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The Current and Future State of LMSs
A comparative features analysis

by
Roza Micha

Supervisor
Panagiotis Panagiotidis

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Preface

The terms Learning Management Systems (LMS) or Virtual Learning Environments (VLE) are used interchangeably in the literature, as to describe software solutions, which can be used for the implementation of fully online courses, blended courses, or just to enhance traditional face-to-face ones. Some of them are offered as open source, and thus for free, whereas others are proprietary. Worldwide, Higher Education Institutions and K12 schools deploy LMS solutions in order to achieve educational goals. Besides, the instance of distance-learning programs is gradually developing as the years pass. In a simple research on the net, there can be found many colleges and universities that are willing to evaluate the LMS that are using and consider the available alternatives. Therefore, the purpose of this study is to suggest the “ultimate LMS”, which is actually a synthesis of the most powerful tools that align with the technological trends of today’s world. To that end, we compare the latest versions of five leading (LMS) solutions: Canvas 2019, Sakai 12.5., D2L Brightspace 10.8.9, Moodle 3.5.2+ and Blackboard Learn 9.1., in terms of the features and tools presented. Since we are now found ourselves within Web 3.0 generation, we focus our attention on the technologies that echo this era. The study is organized into four sections. The first section introduces the idea of online learning and elaborates on the reasons behind its advent. Moreover, it aggregates the advantages and disadvantages if this type of learning. Apart from those, it refers to synchronous and asynchronous online learning, explaining the positive and negative aspects of each delivery mode. The second section focuses on LMS and describes the way the four different generations of the Web have gradually changed the capabilities of these platforms. In addition, it includes the latest Market Share Data and reviews on the five major LMS. It also discusses the advantages and disadvantages that accompany their usage. The third section displays both the findings of the current comparative features analysis and LMS comparison and evaluation studies, conducted the last ten years. Finally, the forth section overviews the study and suggests lines for future research.
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1. Online learning

Since the end of the cold war (1980), the term “globalization” has indicated a global restructuring, rather than a simple internalization (Spronk, 2003). The process of this phenomenon has been assisted by technological developments. More specifically, in the mid-1980s, the broad adoption of the personal computer, in conjunction with the Internet and the World Wide Web, has caused fundamental changes in communications technology. The reality is that, with the advent of electronic communications and digital networks, communication and entertainment practices have been reformed. At the current work, we shall concentrate on the tremendous effects of computer communications on people’s need and opportunity to learn. Since communication is oriented at the centre of any educational interaction, the growth of a new learning ecology, which includes multiple media (i.e. textual, visual, audio) and outreaches temporal and regional obstacles, has transformed teaching and learning (Garrison & Anderson, 2003). However, the introduction of Information and Communication Technology (henceforth ICT) not only assists and makes easier the educational practice, but also has caused a significant rise in the educational standards. To put it in other words, nowadays, in order someone to survive, has to be fully-qualified; and this is only possible in the context of life-long learning (Paine, 2003). As a consequence, it becomes overt that ICTs have changed the world and made demands, which are unavoidable.

Reading through the literature, which is associated with the topic of “online learning”, anyone could be aware of the confusion that characterizes the terminology describing the field. Some theorists and researchers make use of specific terms synonymously, whereas some others try to differentiate them, highlighting their nuances. For the purposes of the current study, we shall firstly attempt to define the involved terms, by organizing a classification system, whose parts are mutually connected. We shall conceptualize our taxonomy as having a triangular shape (see figure 1).

“Distance learning” is located at the bottom line of the triangle, since it is the broadest concept. Anohina (2005) has summarized the features of “distance learning”, naming:

- geographical and/or time separation between teacher and learner,
- learner-learner and teacher-learner interaction mediated by any kind of ICTs (correspondence, TV, phone, audio conference, videoconference, course material on Web, radio, satellite broadcasts, videotape, etc.)
- learner’s self-organization of the learning process in accordance with their time, place and pace

- tutor’s role to act as a facilitator, who helps and evaluates the learners and may occasionally arrange some face-to-face contacts.

**Figure 1. The proposed taxonomy**

At the upper level, we could place “e-learning”; a quite vague term that rises conflicting definitions. More specifically, Anohina (2005) has claimed that the prefix “e” expresses the involvement of any electronic medium or environment during the learning process. However, these media do not necessarily display networking features, since they could be audio/video devices, satellite broadcasts, CD-ROMs/DVDs, interactive TVs/phones, offline computers. On the other hand, many scholars put at the core of e-learning not only the new multimedia technologies, but also the use of a network (internet or intranet), which provides exposure to vast knowledge resources and enhance communication, interaction and autonomy (Garrison, & Anderson, 2003; Rosenberg, 2001; Shihi & El Kadiri, 2010). It is worth noting that, although this term is related to the broader and older term “distance learning”, they do not overlap, because “e-learning” presupposes neither the distance between the tutor and the student nor
their di-directional communication (Panagiotidis, 2012). According to Rosenberg (2001) “e-learning is a form of distance learning, but distance learning is not e-learning” (p. 29). Due to the early appearance of the first definition of “e-learning” – in 1997 - very upcoming technological development has resulted in the construction of a new term. For that reason, the terms Computer-based learning/training (CBL/T), Web-based training (WBT), Internet Based Training (IBT), Distributed Learning and Online Learning are being used as synonyms, with the latter one to be invented lately (Panagiotidis, 2012). The learning object can be delivered online, either in a synchronous, or in an asynchronous way. The subsections 1.1 and 1.2 present this subject matter.

