OVERVIEW AND ASSESSMENT OF E-LEARNING ECOSYSTEMS IN HIGHER EDUCATION: STANDARDS, STRENGTHS, WEAKNESSES, AND RECOMMENDATIONS FOR AN ENHANCED E-LEARNING EXPERIENCE.

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Abstract *– E-learning evolution strives to keep up with the pace of digital and technological developments; while the variables involved in the formula for successful implementation of online learning initiatives are many, among which can be listed the most relevant interactors in the e-learning ecosystem, namely, e-learning standards organizations, e-learning platform providers, makers of authoring tools, education institutions, and the end users (i.e. learners and educators). This research on e-learning provides overall definitions and a brief historical review of standards, analyzes current trends, assesses strengths and weaknesses, and presents recommendations to enhance the user experience in this field.*

Keywords*: authoring tools, digital interactivity, e-learning, b-learning, m-learning.*

INTRODUCTION

Along with the rise of information technologies in the past decades, also came the development of Information and Communication Technology (ICT) tools aimed to support different types of learning processes. Hardware developments that have highly fostered this step upward in learning methodologies include the creation of the personal computer, the birth and growth of internet with its ever-increasing speed, the introduction of smartphones and other handheld devices that now allow users to carry a minicomputer in their pockets, as well as the advances in software development in the niche of training and education. As plainly put by Wikramanayake: “Advances in digital technology have opened up many avenues of learning. Technology has made information accessible/transmittable from anywhere and by/to all groups of people. Education has reached most parts of the world and IT has become an integral part of human life.” [1, p. 1]

Learning and e-learning

Poltrack, et al. define the learning experience as: “the result of one’s encounter with a learning activity that could take place in an informal, formal, or blended setting. From a learner’s perspective, he or she is experiencing something that results in a change in thinking, understanding, or behavior. This represents a shift from the typical view of content – that somehow learning (and especially learning to do or understand) is transmitted from the content to the learner simply by presenting content to the learner with intent to absorb it.” [7, p. 5]. Furthermore, as put by Cojocariu et al., “The concept of e-learning can hardly be the subject of a comprehensive and universally accepted definition, due to the different forms it takes now and to the multiplicity of variables involved, which have a large and permanent dynamic”. [8, p. 55].

However, after thorough literature review regarding the way different authors define e-learning, it can be summarized that e-learning comprises teaching and learning activities that take place via computer, mobile and online, either inside or outside the traditional classroom [6, p. 1]. From the perspective of Cojocariu, e-learning deals with “instruction, training, retention, transfer, consolidation, evaluation, review, systematization by mainstreaming the 'e' dimension in teaching and learning.” [8, p. 56]. Moreover, Zlatkovic states that e-learning “has created a stimulating and positive climate for many changes in education, so e-learning can reasonably be called a catalyst for change in higher education.”

[6, p. 1]. Additionally, E-learning plays an essential role in today's education because it facilitates the access to educational content regardless of time and place [9, p. 68].

The online learning environments are in constant evolution, and among them we can find: WBT (Web-Based Training), LMS (Learning Management System), LCMS (Learning Content Management System) CLCS (Computer Support for Collaborative Learning), MOOC (Massive Open Online Course) etc. [9, p. 67]. For the purposes of this research, the term e-learning is used to refer to the processes, activities, technology, and resources used for all educational endeavors that take place in digital environments. Therefore, as used in this document, the term e-learning also refers to its derivations, that result from the evolution of e-learning and emerging technologies, such as B-learning (blended learning), M-learning (mobile learning), and U-learning (ubiquitous learning).

Some historical facts on the evolution of e-learning

Over the past years, education industry leaders have been working on the definition of e-learning tools and standards for the next generation. A 15-year-old digital education standard may have become old enough to consider its radical refurbishment or retirement. The SCORM (Sharable Content Object Reference Model) standard was created in 2001 by Advanced Distributed Learning (ADL), a program by the Department of Defense of the United States, and its subsequent updates were mostly aimed to solve flexibility issues. Proposals were presented a few years ago in an effort to devise the next generation of e-learning, the so called next generation of SCORM [7, p. 3]. Different research papers and articles have been written on this issue with the main focus of assessing the state of the art in digital education, to then identify the present weaknesses and strengths, and the opportunities that lie ahead in this field. Asselman, et al outline with regards to the present e-learning systems that "despite all their benefits, these systems have recognized a major obstacle due to poor management of learning time and lack of orientation on the platform." [9, p. 67].

