

# Learning Environment For Software Product Lines Online Learning Applications

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**Abstract**—The process of learning and teaching online learning has undergone many changes in line with technological developments. Education institutions have begun introducing new methods of learning this. However, it needs a huge amount of labor intensive to produce and maintain educational technologies due to its huge size (literacy, vocational education, school education, engineering and medical education) and huge variants (language, dialect). With the growing demand and at the same time would like to reduce the factor of cost, time and effort is long, then the need for an effective solution allowing rapid system development. A Software Product Line (SPL) approach is one of the best methods that can be used to develop an educational software family. The research contributes to the development of online learning SPL by studying issues in online learning SPL, identify appropriate pedagogical approach to online learning environment that is constructivism, and designing constructivist learning environment based on the theory of constructivism and design principles. In this paper, comparison between 10 VLE was tabulated against constructivist learning environment. The comparative evaluation is to discover commonalities and variabilities between online learning applications. The results should be useful as the process of domain analysis that is to document the commonalities and variabilities between SPL members. Hence, it can be used to enhance the feature model for online learning applications.

**Keywords**—learning environment; software product lines; pedagogical approach; online learning

## I. INTRODUCTION

The internet has undoubtedly changed the way people perceive education, and undoubtedly, there is a growing interest in new approaches and innovations particularly for web-based learning. Learners nowadays are knowledgeable in the utilization of smartphones, text messaging and web browsing, thus it is fairly easy to encourage them to take part in online courses. The Internet has really eased the process of content delivery and empowers new learning methods, resulting in the widespread utilization of online learning. Hence, online learning is rapidly changing as the Internet is making everything to be open and readily accessible to everybody. Because the technologies used to produce interesting courses is rapidly changing, thus to remain relevant, course contents should, one way or another, cope with these

changes. Course contents need and ought to be revised periodically to present students with the most recent data

Online education has many aliases, among them: virtual education, Internet-based education, web-based education, and education via computer-mediated communication. The Web-Edu project defined online education based on Desmond Keegan's (1988) characterization of distance education [1]. They described online education as:

- i. the utilization of Internet to offer or disseminate educational matters
- ii. the use of two-way correspondence using the Internet so that students may benefit from the arrangement among themselves, as well as educators, and support staff.
- iii. the partition of instructors and learners which differentiate it from personal education
- iv. the pressure of an educational association which differentiate it from self-study and private coaching
- v. the arrangement of two-way correspondence by means of a PC organize so understudies may profit by correspondence with each other, educators, and staff.

Technologies employed in online-based learning ought to be tailor-made to ensure that they suit their target audience. It is important that these applications can be used in many scenarios to cater [2].

- i. different e-learning platforms;
- ii. different learning strategies, subjects and organization of courses; and
- iii. different environments.

## II. WHY IT IS HARD TO PRODUCE ONLINE LEARNING APPLICATIONS?

Educational technologies can be utilized in different situations and settings. There are powerful tools that are able to assist teaching/learning activities. However, it needs a huge amount of labor intensive to produce and maintain educational

technologies due to its huge size (literacy, vocational education, school education, engineering and medical education) and huge variants (language, dialect). Although several methods exist to tackle this (for example IMS Learning Design, E2ML, PALO, coUML and standards like SCORM, IMS Global Learning Consortium, and AICC), yet, in terms of technology, the effort made is not worth it from an instructor's viewpoint. Unfortunately, the strive in producing and retaining huge scale and different types of educational technologies is commonly perceived as a type of content development and infrastructure management, often overlooking the software engineering aspects of this issue [3].

It is not easy to produce high-quality educational software. It requires a huge amount of capital, time-consuming, and is usually performed in special cases, for example as students' research projects in universities. Studies found that, in extreme cases of highly computer-managed learning, at least 100 hours of programming is needed for one hour of instruction [4]. The process of creating a new interactive system needed by instructors and lecturers is not cheap. This is because there will be extra cost related to specifying, developing and testing the system with the final users which are teachers and students [4].

Developers use different approaches in the process of developing an educational system. Specific approaches are used in specific situations. In the development of systems which offer extreme interactivity tasks, problems during their development include the difficulties to handle component repositories and the absence of a systematic process that is able to support code reuse.

Despite the fact that the project development team may produce a versatile that is adaptable and able to accommodate e-learning application and handle the variations stated before, yet these adjustments need to be manually performed, making it be a troublesome, expensive, tedious and error-prone task.