1.1. Synchronous Online Learning

The synchronous delivery mode includes live programs that take place in real time via network technologies, and therefore require from all parties to be present simultaneously. Cases of recorded live sessions correspond to asynchronous online learning. It typically involves tools, such as live chat, shared whiteboard, virtual “hand raising”, audio/video conferencing, data and application sharing and joint viewing of multimedia presentations (Martin & Parker, 2014; Welsh, Wanberg, Brown, & Simmering, 2003). Although, live group experiences are time dependent, contemporary Web technologies, make them place independent (Rosenberg, 2001). For this reason, Rosenberg (2001) and Barcelona (2009) have argued that the synchronous format surpasses the asynchronous one, in terms of community building and cost-efficacy. The synchronous meetings result in creating connections among the involved partners and reducing the feelings of isolation that are usually reported in online learning settings (Barcelona, 2009).

1.2. Asynchronous Online Learning

The second way for delivering knowledge online is through asynchronous methods. These programs are independent of time and since - most of the cases- nothing has to be scheduled, they can be accessed as many times as preferred. Asynchronous courses promote collaborative learning and allow instructors to check the understanding and the participation of their learners by reading through chat entries, discussion boards etc. Moreover, according to Saghafi, Franz
and Crowther (2014), the virtual asynchronous workshop turns out to be better suited for constructive discussion, archival of design development and review of individual or peer progress. The so-called learning management systems (LMS) or virtual learning environments (VLE) are typical instances of asynchronous online learning, which means that their content can remain at learners’ disposal (Nortvig, Petersen & Balle, 2018; Rosenberg, 2001).

1.3. Advantages & Disadvantages of online learning

1.3.1. Advantages

The increased discussion around the online learning movement can be explained by the benefits that accompany its use. There is a large number of studies, which compare different teaching and learning formats (i.e. face-to-face instruction, online learning, blended learning) in terms of learning efficacy (Arenas, 2015; Hgyen, 2015; Nortvig, Petersen, & Balle, 2018). However, for the purposes of the current work we just shall lay emphasis on online learning.

Examples of learning/teaching experiences supported by ICTs indicate that both advantages and disadvantages emerge. Researchers and theorists imply or clearly state them. Regarding the advantages, we shall mention that online learning:

- motivates learners
- offers easy access to learning to all and more effective curriculum delivery
- encourages autonomous learning
- largely cultivates the development of communication and presentation skills.

First of all, the late years, undoubtedly, people of all ages and especially the youths, tend to utilize digital tools in their everyday life. They usually send messages, meet on social networks and generally interact with the virtual world. They are able to rapidly acquire knowledge and information. The same condition exists in the majority of the working environments (Solomon & Schrum, 2014). For these reasons, it is stated that attending an online class can be highly motivating, especially for those students that are more hesitant about participating in group conversations (Arenas, 2015; Jenkins, 2003; Online learning methods, n. d.). Apart from highly motivating, online learning is easily accessible due to anywhere and anytime features it presents. Sessions with qualified instructors and collaboration instances with remote
universities are available at a «click» (Rudestam, & Shoenholtz-Read, 2010; Online learning methods, n.d.). Provided that someone possesses an electronic device with a fast internet connection, the process of learning can take place without any temporal or regional restrictions (Paine, 2003; Welsh, et al., 2003). A mobile phone definitely could stand as a stronger defender of the portability asset than a desktop computer (Stockwell, 2008). Nevertheless, in any case, learners can be connected permanently into their learning community and parents can have the opportunity to trace their child’s achievements (Paine, 2003). An added, positive dimension is enclosed in the aforementioned benefit of online learning; that is, the fact that it protects the human right to basic education by providing it to all- even to refugees and displaced people- without any discriminations (Brophy, 2003). Although, in the literature, researchers voice concerns about the appropriateness and efficacy of such attempts, there are examples of encouraging outcomes (Brophy, 2003).

Further, scholars have concluded that learning with the mediation of ICTs promotes autonomous learning at some extend, since learners are inclined to expand their capabilities by exploiting the opportunities offered by the involved technologies (Paine, 2003; Online learning methods, n. d.). Baring also in mind that Computer Mediated Communication (henceforth CMC) steams from socio-cultural theories and thus encourages interaction amongst learners, it has been argued that it facilitates learners’ multimodal communicative competence (Hauck, & Youngs, 2008). At this point, it is worth referring to the content that Royce attributes to this term, that is, “the ability to understand the combined potential of various modes for making meaning” (2002, p. 92). Otherwise stated, learners can become versed not only in developing an awareness of the affordances of different modes, but also in making an informed choice of the certain modes for specific communication needs (Hauck & Youngs, 2008). Therefore, it becomes overt that the cultivation of multimodal communicative competence, which is enabled by the advanced networked technologies, combines the development of both electronic literacy and communicative competence. In a CMC environment the ability to «play» with learning-oriented electronic tools (electronic literacy) and the ability to communicate the acquired knowledge to other learners and/or tutor (communicative competence) are prerequisites for the ability to make meaning by combining various semiotic modes and different tools (multimodal communicative competence) (Hauck & Youngs, 2008). Finally, Jenkins (2003) indicates that the adoption and the implementation of ICTs in the learning/ teaching process increases the flexibility of the curriculum. Consequently, it becomes more learner-centered and serves the diverse learning needs.
1.3.2. Disadvantages

As far as the disadvantages of online learning are concerned, it is worth annotating the followings:

- the considerable cost
- the young age of learners
- the educators’ new and demanding role
- the high drop-out rates.