Due to the fact that the most popular digital learning standard at present was developed before the birth and spread of mobile technology, handheld devices, and social networks, it is not difficult to understand why it has not evolved at an appropriate pace, and why the pedagogical merits and learning experiences found in SCORM have been highly limited [7, p. 3]. Although, the advent of the HTML5 standard, born back in 2008 and officially launched in 2014, offered new opportunities in the authoring of e-learning material, its potential does not seem to have been fully exploited in the e-learning community to this day.

In retrospective, nearly a decade ago, Adobe's standard Flash (1996-2020) dominated the scene in the development of educational and training material (among other applications) which was mainly delivered on personal computers either by internet or by means of external storage units (CD's, thumb drives, hard drives, etc.). With the rise of mobile touch devices, with Apple's iPhones and iPads leading development and marketing all over the globe, a new opportunity emerged for the deployment of e-learning material. Nonetheless, Adobe's Flash standard would always struggle to gain momentum on this new type of devices, and eventually, very few smart phones and tablets other than Apple products would effectively offer compatibility with Flash content.

In April 2010, Apple's founder and CEO, Steve Jobs, issued an official message called "Thoughts on Flash" [4] that would clearly state the reasons for the lack of Flash compatibility with their products, and basically with most mobile devices, despite their differences in processors and operating systems. Poor performance, security issues, battery drainage, and no-touch-friendliness, among the most important reasons cited by Jobs, led to the exclusion of this popular standard from the mobile industry. Additionally, his missive explicitly favored the newly-born HTML5 standard over Adobe's Flash. In Jobs' own words: "Flash was created during the PC era – for PCs and mice… But the mobile era is about low power devices, touch interfaces and open web standards – all areas where Flash falls short… New open standards created in the mobile era, such as HTML5, will win on mobile devices (and PCs too)." [4]

Since its earlier stages, SCORM had relied heavily on e-learning content authored with Flash, which offered user interaction features created in ActionScript, the coding language behind Flash. But, despite its long-lived popularity in the PC industry, Adobe Inc. themselves, officially announced its discontinuation as of December 2020, by stating that: "Given this progress, and in collaboration with several of our technology partners – including Apple, Facebook, Google, Microsoft and Mozilla – Adobe is

planning to end-of-life Flash. Specifically, we will stop updating and distributing the Flash Player at the end of 2020 and encourage content creators to migrate any existing Flash content to these new open formats." [10]

At present, SCORM-compliant e-learning modules (SCOs) are developed in HTML5. But it is important to note that not all HTML5 e-learning modules are SCORM compliant. What makes SCORM more desirable than packages authored as plain HTML5, is that SCORM has the ability to communicate with the Learning Management System (LMS) used for delivery, in order to report learners' progress in each e-learning activity, which is essential for learners to earn academic credit.

Traditional content types and interaction

Knowledge has traditionally been transferred via various media, such as text, graphics, animations, sound, and video. Trying to retain learners' attention and to secure long term retention by means of text without supporting images will lead to learning ineffectiveness. [1, p. 3]. On current e-learning environments, these content types are mainly designed or uploaded by using the editing tools provided by each e-learning system, which basically look and work like a word processor that allows different types of digital assets, including the creation of quizzes, polls, or exams.

Considering the end-user experience, learners navigate through course contents by clicking on a link per learning material or content. When completing each activity in a given unit, they will always be required to navigate back to the course index to search for the next activity in the learning unit. With the global spread of touch mobile devices, which offer interactive, visually appealing apps, this type of interaction looks rather primitive and may be the cause of lack of attention and interest on the learner's side, which may lead to academic failure or dropout. It is worth noting that non-interactive video training materials seem to be a major trend in today's e-learning environments, capturing learners' both hearing and sight.

LMSs, LRSs, xAPI, and CMI5

Most of today's e-learning courses are delivered by means of Learning Management Systems (LMS) such as ILIAS, Moodle, Blackboard, etc. These systems offer structured course setup, addition of learners to courses, basic tracking of learners' progress in each course, and reporting capabilities. Each LMS supports different types of e-learning standards.

A Learning Record Store (LRS) is a more recent development, used with the xAPI standard (Experience API, originally known as Tin Can API), which consists of a database that records all learner's interaction within an open learning session. It tracks learners' actions in the form 'actor + verb + object' (e.g. 'John paused the video') not only within an LMS, but on any outside app or environment, even offline. LRSs offer more thorough reports, going beyond completing, passing, or failing an LMS course, and enabling a closer look to the individual learning process or learners' detailed interaction with course materials [11, p. 5]. Some LMSs are starting to adopt the xAPI format, thus extending their compatibility to newer standards. Moreover, the cmi5 standard (Computer Managed Instruction), co-developed and launched in 2016 by ADL (creators of SCORM), can basically be perceived as the combination of both an LMS and an LRS in one single system [5, p. 5].

