which are important skills for learning and for youngsters' self-esteem.

4. RELATED WORK

In this section, we provide an overview of related work, i.e. models and frameworks in the domain of technology enhanced learning.

In formal education, Learning Management Systems (LMS) are the main tools to provide structure and support for learning (Alias & Zainuddin, 2005). The LMS allows teachers to quickly distribute course content, assignments and announcements. Students can submit assignments through digital drop boxes and teachers can grade the work within the system. Traditional LMSs are teacher or institution centric, because the course structure and content are created by the teacher. Student initiated activities and interactions are mostly limited to content consumption. Whereas LMSs help to make teaching processes more efficient by streamlining content management, delivery, grading and analytics, they neglect informal learning activities.

Attwell (2007) and Vassileva (2008) acknowledge that modern learners have new patterns of information access, attention, and preferences which cannot be satisfied by LMSs. Therefore, they proposed the Personal Learning Environment (PLE) in which learners utilize a collection of resources and tools (e.g. search engines, blogging, social networks) to take control over their learning. PLEs are the opposite of LMSs.

Open Learning Networks (OLN) help to bridge the gap between PLE and LMS (Mott & Wiley, 2009). They consist of a series of modules that connect existing LMSs with web-based tools, applications, content stores, and a service layer that allow them to function together seamlessly. Until now, not many implementations of OLNs have been realized. (Wilson et al., 2009) described an extension of the Moodle LMS using the W3C Widget and the Google Wave technology which enabled to use informal learning functionality inside Moodle. Unfortunately, Google Wave was discontinued in 2012. García-Peñalvo et al. (2013) present a service-based framework to facilitate interoperability between a OLN and an LMS. However, OLN mainly remains a theoretical concept and has not been widely adopted by schools or universities.

As part of the Lifelong Learning initiative, Smart Learning integrates formal/informal learning and frees the learner from the space and time limitations of the traditional classroom (Temdee, 2020). Smart Learning focuses on the adaptability of learning content and presentation techniques based on the user's context which does not only include current location but also preferences, deficits and learning objectives to improve and accelerate learning. Learning environments that support this type of learning are called Smart Learning Environments (SLE) (Gros, 2016; Hwang, 2014; Spector, 2014). The 3Es meta-model (Jonathan Michael Spector, 2014) already highlighted the importance to promote engagement, i.e., the SLE must be capable of motivating and sustaining continuing interest and participation of a variety of learners. Besides providing learning activities to the learner, Koper (2014) argues that the key to engagement is the conditioning of the

environment of the learner by providing positive and negative feedback, incentives, and contingencies. This means that there is an important overlap between the features of a SLE and a MPLE. The difference is in the emphasis on mobile and playfulness for MLPE, and a greater focus on the smart aspect in a SLE.

5. CONCLUSION

Even though modern communication technologies could lead to a situation of no boundaries to knowledge construction and thus independent learning, many learners require guidance in their learning process. Therefore, this paper proposes the Mobile Playful Learning Environment (MPLE) model that proposes a reference model for a new way of learning, mainly based on the concept of informal learning and taking into consideration characteristics of digital natives.

Our MPLE model combines seven features, among which persuasion and playful elements to encourage continuous usage and engagement. The other five features are Mobile User Context, Data Collection and Analysis, Learner Visualization, Self-Monitoring, and Micro-Learning. The aim is to support a learner in self-monitoring the progress of the learning activities for the purpose of self-reflection. The mobile context is crucial for a more informal learning approach. Learning progress should be collected, analyzed and presented to the learner with the help of playful, visualization techniques to facilitate self-reflection. Learning content is presented in small chunks, following the micro-learning approach. To exemplify the MPLE model we discussed TICKLE, an app to re-activate and motivate youngsters at risk for school dropout.

REFERENCES

Alias, N. A., & Zainuddin, A. M. (2005). Innovation for better teaching and learning: Adopting the learning management system. Malaysian Online Journal of Instructional Technology, 2(2), 27–40.

Attwell, G. (2007). Personal Learning Environments-the future of eLearning? Elearning Papers, 2(1), 1–8.

BookWidgets. (2020). Create Your Own Interactive Exercises and Automatically Graded Tests in Minutes! https://www.bookwidgets.com/

Bruck, P. A., Motiwalla, L., & Foerster, F. (2012). Mobile Learning with Micro-content: A Framework and Evaluation. Bled eConference. https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1041&context=bled2012

Cialdini, R. (2001). 6 principles of persuasion. Arizona State University, eBrand Media Publication. https://www.pnahfoo.com/image/pnahfoo/image/data/images/learning/cialdini.pdf

Clemens, C., Kumar, V., Boulanger, D., Seanosky, J., & Kinshuk. (2018). Learning Traces, Competence Assessment, and Causal Inference for English Composition. In J. M. Spector, V. Kumar, A. Essa, Y.-M. Huang, R. Koper, R. A. W. Tortorella, T.-W. Chang, Y. Li, & Z. Zhang (Eds.), Frontiers of Cyberlearning: Emerging Technologies for Teaching and Learning (pp. 49–67). Springer Singapore.

Collins, C., Penn, G., & Carpendale, S. (2009). Bubble sets: revealing set relations with isocontours over existing visualizations. IEEE Transactions on Visualization and Computer Graphics, 15(6), 1009–1016.

De Troyer, O., Maushagen, J., Lindberg, R., & Breckx, D. (2020). Playful Learning with a Location-Based Digital Card Environment: A Promising Tool for Informal, Non-Formal, and Formal Learning. Information. An International Interdisciplinary Journal, 11(3), 157.