To begin with, the most-frequently mentioned drawback of online learning is the necessary investment in both Information Technology (hardware, software) and technical staff. Although such initiatives are cost-effective for learners, who wish to decrease the rising cost of postsecondary education, this is not the case with the course providers (Huyen, 2015; Welsh et al., 2003; Online learning methods, n. d.). The cost that needs to be covered for ICT infrastructure (equipment, software, Internet access etc.) and technical support personnel is quite high (Pelgrum, 2001; Welsh et al., 2003; Online learning methods, n. d.). Moreover, concerns have been expressed about the efficacy of open and distance learning with school-age pupils (Jenkins, 2003). It is generally accepted that the younger a child is, the less learning-motivated can be. This is in all probability due to children’s lack of maturity, experience and skills (Jenkins, 2003). For example, if they have to deal with a technical problem (a quite common condition in CMC environments), they may feel frustrated and reject the whole process (Yang & Durrington, 2010). However, examples of distance education in Australia and other countries suggest that older students can cope well with learning materials originated from curricula designed for adults (Jenkins, 2003).

Furthermore, in the context of our interest, all students, regardless their age, need a high level of support. To that end, teachers have to undertake a new and challenging role, moving away from instructivist approaches, which correspond to traditional learning, and thus consider teacher to be the source of knowledge. (Jenkins, 2003). More specifically, tutors have to be trained in order to adopt sociocultural theories of learning and, consequently, aim for democratic and learner-centered methods (Hampel & Hauck, 2006). Besides, the online environments available today in CMC incorporate features that promote interaction amongst participants and force tutors to give up control in favor of their students (Hampel & Hauck,
2006). In other words, teachers should learn to act as a facilitator and guide/scaffold the learning process by providing support (Hampel & Hauck, 2006). Moreover, fostering students’ sense of belonging to a meaningful learning community is another one tutors’ duty. The establishment of a strong educator presence, therefore, is a crucial factor in online learning, since collaboration activities and student-student interactions are not sufficient to build a sense of community amongst learners (Joksimovic, Gaševic, Kovanovic, Riecke, & Hatala, 2015; Tomas, Lasen, Field, & Skamp, 2015). Teachers are invited to create a supportive learning environment, by strategically combining audio, video, synchronous and asynchronous sessions, activities and other digital tools to engage students (Gray & Diloreto, 2016). In that way, meaningful learning communities that promote students’ social relations are developed.

However, Fletcher and Bullock (2015) have highlighted that the cultivation of the feeling of connectedness between students, teachers and content may be impeded by online learning cases that involve only asynchronous group meetings. The lack of community and the feelings of isolation are especially referred to Learning Management Systems (LMSs), which are representative instances of asynchronous online learning. Their characteristics will be elaborated at the following chapter.

Nonetheless, it is generally accepted that the majority of educators lack sufficient knowledge and skills regarding ICTs, since most countries have not yet provided relative training (Pelgrum, 2001). It is also worth considering that the contemporary generation of teachers has been educated in a way that allows a uni-directional transfer of information: from the teacher to the student (Pelgrum, 2001). For that reason, they might adopt a suspicious stance and -at an excessive level- a negative attitude towards the benefits of implementing ICTs in education. Even though, they might use technology for their own social purposes in a daily basis, often are unaware of the benefits that the various tools involve for learning (Solomon & Schrum, 2014). On the whole, it becomes overt that educators’ training is of great importance, as they have to acquire knowledge regarding acting in an online environment. Since online learning is a different learning format, pedagogical practices originating from face-to-face courses cannot be replicated effectively (Mills, 2015).

To conclude, although online learning encompasses many advantages, as we have already seen, high drop-out and withdrawal rates are still reported. This phenomenon could be justified by the nature of online learning programs, which lack face-to-face contact with instructor and peers, especially those that are distributed only in an asynchronous manner (Schmidt & Werner, 2007). For that reason, blended or hybrid learning seems to be more effective, as it combines
the strengths of both online and face-to-face learning. Another potential justification of the high drop-out rates could be the shortage of academic self-discipline and motivation. As it has been stated previously, students fail to successfully reflect, control and manage their learning due to their immaturity (Jenkins, 2003).

2. Learning Management Systems (LMS)

Massive societal changes have brought with them radical reforms in every aspect of life, including educational system (Watson, Watson, & Reigeluth, 2015). First of all, in the agrarian age, the paradigm of the one room schoolhouse was dominant. Later on, in the industrial age, the factory model of education was prevailing and aimed to produce “knowers”, or else individuals who master the same material in the given time framework. (Watson et al., 2015) Although the factory-like educational process was firstly presented in the late 18th century, some persistent remains of the industrial-age icon could be detected a lot afterwards (Laszlo, Rowland, Johnston, & Taylor, 2012). Laszlo at al. (2012) have voiced their concerns about the educational approaches that are being used in the 21st century, because they echo back to the acquisition of learning deficiencies. Moreover, they have emphasized the evolution that has taken place in the ways and means by which our society operates. Therefore, the information age society that we have already entered, since the begging of the millennium, requires “learners” instead of “knowers”. Students should not be restricted to confront a finite set of challenges, otherwise they should learn to become learning-oriented. The information age educational system should be in synchrony with the times and focus on mastery learning and customized learning (Watson et al., 2015). Essential features of the current educational system are: customized and personalized learning plans accompanied by innovative technological inventions.