Table 1 shows a list of the most popular e-learning platforms, indicating their respective type (LMS or LRS), and a summary of their supported e-learning standards. It is clear that SCORM 2004 is the most common standard for e-learning design, and history of e-learning can be defined as pre-SCORM 2004 (Previous versions, and Flash) and Post-SCORM 2004 (in development and gradual adoption, such as xAPI and cmi5). The concept of gamification in e-learning deals with granting learners points by succeeding in e-learning course activities in order to gain badges for public recognition on the LMS and/or social media. This strategy takes advantage of the competitive nature of learners in an effort to foster course completion.

Table 1. Supported E-learning Formats by E-learning Platform

	Supported formats									
	LMS	LRS	AICC	SCORM 1.2	SCORM 2004	HTML5	xAPI/Tin Can	CMI5	VIDEO	Gamification
E-learning System	Year created>>		1988	2001	2004	2008	2013	2016		
Academy of Mine	●	●			●		●		●	
Blackboard (Business)	●	●					●		●	
CourseCraft	●	●		●	●	●	●		●	
Docebo	●	●					●		●	
edX (Harvard/MIT)	●	●		●	●	●	●	●	●	
Google Classroom									●	
ILIAS	●				●	●			●	
iSpring Learn	●	●			●	●	●	●	●	●
LearnWorlds	●			●	●				●	
Moodle	●	●		●	●	●	●		●	●
Open OLAT	●			●	●				●	
Ruzuku	●								●	
SAP Litmos	●				●		●		●	

Source: Authors

SCORM compliant e-learning packages are made via authoring tools. An authoring tool is either a piece of desktop software, an extension (plugin) to another desktop app, or an online service/suite, aimed to design, create, and export e-learning modules packed as one single solution that contains all learning materials, activities and evaluations of a given learning unit. These learning packages can be exported to meet different e-learning standards, depending on the technical specifications of the e-learning platform. Table 2 shows e-learning standards that can be created by means of the most popular authoring tools.

Table 2. Supported E-Learning Standards by Authoring Tool (Source: Author)

Authoring Tool	HTML5	SCORM 1.1	SCORM 2004	xAPI/Tin Can	AICC	CMI5	Video Edition	PPT Import
Adapt	●	●	●					
Adobe Captivate	●	●	●	●	●		●	●
Articulate 360		●	●	●	●		●	●
DominKnow		●	●	●	●		●	●
EasyGenerator		●	●	●				
Elucidat	●	●	●	●				
Gomo Learning	●	●		●				
iSpring Suite	●	●	●	●	●	●	●	●
Lectora Inspire	●	●	●	●			●	●

Source: Authors

Based on the literature review, despite that LMSs use current e-learning standards, they have been structured with little regard to the relevant aspects of human cognitive architecture, or learners' feedback [9, pp. 68, 77]. Furthermore, although educators at higher education institutions may be experts in their respective field of knowledge, institutions may need to assess how well they perform from the pedagogical perspective in digital education. This is of high importance when it comes to tailoring and authoring e-learning materials under standards such as SCORM and subsequent ones, in order to provide an enhanced learning experience.

Additionally, as pointed out by Capogna: "We can recognize a spreading of hybrid models which use distance learning systems in various ways. Very often, they tend to use technology as a vehicle for transmission of learning content characterized by lack of multimedia connotation." [12, p. 46]. This can be explained as the result of implementing an LMS without an accompanying authoring tool that takes advantage of interactive e-learning standards. However, investing in authoring tools without the due training on its use may also cause e-learning authoring to default to the LMS's static content editor.

Course content organization, insufficient orientation on the LMS structure, and poor management of learning time are also counted among the major obstacles found in e-learning. Usually, learners may feel overwhelmed by the large amount of links and digital resources, leading to lack of motivation and dropout [9, pp. 67-68]. Among other weaknesses mentioned by Cojocariu, we can also find: poor customization of the learning process, superficial learning caused by the teaching methodology, loss of direct communication and immediate collaboration between the learner and the educator, and between peers [8, p. 56].

Studies have evidenced that another relevant downside of e-learning systems is their ineffectiveness in fighting drop-out rates. Despite the great benefits found in e-learning digital ecosystems, their tracking and reporting tools still need major improvements to help retain learners through the integration of certain information and communication techniques to benefit from this strength [9, pp. 68-67]. On this regard, Zlatkovic et al. stated that "the activity, motivation, and self-discipline of individuals are key motivating factors for successful teaching. E-Learning guarantees success only for highly motivated learners since learners who study exclusively online are more often susceptible to dropout." [6], [13].