From the viewpoint of software engineering, endeavors for development and maintaining of such systems is a bit high, including several challenges as stated below [5]:

- i. Insufficient of a uniform product organization and software production process in every e-learning systems
- ii. Insufficient of accessible common items for production and customization in every e-learning systems
- iii. Difficult to share and transfer knowledge and ideas between different fractions of e-learning systems
- iv. No single universally accepted domain understanding and development of the e-learning systems

### III. IMPORTANCE OF SOFTWARE PRODUCT LINES (SPL) IN ONLINE LEARNING APPLICATIONS

One of the most important aspects of online learning applications is on the development and improvement of different software and digital content. The complexity and effort needed to produce and preserve learning technologies can be minimized with Software product lines (SPL) approach.

SPL is a paradigm used to enhance the efficiency of a family of systems as highlighted in Figure 1.1 below. Its goal is to demonstrate a normal situation in software product line. This figure portrays how the aggregated production cost of a set of similar but quite different software products mature with the quantity of software released. In the figure, two plots are given for software product line engineering and single-system engineering approaches [2].

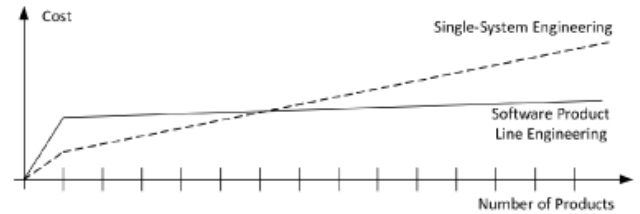


Fig. 1. Cost-effectiveness plots for Software Product Lines

A Software Product Line (SPL) approach is one of the best methods that can be used to develop an educational software family. The importances of SPL in online learning applications are:

- i. less expensive and is able to enhance maintainability during software development code reuse process [4].
- ii. to overcome the limitations of Learning Management System (LMS), and on the other side, to provide institutions with e- Learning applications that fit their own requirements and at the same time share the development work of a set of product using common means of production, in order to reduce the costs and effort of development, maintenance and test, decrease time to market and improve quality. [6].
- iii. SPL can help to the development of software auxiliary applications for e-learning platforms where it carried out practically with no cost in order to fit it with the requirements of a specific customer, since this process is performed automatically. The process is executed by a computer can avoid human mistakes, assuring product quality and reducing cost associated to fixing human mistake. [7].
- iv. the effective utilization of software assets in e-learning, thus reducing considerably the development time and cost of software products. [8].
- v. there is a challenge to produce and maintain online learning systems to be used by large scale and different types of systems with a lot of constraints. Many proofs are available on the use of SPL to improve the efficiency of various domains [5]

#### IV. CHALLENGES IN ONLINE LEARNING SOFTWARE PRODUCT LINES

Although advancements have been seen in SPL approach for online learning, but several issues persist, for example, systematic use and reuse of components available in repositories, restricted interactivity as well as pedagogical methods that stop educators from using the developed systems and software in a bigger educational setting [4]. It also can be noted that technology is not extensively used in the education sector, and the majority of educators are hesitant to use technology to assist in their profession [9].

[10] has stated that SPL may offer a good answer to tackling issues arising from the process of production and maintenance of a family of online learning systems. However, there are several issues that need to be addressed in this aspect:

- i. lack of learning design for the majority of today's advancements. Presently, the majority of the learning approaches utilized mainly concentrate on supporting administrative and managerial aspects of learning.
- ii. instructional design and technology aimed to be used by grown-ups are quite complex. The most important thing is the majority of information pertaining to adult literacy instructional design is not explicitly modeled.
- iii. analytically model different aspects of adult literacy instructional design (i.e. goals, processes, contents and so on)

Recently, [11] thoroughly deliberated several challenges in online learning SPL. One thing to note is such methodologies and courses should be accompanied with an instructional design basis in order to deliver quality learning and teaching that is usually being overlooked in instructional design. Yet, in contrast, present methods do not give the needed emphasis on the said issue.

#### V. CONSTRUCTIVISM AS PEDAGOGICAL APPROACH IN ONLINE LEARNING ENVIRONMENTS

The shifting e-learning paradigm changes the traditional pedagogical practices and online learning environment requires a different pedagogical approach than the one used in the traditional face-to-face teaching environment [12]. The most important condition for the successful implementation of e-learning is the need to consider basic pedagogy, or how learning occurs online. Pedagogy is connected with learning and student achievement, and has been widely accepted on epistemology and empirical factors. Due to this, the issue of integrating e-learning into pedagogical system has recently emerged as an important research focus [13]. Most researchers agree that there is a need to understand the new way of teaching and learning in terms of learning environment and pedagogy for teachers and students. Research on effective pedagogy in the online environment is still in its infancy [14].