According to Davis, Carmean, and Wagner, at the end of 1990s, the “traditional classroom experiences were being “ported” online, redesigned (or at least reconfigured) for computer mediated delivery, and distributed via the Internet.” (2009, p. 4). At the begging, the computer assisted and internet based learning management experience was reduced to the management of messages sent and received. But, in 1997, the first Learning Management Systems (LMSs) were released (Davis, et al., 2009). The advent of LMS represents the formulation of an information-age type of education. There are various types of LMSs, which could be split in the following main families: open-source LMSs, proprietary LMSs, and cloud-based LMSs.
These are being analyzed in the section 2.3. But, regardless the type of LMS, we shall focus on the essential involvement of ICT technologies in the new era of education, since people are getting connected to the system through electronic (computer/tablet/mobile/smart phone/networks) and virtual means (Internet, Cloud computing etc.) (Dobre, 2015).

Course Management System (CMS), Learning Content Management System (LCMS), Virtual Learning Environment (VLE), Virtual Learning System (VLS), Learning Portal (LP), or e-learning platform are various names, which are being interchangeably used in the literature in order to describe LMS systems (Wright, Lopez, Montgomerie, Regu, & Schmoller, 2014; Panagiotidis, 2012). Even though each term might have a slightly different meaning, throughout this piece of work, we'll use the term LMS. We could define LMS as a software program that organizes, documents, records and delivers courses (Bezhovski & Poorani, 2016). It can either support traditional face-to-face instruction, facilitate blended courses or serve as a platform for fully online ones (Lang & Pirani, 2014). The early systems were all server-based, whereas nowadays there are also web-based and cloud-based LMS (Bezhovski & Poorani, 2016; Bri, Garsia, Coll, & Lloret, 2009). They have been nearly ubiquitous in developed countries for more than 10 years, whereas developing ones are not that much familiar with these systems (Mijatonic, Cudanov, Jednak, & Kadijevich, 2013; Watson et al., 2015). They are mostly used by Higher Education Institutions and offer an integrated suite of online resources (e.g. reading materials, video and audio, learning games, testing, grading etc) and communication tools (e.g. wikis, web conferencing, chats, forums, blogs etc) (Bezhovski & Poorani, 2016). However, it is worth noting that the term LMS has also been used to describe either a comprehensive educational software that relies on drill-and-practice instruction (e.g. Edmentum) or a software that enterprises use to track and manage training for employees (Watson et al., 2015).

Due to the fact that its usage is extremely increasing year by year (check section 2.3.), its functionalities evolve to meet stakeholders’ expectations. In order to elaborately depict its functionalities, we could refer to the execution of course preparation (the gathering of educational content and resources), the delivery and tracking of student activities, (e.g. discussion, collaboration etc.), the administration of assessment activities, and the accumulation and presentation of marks and grades (Wright, et al., 2014). Otherwise stated, the LMS operates simultaneously as a grade book, an assignment distributor/collector, a grade giver, an attendance taker, a conversation facilitator, a collaboration tool, an instant messaging platform, an e-mail client, and more, all in one (Reid McLain, 2017). The authentication,
security, and privacy of all the aforementioned activities are certified because of the existence of a virtual wall that acts as a measure. Modern LMS software also tracks student activities. This information can be viewed by instructors and administrators from different perspectives in order to detect patterns that might suggest how students can be better supported (Wright et al., 2014).

2.1. Evolution of the Web

It is more than obvious that the exponential growth of the web has revolutionized and changed the capabilities and the implementation of LMS into online learning settings (Dominic, Francis, & Pilomenraj, 2014). Nonetheless, Kroner and the Edutechnica team (2014) have underlined that the basic capabilities of LMS have not followed the significant evolution of their implementation over time. Therefore, it is worth looking into the 4 different web generations.

Firstly, we shall define the term “web”, since it is the starting point of the following research. Even though it is the most prominent part of the internet, it is not a synonym for it. The World Wide Web or -as it is often abbreviated- the Web, is a space, where various versions of information (i.e. text, pictures, audio, video) are stored and accessed through the use of a network (Boulos & Wheeler, 2007; Dominic et al., 2014). The idea of this transformable information construct has been introduced by Tim Burners-Lee in 1989 (Getting, 2009). His dream has been to create a common information space that promotes communication amongst people, who share information (Berners-Lee, 1998). The picture 2.1.1 constitutes an evolutionary depiction of the web and its features, as the years go by.
Web 1.0, the 1\textsuperscript{st} generation of the web, is commonly recognized as a read-only web and a system of cognition, because of the static information and minimal interaction between websites that it offered (Dominic et al., 2014, Getting, 2007). The websites included static HTML pages that were rarely updated. It began as an information place, where businesses could provide catalogs or brochures to advertise their productions and people could read them and contact the vendors (Getting, 2007). In this, somewhat mono-directional way, the main goal of the websites was to establish an online presence for anyone by sharing information, which users were unable to curate (Dominic et al., 2014, Getting, 2007). The role that the users and visitors of the websites played did not include any impacts or contributions to the provided information, since the early web allowed them only to search and read it (Dominic et al., 2014).