1. General objetive

This research aimed to identify the strengths and weaknesses of current online learning ecosystems in higher education, starting with a historical perspective, present an overview of e-learning standards, and evaluate their implementation to present relevant recommendations for improve online learning.

2. Methodology

Over the past 15 years, online educational platforms have relied on formats that have not evolved much (e.g. SCORM - Sharable Content Object Reference Model), or that tend to be discontinued for cross compatibility issues (e.g. Adobe Flash). This has led to the search for cross-platform standards that allow authoring of e-learning materials for viewing in any type of digital device. In 2014, HTML5 (Hypertext Markup Language, version 5) started to position in the market as an alternate open format to the now soon-to-be discontinued Adobe Flash [2, p. 1] in order to satisfy the new demands posed by developments of Web 2.0 (Community/social web), Web 3.0 (Semantic web, data analysis), and Web 4.0 (mobile web) [3, pp. 811-813].

Regarding the HTML5 standard, Steve Jobs, Apple's cofounder and CEO stated that "HTML5 [...] lets web developers create advanced graphics, typography, animations and transitions without relying on third party browser plug-ins (e.g. Adobe Flash). HTML5 is completely open and controlled by a standards committee, of which Apple is a member." [4]. It is on the HTML5 standard that most new e-learning platforms are being developed. Despite this evolution, the look and feel of training materials in the various platforms found in the market do not vary much from older formats in functionality, although size, portability and security may have improved. On the other hand, at present, learners' interaction with online learning material is roughly recorded and monitored to actually assess the effectiveness of learning methods based on ICT tools. [5, p. 53].

E-learning capabilities caught the attention of higher education institutions, leading them to dive into the digitization of course contents, either in part or in full. Although, it is found that the efforts of higher education institutions in order to deliver training online may require an adjustment in the approach and strategy presently being followed for such purposes. According to Zlatkovic, et al: "Despite the benefits of introducing E-Learning, the problem is related to how E-Learning is implemented, and that is the so-called 'bottom-up' approach that avoids strategic planning for the introduction of E-Learning in higher education. The implementation of E-Learning was done without a strategic plan and without creating the necessary preconditions for the strategic introduction of E-Learning into the existing practice and institutional structure of the university." [6, p. 2]

3. Results

Survey on e-learning at partner universities

Latin American partner universities of the FH Dortmund in the HAW InduTwin program were invited to take part in an online survey intended to measure users' perception of different aspects of their respective e-learning ecosystems. Nearly 500 effective responses were collected from learners in Mexico, Chile, Peru and Colombia between March and May 2020 using the official survey system of the FH

Dortmund (EvaSys). A similar questionnaire was sent out to educators at the same institutions for the same period, adding up to a total 68 responses as of the cut date for this paper (May 4th, 2020). Educators were required to answer one additional question regarding their use of e-learning authoring tools.

A dominating use of Google Classroom (57%) as educational platform was detected. This tool is more suitable for schools as a school-assignment system than as an e-learning platform, now that it is not even an LMS by definition. It does not offer course enrollment, grading, nor reporting tools, just as it is not SCORM compliant. Moodle, a fully-stocked LMS, comes in second with just 12%. Other robust LMSs such as Blackboard or ILIAS do not report use among surveyed universities.

Among the surveyed institutions, the most offered types of digitally supported learning are e-learning (38%), b-learning (17%) and m-learning (13%). This means a mixed offer ranging from courses that require total learner's independence, to educator-supported training via online platform. However, the implementation of m-learning seems to be only in its initial stages. Besides, 21% of respondents are not able to identify which type of online training is offered at their institution.

As for course content types, PDF readings (24%), video tutorials (16%), and audio books/articles (14%) conform the most common way of delivering online learning content. Static and interactive slideshows sum up to 21% of content, and the remaining 25% is distributed among case studies, in-lesson evaluations, simulations, AR, VR, MR, and other content types, meaning an underuse of e-learning potential.

Regarding the means for providing feedback on individual learning progress, e-mail (36%) and instant messaging tools (24%) dominate the scene, followed by synchronous educator-learner interaction via online classrooms (12%) and in-person (6%); and other asynchronous means: online forums (8%) and blogs (6%). Aiming to assess the level of difficulty of key aspects of e-learning platforms, survey takers were consulted concerning their access to the LMS and course content, course navigation, and online communication with educators and peers, resulting in an average 45% in the intermediate range of difficulty, 23% at medium-low, and 25% at low.

