Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 172 (2020) 784–790

Procedia Computer Science

www.elsevier.com/locate/procedia

9th World Engineering Education Forum 2019, WEEF 2019

Disruptive smart mobile pedagogies for engineering education

P. Punithavathi, S. Geetha*

School of Computing Science & Engineering, Vellore Institute of Technology-Chennai Campus, Chennai-600127, Tamil Nadu, India

Abstract

Mobile technologies are becoming more ubiquitous and multifaceted in today's society. The rise of smart mobile devices like mobile phones, tablets, etc. has sparked a revolution in mobile learning paradigm. Educational researchers have started exploiting the potential and scope of smart mobile technologies in education. The mobile technology embraced by new smart pedagogies, can disrupt the notions of engineering education. We have examined the nature of several smart pedagogies in engineering education and explored the way they intersect with the mobile pedagogies. We have unpacked philosophies of modernization and disruption. We have then discussed smart mobile learning activities for engineering students, together with the pedagogical principles supporting them. We have also outlined the ways to implement 'feasible disruptions' through the smart mobile pedagogies.

Keywords: Disruptive technology; Engineering education ; Learning principles; Mobile learning; Smart pedagogies; Smart learning; Teacher education

1. Introduction

The term "Mobile Learning" or M-learning, is a subset of distance education, educational technology and E-Learning. M-learning motivates learning across several contexts with mobile devices like smart phones, Personal Digital Assistants (PDAs), etc. It is apt to call M-learning using various names like personalized learning, ubiquitous learning, learning while mobile, handheld learning, anywhere /anytime learning, etc. The M-learning has been defined as, "any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning

* Corresponding author. Tel.: 0-984-255-0862
E-mail address: geetha.s@vit.ac.in

10.1016/j.procs.2020.05.112

that happens when the learner takes advantage of the learning opportunities offered by mobile technologies" [1]. In other words it is defined as, "With the use of mobile devices, learners can learn anywhere and at any time" [2]. Evidently, the term M-learning is defined as the facility to learn and teach via mobile devices.

M-Learning focuses on the mobility of the learner, networking with portable technologies, and scalability with increasing mobile population. For instance, podcasts of lectures can be made available for downloading. Learners can engage with these learning resources though away from the conventional learning spaces. Within a span of ten years, M-learning has grown significantly from a minor research interest to an important learning tool in engineering institutions around the world. M-learning is not merely an aggregation of 'mobile' and 'learning' but also an extension of E-Learning. Since M-learning offers learning while user is mobile makes it different from other types of learning, specifically crafting learning practices that exploit the opportunities offered by mobility.

2. Smart Learning and Smart Pedagogies

In the learning process, the term 'smart' is interchangeably used to define the teaching strategies (i.e. smart education), approaches adopted by educators (i.e. smart pedagogies) and the spaces within which learning occurs (i.e. smart learning environments), and the processes and outcomes experienced by smart learners or students (i.e. smart learning process), as shown in Fig. 1. Smart learning process highlights the sovereignty and freedom of the learner in an environment that is adaptive and responsive to their individual learning needs [3]; [4]; [5]. Smart learning process is a student-centric learning approach. It is entirely different from conventional teaching models which are a teacher-centric learning approach and the learners can hardly access any learning aid.

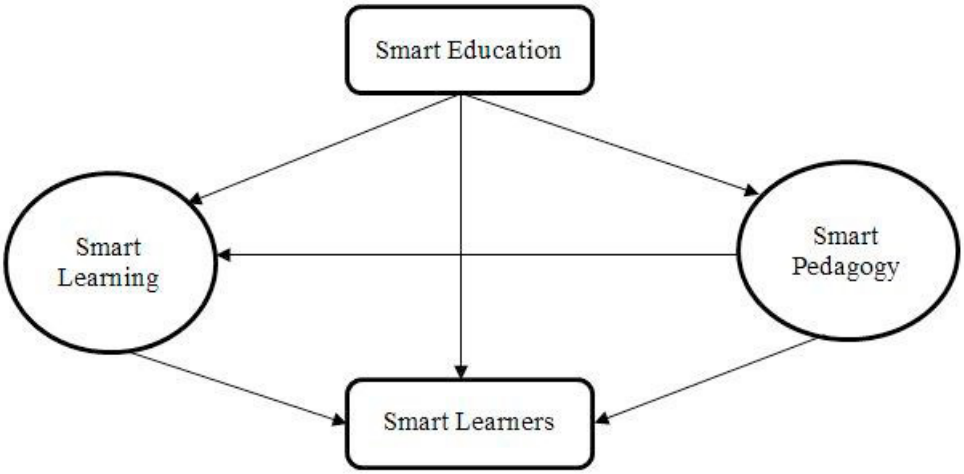

Figure 1. Smart Education Framework

This section is primarily focussed on discussing the components of smart learning and the allied smart pedagogies. The smart pedagogies linger as the driving force behind smart learning, and make smart learning a reality. The analyses of the constituents of smart learning vary as some focus on the technological drivers behind it and others highlight learner-centric and holistic features. The essential components of smart learning are broadly classified as shown in Table 1.