In 2004, Dale Dougherty coined the term “read-write web” in order to define the second phase of the web that was emerging at that time (Berners-Lee, 1998). The differences between Web 1.0 and Web 2.0 are numerous. First of all, Web 2.0 provides both reading and writing capabilities, establishing a bi-directional construct (Murugesan, 2007). Moreover, Web 2.0 is a full computing platform, which replaces desktop applications with web applications and displays attributes like network as platform, continuous updated software, consuming and remixing data from various sources (Deerwester, Dumais, Furnas, Landauer, & Harshman, 1990; Murugesan, 2007). Added to those, the users of web 2.0 have more interaction with less

\footnote{Source: http://www.mecs-press.net/ijmecs/ijmecs-v6-n2/IJMECS-V6-N2-2.pdf}
control (Murugesan, 2007). Besides, collaborative content creation and modification is one of the outstanding features of Web 2.0. For all these reasons, it is also known as the wisdom web, people-centric web and participative web (Murugesan, 2007). The main technologies and services of web 2.0 composed of social networks (blogs, wikis, tweets, tags, tag clouds), really simple syndication (RSS), audio/video conference and mashups (Angaei, Ali Nematbakssh, & Khosravi Farsani, 2012; Dominic et al., 2014).

The 3rd generation of the Web, within which we now found ourselves, is known as intelligent web or semantic web (Aghaei et al., 2012; Dominic et al., 2014). Web 3.0 desires to concede priority to machines instead of humans (Aghaei et al., 2012). This can occur by decreasing human’s tasks and decisions and providing machine-readable contents on the web (Hassanzadeh & Keyvanpour, 2011). Unlike the content creativity of users and producers that has been pursued by Web 2.0, Web 3.0 acting like a global database, targets on making links to connect related data (Aghaei et al., 2012). More specifically, due to the fact that web 2.0 has generated a vast amount of data -via wikis, blogs and tweets- that has been remained underutilized, because of its free-form and different characteristics, Web 3.0 aims to link, process and utilize it, as to boost discovery, automation, integration, and reuse (Dominic et al., 2014; Nykänen, n. d.). Generally speaking, web 3.0 operates in two main stages. The first stage includes semantic technologies, which represent open standards applicable in the top of the web. The second stage contains a social computing environment, which enables humans to cooperate with machines and builds -in that way- a large number of social web communities (Suphakorntananakit, 2008).

At this point, we would like to add an emphasis to the involved technologies that actualize the aims of Web 3.0. First of all, artificial Intelligence (AI) has stood as the perfect tool to extract the patterns of data and its utilization (Dominic et al., 2014). Moreover, it should be considered that the processing and analysis of such a large set of data requires a significant amount of infrastructure, which consequently would increase the economic burden. Nonetheless, the utilization of cloud computing services can alleviate the bad effects (Dominic et al., 2014). Furthermore, we should not omit to refer to the technologies that enhance learner experiences and satisfaction, that is, 3D Visualization and Augmented Reality. More specifically, 3D visualization enriches the learning process by making the interaction among the involved actors easier regarding motor skills, exploration of virtual spaces and manipulation of virtual objects (Dominic et al., 2014). As far as augmented reality technologies are concerned, they recognize user’s actions in the real world and try to enhance them by the computer usage (Hitzler &
Janowicz, 2013). However, Virtual reality technologies substitute the real world with an artificial one (Dominic et al., 2014). In addition, Web 3.0 deploys distributed computing services, which allow tasks to be simultaneously tackled by various computers. In that case, each computer performs its own distinct role. This scientific approach tries to convert web to a giant brain, able to think by distributing, analyzing and extrapolating (Dominic et al., 2014). However, it is worth mentioning that in the 3rd generation of the Web, tasks can be carried through with miniature electronic devices worn or held by the stakeholders. Some of these devices can be PDAs, smart phones, tablets, which are hand held, hand/leg worn, and head worn (Dominic et al., 2014). All the aforementioned technologies seem to upgrade the learning experience and achieve higher levels of customer’s satisfaction. They promote the existence of a more active learner that is able to collaborate with others surpassing temporal and regional barriers, improve data management, support accessibility of mobile internet and encourage factors of globalization phenomena (Aghaei et al., 2012).

Finally, Web 4.0 and its involved technologies remain to be seen. According to expectations, the web will proceed into the future by establishing a stronger interconnection between human and machines. Hence, AL is going to play a major role in enabling web to interact with human (Dominic et al., 2014). Web 4.0 is also known as symbiotic web, since the dream is humans and machines interacting in symbiosis. More powerful interfaces are expected to being built with the assistance of web 4.0. In simple terms, machines’ intelligence would be parallel to the human brain, and therefore able to read the contents of the web and react in order to build more commanding interfaces (Farber, 2007; Hemnath, 2010).

2.2. Evolution of the LMS

To begin with, the attributes of e-learning 1.0 and, consequently the 1st generation of LMS, emerged from the capabilities of web 1.0 (Dominic et al., 2014). Due to the fact that Web 1.0 set limitations on content creation and sharing, it engaged the traditional learning theories of instructivism, behaviorism and cognitivist. The 1st generation of LMS, therefore, copied aspects of traditional learning (Dominic et al., 2014). More specifically, in the late 1990s, the need for “class web presences” gave rise to the creation of the 1st LMS (Kroner & Edutechnica Team, 2014). They featured the following characteristics: (a) the ability to create and upload static content; (b) basic assessment tools that offer limited variety of testing formats; (c)
discussion forum or messaging tool to promote interactive communication; and (d) basic gradebook capabilities (Kroner & Edutechnica Team, 2014). However, the need for a more automated creation of class websites and an increased management of the content, resulted soon in the augmentation of these basic capabilities (Kroner & Edutechnica Team, 2014). In short, LMS 1.0 evolved to offer advancements in grading and assessment options, better organization of the course content and the capability to copy/reuse it in subsequent steps, integration with Student Information System (SIS) and central authentication (Kroner & Edutechnica Team, 2014). The aforementioned attributes constitute the basic capabilities of LMS.