In practice, however, this is often the most overlooked aspect in any e-learning implementation process. There are studies in LMS which combine software design pedagogy. These studies show that most LMS vendors deliberately stay away from issues of pedagogy [15].

Constructivism is cognitive learning in which knowledge is accumulated by the active process of construction and not just passive information. Researchers agree that constructivism learning theory, which focuses on building knowledge based on previous learning experiences, is suitable for e-learning, because it ensures learning among students [16]. Constructivism emphasizes construction of knowledge while objectivism mainly with the aim of knowing. This is the fundamental difference between knowledge and learning, both in terms of philosophy and implications for instructional design [17].

#### VI. DESIGNING CONSTRUCTIVIST LEARNING ENVIRONMENTS

Learning environment refers to tools that can be used within the environment or the type of learning that will be delivered within the system. The design of different types of learning environments depend on the learning objectives, target audience, access (physical, virtual and/or both), and type of content. Hence, it is important to know how the learning environment is used, and the techniques that differentiate the variances in learning outcomes [18].

Based on the theory of constructivism, learning environment develops the educational environment and can enhance learning [19]. Educators and cognitive psychologists have applied constructivism to the development of learning environments. From these applications, there are the design principles [20]:

Fig.1. Constructivist Learning Environment design principles



These principles will be integrated with the total learning environment which consists of many sub-environments that are put together to ensure a meaningful and memorable learning experience. Learning does not only occur in classrooms, but it happens all the time and from all sources. In the case of adult learning, the following components are essential in a total learning environment [21] [22] [23]:

- i. Instructive environment - instructional strategies using appropriate media (graphics, animation, simulated scenarios and exercises) to bring this text to life.
- ii. Situating environment - real-life environment is made concrete by situating the learner in the environment of their own culture and context through authentic activities
- iii. Constructive environment- provides a cohesive setting for learning to the extent that the acquisition of new knowledge and contributions to discussion forums
- iv. Supportive environment - cognitive support is provided through the e-resources that are available, literally and metaphorically
- v. Communicative environment - conversational style to create a more personal and approachable interface for the student
- vi. Collaborative environment - peer learning in online teams. Highly contingent upon the communicative environment

- vii. Evaluative environment - Formal and informal formative evaluations (Self-assessment, peer assessment)

## VII. FEATURES AND CAPABILITIES OF ONLINE LEARNING APPLICATIONS

### A. Virtual Learning Environment (VLE)

A virtual learning environment (VLE) is a collection of education tools created to improve students' learning experience by the use of computers and the Internet. The goal of VLE is to enhance students' experience and encourage flexible and exciting education [24]

From the comparative studies by [25], 10 Virtual Learning Environment (VLE) products has been selected, including Moodle, to make comparisons between them, and the first comparison is based on the features and capabilities of VLE tools. The comparison has two answers, Y or N. Y means the product has the feature and N means the product does not has the feature.

The first comparison between the VLE products is based on Learner Tools. Four products are shown to be the best with almost the maximum number of features 15 out of 16 features or capabilities of Learner Tools. These products are Moodle, Desire2Learn, ANGEL Learning Management Suite, and Sakai. This means that Moodle and the other remaining products are strong on Learner Tools. All products have all features and capabilities except Scholar360, TeleTOP Virtual Learning Environment and The Blackboard Learning System (V.7).

The comparison of VLE product that based on support tools contain three kinds of tools: Administration Tools, Course Delivery Tools, and Content Development Tools, and all of these tools have features and capabilities. In this phase, all products have all features and capabilities except Scholar360, TeleTOP Virtual Learning Environment and The Blackboard Learning System (V.7). This means that Moodle and the other remaining products are strong on Support Tools.

The final result shows Moodle 1.8 is the best product, which has missed just 2 out of 40 features. Desire2Learn 8.1, ANGEL Learning Management Suite (7.1) and Sakai 2.3 are equally the second places, which has missed 3 out of the 40. Moodle also is the best of the OSS products. The weakest product is LON-CAPA, which has missed 10 out of the 40. [25].