When asked to rate the overall quality of various features of the e-learning platform such as security, variety of activities, progress reports, user interface layout and design, and content, an average 51% goes to the intermediate range of satisfaction, while 27% goes to the medium high, and 14% to high. The frequency of e-learning content upload and/or update among surveyed universities placed weekly (54%) and daily (21%) at the top of the list, followed by 12% of survey takers who do not know this information. This means a high frequency of publication of e-learning material. Another aspect that was measured corresponds to the relevance of the e-learning content published on the platform, with a 45% of 'I agree on the whole' responses, and an average 23% on the 'I totally agree'. A third of the responses would show that content and activities may fall into the category of irrelevant/unrelated to course objectives according to respondents.

Intending to assess the pre-conditions on the learners' side for the use of e-learning, 59% of respondents rated the adequacy of their university Wi-Fi infrastructure from average to low, while 50% agree to the statement that they have adequate digital devices to access the e-learning platform. Even more, 68% consider that they have the technological skills required to make use of the e-learning environment provided by their university. Institutions should pay attention to the remaining 32% on this last line, since only 50% consider that enough training is provided on the use of the e-learning platform. When asked to assess the effectiveness of their university's e-learning efforts, 38% would disagree with the statement 'The e-learning material enhances my learning process.' This could be the result of various factors which would require a more in-depth, individual assessment and analysis.

The additional question that educators were asked to respond, i.e. "Which authoring tool(s) is/are in use at your institution?" evidenced that Microsoft PowerPoint leads the list at 30%. As a result of a common practice in order to share PowerPoint slideshows online, it is used in combination with two popular online slideshow services: Google Slides and SlideShare. Prezi, an independent online slideshow service, reports 17% of use in the second place. Kahoot (online interactive quizzes) and video editing software each reports 11%. Interestingly, among the authoring tools known to have the capacity to produce SCORM compliant e-learning packages or HTML5 interactive e-learning apps, only Adobe Captivate shows certain use by reporting 8%.

CONCLUSION

E-learning, when implemented appropriately, is proven to enhance the learning process more than traditional classroom education [9, p. 68]. User satisfaction is essential to increase retention, which means that the learning experience on digital media must be improved to follow new and emerging e-learning standards. Much more can be done in regard to the use of HTML5 and SCORM to provide a more interactive way of delivering content. E-learning course content and activities need to rise above the traditional static objects such as PDF readings, PowerPoint-like sequential slideshows, images, forums, and blogs, among others. Even training dispensed by video can be improved to include more interactivity features.

Mobile learning, and micro learning are not only becoming more popular, but are also a convenient way to allow learners to carry course contents and activities with them at all times. The learning experience on mobile devices should resemble that of a smartphone interactive app to deliver learning material and evaluations, exploiting the potential of these touch devices, which is absolutely feasible under current standards, such as SCORM, xAPI, and cmi5, with the appropriate authoring tools.[12]

Additionally, the integration of social networks to e-learning is an increasing trend, allowing a greater interaction and collaboration of learners and educators with a larger group of peers and experts, thus enriching the learning experience. Data collection of each learning session could lead to a deeper analysis of the learning experience, which might serve as the basis for improvement [7, p. 5].

A successful implementation of an e-learning endeavor at an institutional level requires a structured approach with clearly defined phases. Investment is required in areas such as: research for the right LMS/LRS; investment in technical requirements (e.g. servers and licenses); suitable authoring tool(s); and training on current e-learning standards and trends, and on the use of the LMS and authoring tools. Learners will also greatly benefit from training on the effective use of the e-learning platform in place. Zlatkovic proposes three phases for a systematic approach to the adoption of e-learning technologies and standards by higher education institutions, namely, initialization, implementation and institutionalization [6, p. 2]. Each of these phases requires careful attention at least to the following different aspects: New and under-development e-learning standards, LMS potential and supported standards, compatible authoring tools, training for authors on best e-learning practices and use of authoring tools, educators' and course requirements, learners' learning needs and training on the use of e-learning, and mobile responsiveness, among others.

The development of interactive e-learning modules under state-of-the-art standards fits perfectly into Agile project management methodologies. In connection with this, e-learning development teams would benefit from the inclusion of the framework known as User-centered Design (UCD) in order to ensure that the usability, the interactivity, the user characteristics, the learning environment, the learning activities, and the integration of e-learning modules are correctly defined in order to meet course requirements and learning needs.

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