However, the advent of web 2.0, cultivated the need for a more learner centric reality that could be based on the learning theory of social constructivism (Dominic et al., 2014). The course-oriented nature of LMSs 1.0, which were being largely used as static repositories to store course syllabi, assignment descriptions, and lecture slides, and they were being focused on institutional control, gave rise to increased criticism against them (Bush & Mott, 2009). LMS 2.0 emerged in order to improve user experiences by utilizing web 2.0 capabilities, such as interactive and embedded content, mobile technologies and analytics tools (Kroner & Edutechnica Team, 2014). In more details, LMS 2.0 presented the following developments:

- analytics that could combine multiple data generated by external sources
- alternative credential approaches, such as badges, which reinforced gamification in education
- implemented social profiles
- alerts and notifications that were delivered in various modes (e. g. feed, text messages…)
- scalability that made the LMS responsive regardless the load demand during the semester
- software updates that did not cause noticeable downtime
- existence of a mobile app that was regularly enhanced to support mobile experiences across devices
- independence from PDF readers, Word or PowerPoint. All in all, it is obvious that second-generation LMSs began to recognize the need for interoperability and
consequently supported open standards for learning tools, learning content, and back-end integrations (Kroner & Edutechnica Team, 2014).

However, it has been supported by Small and Vorgan (2008) that despite the blogging feature directly available for the students as a part of LMS, many hesitate to adopt it and still utilize social networks and blogging sites away from the university itself. Moreover, students seem to be also reluctant to use technologies that are part of or built-in with LMS and offer update or sharing capabilities (e. g. RSS, Twitter) (as cited in Crane, Benachour, & Coulton, 2011).

Since 2012, there have been calls for a new type of LMS, whose characteristics are quite vague. The term “Next Generation Digital Learning Environments” (NGDLE) is being used to describe it. Educause researchers have proposed that the fundamental functionalities of NGDLE are: interoperability, personalization, analytics (advising and learning assessment), collaboration, accessibility and universal design. Due to the fact that no single application can deliver in all these domains, NGDLE are expected to be comprised of miscellaneous components that are built together in accordance with individual or institution requirements and goals (Brown, Millichap & Dehoney, 2015). The point of departure for this is the transformation of LMS platforms into learning solutions ecosystems that are architected by faculty members in accordance with the individual needs of the program, the course or the learner (Kroner & Edutechnica Team, 2014; Pugliese, 2012). Otherwise stated, Web3.0. technologies are expected to be adapted to the art of teaching and therefore, the learning content should be subscribed and syndicated to student learning profiles (Pugliese, 2012). Users are empowered to make choices related to content and tools (Kroner & EduTechnica team, 2014).

In that way, the learning process is an exploration of students’ concepts of interest (Kroner & Edutechnica Team, 2014). It becomes overt that the NGDLE are focused on user demand-side, rather that adopting a vendor supply-side orientation (Pugliese, 2012). Web 3.0 technologies deploy nimble, interoperable, modular and open infrastructure as to make learning contemporary, relevant and engaging. In more details, learning communities are built by new web service, database, and content-provisioning technologies that facilitate course creation, content management and access, and social environments (Pugliese, 2012).

At this point, we shall analyze the rest technological pillars on which NGDLE are based. Apart from featuring adaptive learning paths and content, they incorporate social applications, which create effective learning grids that promote user independence and self-paced learning. Learners are encouraged to participate in learning processes outside of the classroom and
cultivate their content-creation capabilities via a vast array of personalized information sources (Kroner & Edutechnica team, 2014; Pugliese, 2012). It is noteworthy, that comparing NGDLE social networking design with the corresponding features of LMS 2.0, we can conclude that social interactions within learning grids are not an incidental exchange of ideas, but constant and collective resources combing personal knowledge with public one (Pugliese, 2012). Moreover, at the core of LMS is not only posting relevant course content, but also capturing course and student assessment data and recording participant behavior within the online learning ecosystem (Pugliese, 2012). Even though the 2nd generation of LMS has provided static data reporting, the NGDLE design advances analytics capabilities by leveraging e-learning intelligence and offers real-time data about academic activity, student behavior and engagement (Kroner & Edutechnica team, 2014; Pugliese, 2012). This data herald the type of material that lead students to excel and, therefore help instructors act proactively rather than reactively (Kroner & EduTechnica team, 2014; Pugliese, 2012). The study conducted by Marks, AL-Ali and Rietsema (2016) provides insight concerning the value of the new analytics functions and the data store in the LMS in the process of making more informed decisions.

In addition, historically, LMS 1.0 and 2.0 have presented limited content management, creation and sharing capabilities and have tended to utilize third-party management tools, whose efficacy in engaging students has been questioned (Pugliese, 2012). However, NGDLE include advanced digital repositories with components that stem from outcomes measurement, social curation, reporting, analytics and sharing capabilities (Kroner & Edutechnica team, 2014; Pugliese, 2012). These content clouds encourage educators to search and reuse, author, modify, integrate and distribute content in a wide variety of disciplines (Pugliese, 2012). An effective use of curricular resources, timely feedback and an improved platform that maximizes students’ learning experiences are some of the benefits to creating and deploying content clouds (Pugliese, 2012). Moreover, it is worth noting that NGDLE can support various devices. In accordance with device’s capabilities, offline services may be provided. Even though NGDLE offer mobile experiences, which are unhampered, compatibility and usability concerns -across devices and vendors- arise (Kroner & EduTechnica team, 2014). In short, the most challenging aspect is the presentation of learning content and tools in mobile app, mobile web, tablet and full web browser (Kroner & EduTechnica team, 2014). Lastly, NGDLE embrace an open ideology in terms of interaction, sharing and connection and thus promotes the existence of open intellectual property including a technology platform, source code, or worldwide access to open content (Pugliese, 2012).
2.3. Proprietary and Open-Source LMS / Market Share

The available LMS can be classified, by their availability and license requirements, into two different categories: proprietary software and open source software (Pillai & Kevin, 2013). Proprietary LMSs represent the beginning, whereas the Open-source LMSs have been developed as an alternative to the proprietary ones (Dobre, 2015). In this section, we shall focus our attention on the differentiators between the aforementioned software models. To begin with, it is necessary to present the attributes of these two kinds of software in details.