B. MASSIVE ONLINE OPEN COURSES (MOOC)

MOOCs are a continuation of the trend in innovation, experimentation and the use of technology initiated by distance and online learning, to provide learning opportunities for large numbers of learners [26].

MOOC features from various platforms has been summarizes by researcher [27]. From the table, it can be explained that different MOOC platform offers different features with edX and FutureLearn have the highest features 8 out of 12 while the MEC is the lowest number of features are offered: 5 out of 12. Although Canvas Network has fewer features than edX and FutureLearn, however, Canvas Network is the only platform that offers Adaptive Learning. This table will be used for comparison between online learning applications.

C. Mobile Learning (m-learning)

M-learning is a new form of learning where it uses mobile technology and devices to access to educational materials [28]

The comparison of m-learning solutions [29] compares ARISTOTLE and other m-learning solutions - Active-Campus, Leonardo and MobiLearn in terms of Education, Wireless Technology, Classroom support, Equipment, Groupwork, Announcements and Ambient Intelligence.

In terms of Education, ARISTOTLE and MobiLearn is Blended while Leonardo is distance education. All m-learning solutions have wireless technology and all have classroom support except Leonardo. Leonardo also has a limited groupwork with forum and email while Active-Campus does not has Groupwork. MobiLearn only has Announcements.

From the comparison, ARISTOTLE has all features except Equipment and portal server which ARISTOTLE is the only solution involving ad hoc networking. Even without infrastructure, ARISTOTLE provides services for in-class activities and group learning.

TABLE 1. FEATURES AND CAPABILITIES OF ONLINE LEARNING APPLICATIONS

No	Holistic learning environment	Definition	E-Learning (LMS)	MOOC	M-learning
1	Instructive	The content. Various instructional strategies are employed using appropriate media (graphics, animation, simulated scenarios and exercises)	Courseware catalogue, course documents	Educational video, Audio files, Documents, Presentation files, Hypertexts, Projects	Audio and video-conference
2	Situating	Real-life environment is made concrete by situating the learner in the environment of their own culture and context through authentic activities	Situational problems with interesting solutions	Application, problem, or scenario	Field trips, cooperative education, music, sports, laboratories
3	Constructive	Provides a cohesive setting for learning to the extent that the acquisition of new knowledge and contributions to discussion forums	Discussion board, Synchronous tool, Virtual classroom	Discussions	Discussion board
4	Supportive	Cognitive support is provided through the e-resources that are available, literally and metaphorically	Resource centre to help in making decision E-mail to experts, FAQ, Tips, Threaded Discussion, Access to e-Tutor/Coach, experts, e-classmates	Peer support	Classroom support
5	Communicative	A 'conversational' style to create a more personal and approachable interface for the student	E-Mail, Discussion board, Announcement board, Synchronous tool	Email, Discussion Forum, Popular Social Networks	Announcement
6	Collaborative	Peer learning in online teams. Highly contingent upon the communicative environment	E-Mail, Discussion board, Announcement board, Synchronous tool	Discussions,	Groupwork
7	Evaluative	Formal and informal formative evaluations (Self-assessment, peer assessment)	Tracking system on learner progress Assessment Instructor's and Course evaluation	Quiz tests, Peer assessment	Customized, Performance & improvement-based grading, Real-life cases

Table 1 shows the features and capabilities of online learning applications. This is the result of a referral from the literature review features of e-learning [25] and [21], m-learning [29] and MOOC [27]. These features should be used in online learning applications against constructivist learning environment. This table is useful for comparative evaluation in the next step.

VIII. COMPARATIVE EVALUATION

Table 2 shows the comparison on online learning platform based on constructivist learning environment [25]. The purpose of this comparison is to investigate the existence of pedagogical approach in online learning platforms.

TABLE 2. COMPARISON ON ONLINE LEARNING PLATFORM

No	Learning environment	Tools	LON-COPA	Desire2Learn 8.1	ANGEL Learning Management Suite	TeleTOP VLE	The Blackboard Learning System	Sakai 2.3	dotLRN/OpenACS	Scholar360	Atutor 1.5.4	Moodle 1.8
1	Instructive	Course Management	√	√	√	√	√	√	√	√	√	√
2	Situating	Authentic activities	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Constructive	Discussion Forums	√	√	√	√	√	√	√	√	√	√
4	Supportive	Student Community Building	X	√	√	√	√	√	√	√	√	√
5	Communicative	E-Mail	√	√	√	√	√	√	√	√	√	√
6	Collaborative	Groupwork	√	√	√	√	√	√	√	X	√	√
7	Evaluative	Online Grading Tools	√	√	√	√	√	√	√	√	√	√

In Instructive learning environment, all platforms have Course Management tools. Tools can include courseware catalog, course documents as instructional strategies, while MOOC uses Educational Video, Audio files, Documents, Presentation files, hypertexts, Projects and m-learning uses Audio and video-conferencing.