Table 1. Essential Elements for Smart Learning

S. No.	Authors	Essential Components of Smart Learning
1.	Lias & Elias [6]	Highly situated and authentic
2.	Hwang [7] Zhu, Yu, & Riezebos [8]	Responsive and adaptive to changing learning traditions and activities
3.	Kim et al. [3] Middleton, [5]	self-directed , learner-centric and empowering
4.	Hwang [7]	Highly customised and personalised according to the learner
5.	Huang, Yang, & Hu [9]	Interactive and dynamic
6.	Scott & Benlamri, [10]; Hwang [7]	Seamless and highly contextual
7.	Kim et al., [3]	Collaborative, interdependent and highly social

These smart learning components are not entirely new, and many of them such as personalisation, collaboration, and learner-centric approaches have been actively promoted by some educationalists for several decades in order to make learning more purposeful, engaging and meaningful [11]. However, the conditions and technologies are now aligning in ways that make these learning approaches more feasible and achievable than was previously the case. New developments include a combination of technical developments, such as ubiquitous personal devices, rich digital media, cloud computing and learning analytics, allied to the power of social networking and social media in bringing up the smart learning.

2.1. Technological Drivers

Mobile technology is an effective tool to smart education system as they are affordable and scalable. Several mobile technologies are available nowadays to facilitate smart learning. These mobile technologies are collectively constituted by hardware, software and delivery technologies. Figures 2 and 3 show these technologies in a nut shell.

2.1.1. Hardware and Software Technologies for Mobile Learning

The hardware technologies include user terminals like PDAs, smart phones, media players, gaming consoles, compact laptops, tablet PCs, etc. The software technologies include smart learning applications like simple quiz games, M-books, mobile-based Learning Management System (LMS), software providers like Outstart Inc, Short Message Servics (SMS)-based learning tools, software applications-based learning, etc.

2.1.2. Delivery Technologies for Mobile Learning

Delivery technology includes several components that play a vital role in making M-learning a reality. For instance 3GP is used for compressing and delivering audio-visual contents. GPRS provides high speed connection and data transfer rate. Wi-Fi gives connects smart learners and teachers with the resources through internet. Cloud computing can be used for storing and sharing files.

These technologies should be affordable to offer seamless service to the smart learners. The following are the basic qualities to be fulfilled by these technologies. The technologies should be:

- **Highly portable:** These technologies must be available even when the learner is mobile.
- **Independent:** These technologies must be independent so that learners can customize them according to their learning ability, style and knowledge and learning style.
- **Abstract:** These technologies should be abstract such that the learner binds with learning process rather than the technology becoming desperately perceptible and creating ruckus.
- **Adaptable:** The technology should be adjustable to the framework for learning simultaneously while the learner progresses by evolving skills and knowledge.

- **Persistent:** The learner can use the technology to manage learning throughout a lifetime, so that the learner‘s personal accumulation of resources and knowledge will be immediately accessible despite changes in technology.

U**ser-friendly:** The technology must be simple so that there is no pre-requisite or prior training is required to handle them.

Figure 2(a). Software Technologies for Mobile Learning

Figure 2(b). Hardware Technologies for Mobile Learning

Figure 3. Delivery Technologies for Mobile Learning

2.2. Paradigm Shifts: From E–Learning to Smart Learning

The emergence of desktop technologies and web browsers in the 1990s led to the development of E-Learning, but it was inert [12], controlled by the physical infrastructures of the era (e.g. electrical cables and hard-wired Ethernet). Since the technologies were usually procured only by the institutions [13], it lead to a corporate mind-set towards learning in which the individual student had limited agency or control over how they used and interacted with the technology. Consequently e-Learning has tended to resemble traditional, formal learning in its structures, practices and underlying pedagogical approaches [14]. It has supplemented and extended the reach of traditional learning making it available at times and in spaces that were previously inaccessible for learners (e.g. learning at a distance), but the fundamental nature of learning itself has not altered. Indeed, our own research over a number of different studies that include schools, teacher education and universities [15]; [16] suggests educators are exploiting a relatively limited range of m-learning affordances, and it is not common to find mobile technologies used to customise the learning experience of students or to make learning more authentic and realistic.