On the one hand, proprietary software solutions, including proprietary LMSs (known as commercial LMSs as well), retain the source code, which can only be copied, distributed or modified by the vendor (individual or company) (Reg, 2015; Wright et al., 2014). Therefore, it is obvious that institutions, which prefer proprietary LMSs, lack in flexibility and personalization, because even a minor customization of their LMS is forbidden (Curran, 2011). Even though proprietary LMSs entail not only a total cost of the software ownership and an annual license fee per user, but also subscription and maintenance fees, their innovative and ease-of-use features have made them popular (Pillai & Kevin, 2013; Wright et al., 2014; Yupango, 2018). The most used at present commercial LMS is Blackboard Learn, whereas Canvas and D2L Brightspace are strong competitors. Moreover, the fact that they are reviewed by experts, who are also support them technically, confirms their validity. The continuous support system can solve any issue that might arise, major or more minor (Pillai & Kevin, 2013). As a result, they are less prone to security risks (Reg, 2015). Nevertheless, Yupanco (2018) has argued that there is a serious danger of proprietary product disruption, because of merger or collapse. “If one company's LMS is acquired by a different company through purchase or takeover, observations of the current LMS market indicate that the newly acquired software is likely to gradually disappear” (Wright et al., 2014).

Due to their earlier appearance compared to the open source equivalents, they have managed to build a strong industry (Pillai & Kevin, 2013). However, since 2013, the market scenario has indicated the end of the road for the proprietary e-learning software solutions; something that has been likened to the fall of the Roman Empire, highlighting its importance (Asay, 2007; Pillai & Kevin, 2013). At that time, open source model starts developing slowly, yet significantly (Pillai & Kevin, 2013; Reg, 2015). The latest versions of open source LMSs offer many of the features that proprietary systems have previously developed (Yupango, 2018).
Proprietary LMSs are not a viable and cost-effective solution of Higher Education Institutions any more. Due to the strong competition of the Open-source LMSs, proprietary LMS vendors have developed other products as to address the needs of different domains (Dobre, 2015).

On the other hand, open source software solutions provide the users with the ability to obtain the source code at no cost, which they can also modify, change or share it (Dobre, 2015; Reg, 2015). In that way, an active participation of the community-at-large is encouraged, since features are available as plug-ins providing an amazing array of options (Yupango, 2018). Moodle, the most popular open-source LMS at present, has built its momentum because of its extensive availability of plug-ins. Pillai and Kevin (2013) have commented that “it is heartening to know that the open source community through the support of developers is constantly developing its own worldwide accessible and entirely free app store”, which includes additional LMS features (p. 6). The wide and passionate community of users and developers also disseminate valid information through forums, and give advice with regards to the function, modification or enhancement of the software (Reg, 2015). Developers’ aim is to create efficient and adaptable software that caters users’ needs. Actually, developers seek to satisfy their own needs, because they themselves make use of the software as well (Reg, 2015).

Nonetheless, it must be emphasized that open source LMSs –also- entail drawbacks. Although they cost nothing regarding the software itself, issues such as the administration cost, the customization cost, the support cost and the time cost should be taken into consideration, because they are quite large (Pillai & Kevin, 2013; Wright et al., 2014; Yupango, 2018). Any institution that opts for an open source LMS requires purchasing servers and hiring experienced personnel or training the existing one in order to be able to manage in-house hosting (Wright et al., 2014; Yupango, 2018). Either case, a skilled programming team that is familiar with the programming language on which the software is based, is needed to optimize it and provide technical support (Wright et al., 2014). Otherwise, teachers’ and students’ needs will not be met, and therefore they might feel frustrated and be poorly motivated (Pillai & Kevin, 2013). That would be the biggest cost for the LMS usage. Moreover, the fact that it is developed by users, who are not necessarily experts in the field, could explain any technical flaws and the tendency to suffer from viruses (Reg, 2015). However, it has been reported that bugs can get fixed quickly, because the entire online community of developers can access the core, security patch releases occur regularly and features are upgraded continuously (Yupango, 2018).
Having analyzed the positive and negative aspects of each LMS model, some reasonable questions are born in our minds. What about the LMS offer? Is the LMS Market enough developed? Have the users got the opportunity to select and implement an LMS that corresponds to their needs? Which specific LMS has the largest Market share and why? Has the domination of LMS over Higher Education Institutions changed, as time passes? We shall attempt to answer the questions in the following paragraphs. To come to a conclusion, we should rely on facts and figures, rather than assumptions and perceptions.