Situating learning environment indicates learning using Situational problems with interesting solutions as authentic activities, problems, or scenario for students. Such programs include field trips, cooperative education, music, sports, and learning laboratories session. However, no pedagogical approach is defined.

Constructive learning environment requires contribution to discussion forums, thus, all platforms need to use the Discussion Forums. Aside from this tool, Synchronous and Virtual classroom tools can also be used in this environment.

Next, for Supportive learning environment, only LON\_COPA platform that does not use Student Community Building tool. Other tools used include Resource center to help in making decision, E-mail to experts, FAQs, Tips, Threaded Discussion, Access to e-Tutor / Coach, E-classmates, Peer support and Classroom support.

Communicative learning environment is for students to participate in conversations, and E-Mail tool is used by all platforms in this environment. Discussion board, Announcement board, Synchronous and Announcement are other tools that can be used in this environment.

For Collaborative learning environment, only Scholar360 does not use Groupwork tool. This learning environment also uses E-Mail, Discussion board, and Announcement board tools.

Online Grading is the tool used by all platforms for Evaluative learning environment. Other tools used include learner progress Tracking Assessment, Course Instructor's evaluation, Quiz Peer assessment and Performance & Improvement-based grading.

If all the learning environments are consider in the planning and design of online learning platforms, it will create authentic and meaningful learning experiences.

#### IX. CONCLUSION

The problem of developing educational software is not new. When technology developed is inadequate for both teachers and learners [4], it needs labor intensive process to produce and maintain educational technologies due to its huge size. However, the complexity and effort needed to produce and preserve learning technologies can be minimized with SPL approach. Practically, SPL requires no cost since the process is performed automatically. The process is executed by computer, thus it is capable to avoid human mistakes, assure product quality and reduce cost associated to fixing human mistake. Although advancements have been seen in SPL approach for online learning, but several issues persist in the field of instructional design, in specific basic pedagogy or how learning occurs online.

In order to overcome these concerns, this study contributes to the development of SPL online learning by studying issues in SPL online learning identifying appropriate pedagogical approach to online learning environment (constructivism), and designing constructivist learning environment based on the theory of constructivism and design principles. To achieve these objectives, this paper has presented the comparison between 10 VLE tabulated against constructivist learning environment. This comparative evaluation is important in order to discover commonalities and variabilities between online learning applications. The results are useful for the domain analysis process that documents the commonalities and variabilities between SPL members. Hence, the results can be used to enhance the feature model for online learning applications.

#### ACKNOWLEDGMENT

Our profound appreciation goes to Ministry of Higher Education (MOHE) for their financial support in this study.