The promise of smart learning is that it returns control of learning to the student regardless of the context they are learning in. It increases their independence and enables them to feel more empowered which has not been evident in any of the previous technology paradigms:

"Smart learning assumes that the learner is at the heart of their learning: teachers, peers, technologies and the learning environment are, in effect, support actors and props to that purpose." [5]

2.3 Smart Mobile Pedagogies Aligned to Smart Learning

We define smart pedagogies as the teaching strategies, activities and teacher-initiated approaches that support and enable smart learning to flourish. They are not conventional teaching approaches since these would be misaligned with the smart learning principles outlined in this section, particularly those that emphasise the autonomy and agency of the learner.

Table 2. Smart Learning Characteristics and Corresponding Smart Mobile Pedagogy

Smart Learning Characteristics	**Corresponding Smart Mobile Pedagogy**
Location and reliability	Seamless pedagogies that recognise the seamless nature of learning, enabling learners to extend their learning across several contexts
Seamless and contextual	Context-aware pedagogies that offer adaptive and instant support to learners based on circumstantial factors
Learner-centric, empowering and self-directed	Customized pedagogies
Collaborative, social and interdependent	Collaborative pedagogies that encourage and support learners to participate and construct, in networks
Interactive and dynamic	Creative and multimodal pedagogies

Table 2 summarises a selection of possible smart pedagogies alongside the smart learning characteristics they are intended to support. It should be noted that all of these pedagogies are ones afforded by smart devices and ubiquitous connectivity; hence, we use the term 'smart mobile pedagogies'. For the purposes of conciseness, the smart learning characteristics mentioned above have been grouped according to their attributes. The alignment of smart pedagogies and smart learning characteristics provides a clearer idea of what smart mobile pedagogies can encompass. Potentially these pedagogies are inherently innovative and possibly disruptive.

3. Illustrative Examples of Potential Disruption in Engineering Education

To make this confab more substantial, we have examined some works that were found to emphasise on practices which contained pedagogical elements with an ability to potentially disrupt conventional methods in engineering education.

Potts et al. [17] have developed M-learning applications (including quiz-based and touch-based applications) suitable for both the Apple's iOS and Google's Android platforms. They have examined the effect of the applications on the electrical engineering students at the University of Tennessee. The applications have positive influence on the learner and increased their self-learning ability.

Redondo et al. [18] have studied the influence of M-learning and Augmented Reality (AR) in Architecture and Building Engineering. The study was performed to compare the learning performance of two groups namely:

(i) Experimental group – which has a group of students who can visualize a virtual model created by them or their teachers, in order to evaluate an architectural proposal or a construction detail

(ii) Control group – which has a group of students without required facilities but still a part of the course

The experiments carried out have confirmed that M-learning and AR combined with Cloud computing environment creates a new paradigm of continuous and self-learning.

Li and Wang [19] have studied the impact of iPad-based M-learning in teaching creative engineering. The study has been conducted in a secondary school in England which has adopted Problem-based Learning (PBL) methodology in teaching. The results show that iPad-based M-learning is compatible with the PBL pedagogies behind creative engineering module, both practically and philosophically.

Mallya and Srinivasan [20] have made an attempt to study the impact of cloud computing on M-learning competencies of engineering students. They have also studied the performance of learners by investigating the influence of this innovative teaching technique on course outcomes. The rewarding results of the study have an encouraging influence on learning competencies of the learners.

Peramunugamage et al. [21] have studied the effects of mobile plug-in of Modular Object-Oriented Dynamic Learning Environment (MOODLE) for PBL. The results of the study indicate that the students were very much interested to work with mobile plug-in of MOODLE in their learning activities to accomplish the objectives of the course.

4. Conclusion

Mobile pedagogies have been anticipated to be the 'game changer' for some time now, potentially provoking disruptive innovation and bringing higher education into an 'Age of Mobilism'. In spite of these predictions, the use of mobile devices in Educational Institutions has not been disruptive so far, with adopted mobile pedagogies primarily imitating conventional approaches. This survey offers a 'way forward' for breaking out of this cycle and optimising the impact of smart technology use on learning by Engineering students. We argue these principles should be applied to new smart mobile practices that go beyond sustained innovation but at the same time are 'feasibly disruptive' for teachers to implement, within the realities of conservative and often bureaucratic institutions that are resistant to change.