De Troyer, O., Maushagen, J., Lindberg, R., Muls, J., Signer, B., & Lombaerts, K. (2019). A Playful Mobile Digital Environment to Tackle School Burnout using Micro Learning, Persuasion Gamification. 2019 IEEE 19th International Conference on Advanced Learning Technologies (ICALT), 2161-377X, 81–83.

Dresang, E. T. (2005). Access: The Information-Seeking Behavior of Youth in the Digital Environment. Library Trends, 54(2), 178–196.

Eyal, N. (2014). Hooked: How to Build Habit-Forming Products. Penguin.

Fogg, B. J. (2002). Using Computers to Change What We Think and Do. Morgan Kaufmann Publishers Inc. San Francisco.

Gallardo-Echenique, E. E., Marqués-Molías, L., Bullen, M., & Strijbos, J.-W. (2015). Let's talk about digital learners in the digital era. The International Review of Research in Open and Distributed Learning, 16(3). http://www.irrodl.org/index.php/irrodl/article/view/2196/3337

García-Peñalvo, F. J., Conde, M. Á., & Del Pozo, A. (2013). A Mobile Personal Learning Environment Approach. Virtual, Augmented and Mixed Reality. Systems and Applications, 132–141.

Govaerts, S., Verbert, K., Klerkx, J., & Duval, E. (2010). Visualizing Activities for Self-reflection and Awareness. Advances in Web-Based Learning – ICWL 2010, 91–100.

Helsper, E., & Eynon, R. (2010). Digital natives: where is the evidence? British Educational Research Journal, 36(3), 503–520.

Jia, Y., Xu, B., Karanam, Y., & Voida, S. (2016). Personality-targeted Gamification: A Survey Study on Personality Traits and Motivational Affordances. Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, 2001–2013.

Kaptein, M., Duplinsky, S., & Markopoulos, P. (2011). Means based adaptive persuasive systems. In Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11. https://doi.org/10.1145/1978942.1978990

Koper, R. (2014). Conditions for effective smart learning environments. Smart Learning Environments, 1(1), 1–17.

Kovachev, D., Cao, Y., Klamma, R., & Jarke, M. (2011). Learn-as-you-go: New Ways of Cloud-Based Micro-learning for the Mobile Web. Advances in Web-Based Learning - ICWL 2011, 51–61.

Lambert, J., & Hessler, B. (2018). Digital Storytelling: Capturing Lives, Creating Community. Routledge.

Mott, J., & Wiley, D. (2009). Open for Learning: The CMS and the Open Learning Network. In Education, 15(2). https://ineducation.ca/ineducation/article/view/53

Ng, W. (2012). Can we teach digital natives digital literacy? Computers & Education, 59(3), 1065–1078.

Pettenati, M. C., Cigognini, M. E., M.C. Guerin, E., & Mangione, G. R. (2009). Personal Knowledge Management Skills for Lifelong-Learners 2.0. In Handbook of Research on Social Software and Developing Community Ontologies (pp. 298–315). IGI Global.

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of Game-Based Learning. Educational Psychologist, 50(4), 258–283.

Prensky, M. (2003). Digital game-based learning. Computers in Entertainment (CIE). https://dl.acm.org/doi/abs/10.1145/950566.950596

Radford, M. L., Connaway, L. S., Agosto, D. E., Cooper, L. Z., Reuter, K., & Zhou, N. (2007). Behaviors and preferences of digital natives: Informing a research agenda. Proceedings of the American Society for Information Science and Technology, 44(1), 1–15.

Sharples, M. (2000). The design of personal mobile technologies for lifelong learning. Computers & Education, 34, 177–193.

Sharples, M., Arnedillo-Sánchez, I., Milrad, M., & Vavoula, G. (2009). Mobile Learning. In N. Balacheff, S. Ludvigsen, T. de Jong, A. Lazonder, & S. Barnes (Eds.), Technology-Enhanced Learning: Principles and Products (pp. 233–249). Springer Netherlands.

Spector, J. M. (2014). Conceptualizing the emerging field of smart learning environments. In Smart Learning Environments (Vol. 1, Issue 1). https://doi.org/10.1186/s40561-014-0002-7

Thieme, A., Comber, R., Miebach, J., Weeden, J., Kraemer, N., Lawson, S., & Olivier, P. (2012). " We've bin watching you" designing for reflection and social persuasion to promote sustainable lifestyles. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2337–2346.

Thompson, P. (2013). The digital natives as learners: Technology use patterns and approaches to learning. Computers & Education, 65, 12–33.

Tondello, G. F., Wehbe, R. R., Diamond, L., Busch, M., Marczewski, A., & Nacke, L. E. (2016). The Gamification User Types Hexad Scale. Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play, 229–243.

Vassileva, J. (2008). Toward Social Learning Environments. IEEE Transactions on Learning Technologies, 1(4), 199–214.

Walburg, V. (2014). Burnout among high school students: A literature review. Children and Youth Services Review, 42, 28–33.

Wilson, S., Sharples, P., Griffiths, D., & Popat, K. (2009). Moodle Wave: Reinventing the VLE using Widget technologies. In Proc. Mash-Up Personal Learning Environments - 2st Workshop MUPPLE'09, CEUR Proceedings, Conference, Nize France. http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.375.6460

Zhou, R., & Rechert, K. (2008). Personalization for Location-Based E-Learning. 2008 The Second International Conference on Next Generation Mobile Applications, Services, and Technologies, 247–253.