#### REFERENCES

- [1] E. Sustainable, "Online Education, Teaching, and Learning - Part One," *Online*, no. Page 70.
- [2] P. S. Barreiro, D. García-Saiz, and M. E. Z. Pantaleón, "Building families of software products for e-Learning platforms: A case study," *Rev. Iberoam. Tecnol. del Aprendiz.*, vol. 9, no. 2, pp. 64–71, 2014.
- [3] S. Chimalakonda and K. V. Nori, "Accelerating educational technologies using software product lines," pp. 1–4, 2012.
- [4] D. L. Dalmon, L. O. Brandão, A. A. F. Brandão, and S. Isotani, "A domain engineering for interactive learning modules," *J. Res. Pract. Inf. Technol.*, vol. 44, no. 3, pp. 309–330, 2012.
- [5] S. Chimalakonda and K. V. Nori, "What makes it hard to apply software product lines to educational technologies?," *2013 4th Int. Work. Prod. LinE Approaches Softw. Eng. PLEASE 2013 - Proc.*, pp. 17–20, 2013.
- [6] A. Guendouz, "Customer Satisfaction through E-Learning Software Product Line," no. c, pp. 14–18, 2014.
- [7] S. Pablo, D. Garc, M. Zorrilla, and D. Matem, "Software Product Line Engineering for e-Learning Applications: A Case Study," *Proc. 2012 Int. Symp. Comput. Educ.*, pp. 1–6, 2012.
- [8] F. Ahmed and I. Zualkernan, "A Software Product Line Methodology for Development of E-Learning System," *Int. J. Comput. Sci. Emerg. Technol.*, vol. 2, no. 2, pp. 285–295, 2011.
- [9] S. Chimalakonda and K. V. Nori, "Designing technology for 287 million learners," *Proc. - 2013 IEEE 13th Int. Conf. Adv. Learn. Technol. ICALT 2013*, pp. 197–198, 2013.
- [10] S. Chimalakonda and K. V. Nori, "What makes it hard to apply software product lines to educational technologies? BT - 2013 4th International Workshop on Product LinE Approaches in Software Engineering, PLEASE 2013, May 20, 2013 - May 20, 2013," no. May, pp. 17–20, 2013.
- [11] B. Vogel-Heuser, C. Diedrich, A. Fay, S. Jeschke, S. Kowalewski, M. Wollschlaeger, and P. Göhner, "Challenges for Software Engineering in Automation," *J. Softw. Eng. Appl.*, vol. 7, no. May, pp. 440–451, 2014.
- [12] A. Barefah and E. Mckay, "DESIGNING FOR ONLINE LEARNING ENVIRONMENTS: TOWARDS AN ePEDAGOGY DEVELOPMENT MODEL," pp. 175–180, 2015.
- [13] W. N. Mehanna, "e-Pedagogy: the pedagogies of e-learning," *Res. Learn. Technol.*, vol. 12, no. 3, pp. 279–293, 2004.
- [14] B. J. Carwile, "A Constructivist Approach to Online Teaching and Learning," vol. 12, no. 1, pp. 2007–2010, 2009.
- [15] T. Govindasamy, "Successful implementation of e-learning: Pedagogical considerations," *Internet High. Educ.*, vol. 4, no. 3, pp. 287–299, 2001.
- [16] M. Sharma and S. Chawla, "Designing Constructivist Learning

- Environments Using a Concept Browser,” *Int. J. Recent Technol. Eng.*, vol. 3, no. 5, pp. 70–76, 2014.
- [17] M. (Lingnan U. Tam, “Constructivism, Instructional Design, and Technology: Implications for Transforming Distance Learning,” *Educ. Technol. Soc.*, vol. 3, no. 2, pp. 50–60, 2000.
- [18] J. L. Moore, C. Dickson-Deane, and K. Galyen, “E-Learning, online learning, and distance learning environments: Are they the same?,” *Internet High. Educ.*, vol. 14, no. 2, pp. 129–135, 2011.
- [19] D. Gijbels and G. V. A. N. D. E. Watering, “New learning environments and constructivism: The students’ perspective,” pp. 213–226, 2006.
- [20] D. Jonassen, “Designing Constructivist Learning Environments 1.”
- [21] R. Bhandari, “Making Distance Learning Effective: A New Approach in Maritime Education & Training,” pp. 1–16.
- [22] S. Teo, J. B. Williams, S. Chin, and U. Global, “A Theoretical Framework for Effective Online Learning October 2005,” no. 9, 2005.
- [23] M. A. Embi and N. M. Nordin, “Mobile Learning: Malaysian Initiatives & Research Findings.”
- [24] P. Trafford and Y. Shirota, “An introduction to virtual learning environments,” *Gakushuin Econ. Pap.*, vol. 48, no. 10, pp. 143–151, 2011.
- [25] A. S. Al-ajlan, “A comparative study between e-learning features,” *Tech*, 2012.
- [26] T. Daradoumis, R. Bassi, F. Xhafa, and S. Caballé, “A review on massive e-learning (MOOC) design, delivery and assessment,” *Proc. - 2013 8th Int. Conf. P2P, Parallel, Grid, Cloud Internet Comput. 3PGCIC 2013*, pp. 208–213, 2013.
- [27] S. R. Thakkar and H. D. Joshi, “E-Learning Systems: A Review,” *2015 IEEE Seventh Int. Conf. Technol. Educ.*, pp. 37–40, 2015.
- [28] J. Bahru, L. Academy, and J. Bahru, “A FRAMEWORK OF KNOWLEDGE PERSONALIZATION IN MOBILE LEARNING,” vol. 89, no. 1, pp. 122–132, 2016.
- [29] S. Martín, R. Gil, G. Diaz, E. Sancristobal, M. Castro, and J. Peire, “From e-learning to m-learning through b-learning and s-learning,” *50th Int. Symp. ELMAR-2008*, pp. 341–344, 2008.