References:

[1] MOBIlearn, "Guidelines for learning/teaching/tutoring in a mobile environment," MOBIlearn, 2003.

[2] M. L. Crescente and D. Lee, "Critical issues of m-learning: design models, adoption processes, and future trends.," *Journal of the Chinese institute of industrial engineers,* vol. 28, no. 2, pp. 111-123, 2011.

[3] T. Kim, J. Y. Cho and B. G. Lee, "Evolution to smart learning in public education: A case study," *Korean public education. Open and Social Technologies for Networked Learning,* vol. 395, pp. 170-178, 2013.

[4] J. Lee, H. Zo and H. Lee, "Smart learning adoption in employees and HRD managers," *British Journal of Educational Technology,* vol. 45, no. 6, pp. 1082-1096, 2014.

[5] A. (. Middleton, Smart learning: Teaching and learning with smartphones and tablets in post-compulsory education, Media-enhanced learning special interest group and Sheffield Hallam University Press., 2015.

[6] T. E. Lias and T. Elias, "Learning analytics: The definitions, the processes, and the potential," 2011. [Online]. Available: http://learninganalytics.net/LearningAnalyticsDefinitionsProcessesPotential.pdf.

[7] G. Hwang, "Definition, framework and research issues of smart learning environments: A context-aware ubiquitous learning perspective," *Smart Learning Environments,* vol. 1, no. 1, pp. 1-14, 2014.

[8] Z. T. Zhu, M. H. Yu and P. Riezebos, "A research framework of smart education.," *Smart Learning Environment,* vol. 3, no. 4, p. 4, 2016.

[9] R. Huang, J. Yang and Y. Hu, "From digital to smart: The evolution and trends of learning environment," *Open Education Research,* vol. 1, p. 75–84, 2012.

[10] K. Scott and R. Benlamri, "Context-aware services for smart learning spaces," *Learning Technologies,* vol. 3, no. 3, pp. 214-227, 2010.

[11] M. Kearney, S. Schuck, K. Burden and P. Aubusson, "Viewing mobile learning from a pedagogical perspective," *Research in Learning Technology,* vol. 20, p. 14406, 2012.

[12] J. Traxler, "Defining, discussing, and evaluating mobile learning: The moving finger writes and having write...," *International Review of Research in Open and Distance Learning,* vol. 8, no. 2, p. 1492–3831, 2007.

[13] R. J. Kannan, P. Punithavathi and N. Sambandam, "Technology Adoption Models–Adoption of ICT in Educational Institutions in India," in *2018 World Engineering Education Forum-Global Engineering Deans Council (WEEF-GEDC)*, 2018.

[14] J. Zhang, "Technology supported learning innovation in cultural context," *Educational Technology Research and Development,* vol. 58, p. 229–243, 2010.

[15] K. Burden and M. Kearney, "Future scenarios for mobile science learning," *Research in Science Education,* vol. 46, no. 2, p. 287–308, 2016.

[16] M. Kearney, K. Burden and T. Rai, "Investigating teachers' adoption of signature pedagogies," *Computers & Education,* vol. 80, p. 48–57, 2015.

[17] J. Potts, N. Moore and S. Sukittanon, "Developing mobile learning applications for electrical engineering courses," in *2011 Proceedings of IEEE Southeastcon* , 2011.

[18] E. Redondo, D. Fonseca, A. Sánchez and I. Navarro, "New strategies using handheld augmented reality and mobile learning-teaching methodologies, in architecture and building engineering degrees," in *Procedia Computer Science*, 2013.

[19] Y. Li and L. Wang, "Using iPad-based mobile learning to teach creative engineering within a problem-based learning pedagogy," *Education and Information Technologies,* vol. 23, no. 1, pp. 555-568, 2018.

[20] R. K. Mallya and B. Srinivasan, "Impact of Mobile Learning in the Cloud on Learning Competencies of Engineering Students," *International Journal of Online Engineering,* vol. 15, no. 9, pp. 80-87, 2019.

[21] A. Peramunugamage, H. Usoof and J. Hapuarachchi, "Moodle Mobile Plugin for Problem-Based Learning (PBL) in Engineering Education," in *2019 IEEE Global Engineering Education Conference (EDUCON)*, 2019.