A recent market research report, published by MarketsandMarkets, notes that the LMS market size is expected to grow from USD 5.22 Billion in 2016 to USD 15.72 Billion by 2021 (Hill, 2016a). On the contrary, the data of a new free report by Ambient Insight, entitled “The 2016-2021 Worldwide Self-paced Elearning Market”, predicts a $4.9 billion decline in revenues for eLearning in the US by 2021. Revenues from the $20.8 billion reached in 2016 will drop to $15.8 billion by 2021. Due to the fact that the US is the largest Self-paced Learning buying country, even a minor decline can have significant impacts on the global industry. Sam Adkins (2016), from Ambient Insight, has ascribed this phenomenon to the rapid appearance of some new, advanced learning technologies on the Market. Cost-effective Game-based Learning, Simulation-based Learning, Mobile Learning, and Cognitive Learning products have defeated self-paced eLearning, since they transfer the knowledge in far more effective methods.

However, Hill (2016a; 2016b), in e-Literate, has criticized harshly these two market analyses and suspects that the truth will lie somewhere between these forecasts. He has identified as a fundamental flaw the fact that both reports have considered all things labeled LMS (academic LMS Market, corporate training markets) as a single market. Moreover, as far as the analysis by Markets and Markets is concerned, he has underlined that analysts has not understood the dynamics involved in academic LMS Market. In more details, he has commented negatively the fact that they have acknowledged retiring LMSs as market leaders (i.e. Learning Studio, OpenClass), whereas have ignored dominating ones (i.e. Canvas, Schoology). To conclude, nobody can be sure about the size of the global LMS market. Undoubtedly, there are myriad choices available and the task of selecting the one that complies with institution’s mission and goals is quite a daunting one (Fenton, 2018).

2 For more information visit: https://mfeldstein.com/lms-market-triple-5-years-or-get-cut-half/
3 For more information visit: https://www.bizjournals.com/prnewswire/press_releases/2016/08/23/MN74341
4 For more information visit: https://www.bizjournals.com/prnewswire/press_releases/2016/08/23/MN74341
5 For more information visit: https://mfeldstein.com/lms-market-triple-5-years-or-get-cut-half/ and https://mfeldstein.com/marketsandmarkets-getting-lms-market-wrong/
A recent report from the Educause Center for Analysis and Research (ECAR) has noted that LMSs are universal in higher education, since almost all institutions have at least one in place (Lang & Pirani, 2016). Nonetheless, there is not a single LMS that has emerged as dominant, because new products emerge and existing products merge even nowadays (Pomerantz & Brooks, 2017). Despite the instability presented in the Market share figure from year to year, changing patterns can be detected. For example the expansionary dynamics of some LMS are evident in the figure 2.3.1.

According to the graphic above, done by Phil Hill (2018a) and published in e-Literate, the “the Big Four” (Instructure Canvas, Blackboard Learn, D2L Brightspace, Moodle) have dominated the LMS higher education market of North America (US and Canada) in the past five years in terms of institutional enrollment⁷. In this time frame, the aggregate market share of the top four LMSs has been moved from 80% to 95%. As far as the graphic is concerned, the blue line presents the adoption of these 4 major LMSs by higher educational institutions, while the red line visualizes the usage of other LMSs (Schoology, Sakai etc), which is limited to either small

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6 Source: https://mfeldstein.com/na-he-lms-market-share-enrollments-for-2012-2018/

7 For more information visit: https://mfeldstein.com/na-he-lms-market-share-enrollments-for-2012-2018/
schools or particular programs. These findings correspond with a recent Educause case study of LMS that lists Blackboard, D2L, Instructure Canvas, and Moodle Trust, amongst the most popular LMS solutions in almost 9 out of 10 Institutions (84%) (Lang & Pirani, 2016).

Figure 2.3.2. LMS Market Share by enrollments

Regarding the exact market share that each one of the top LMSs has, report results are inconsistent. As per statistics presented by Hill (2018a) and which are depicted in figure 2.3.2., quoted from e-Literate, Canvas has grown at an amazing pace (~35%), surpassing Blackboard (~33%). In more details, it is illustrated as the most-adopted LMS in North American higher education markets, scaled by enrollments. Moreover, D2L Brightspace has been placed third (~15%) in the North American total enrollments for LMSs, since 2016. Moodle has been dropping in recent years and is fourth (~13), but is a worldwide leader in total installed base. It is noteworthy that Hill (2018a) has asserted that the enrollment-based measure, instead of the institutional count, provides a more direct connection to company finances. For that reason, it is preferred by the LMS Market Analysis Service of e-Literate. Besides, Hill (2018a) has clarified that LMS company revenue is usually based on the total enrollment of adopting institutions. Nevertheless, there is also Market Share data in e-Literate that has been based on

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8 Source: https://mfeldstein.com/na-he-lms-market-share-enrollments-for-2012-2018/
institutional adoption⁹, but it still supports the same assertion: Canvas has overtaken Blackboard as the market leader (Feldstein, 2018a) (see figure 2.3.3.).

Figure 2.3.3. LMS Market Share by Institutional adoption¹⁰

However, it should be highlighted that the findings of Edutechnica analysis¹¹ of institutional LMS usage in US higher education are slightly different, especially regarding the LMS that has the strongest market presence. In figure 2.3.4, the maintenance of Blackboard in the first place is evident in terms of institutional adoption (31% compared to Canvas 30%), whereas Canvas seems to have surpassed Blackboard in terms of student enrollments (6,479,361 compared to Blackboard 6,422,827).

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⁹ https://mfeldstein.com/whats-important-about-the-blackboard-market-share-news/
¹⁰ Source: https://mfeldstein.com/canvas-surpasses-blackboard-learn-in-us-market-share/
Blackboard persistence in the leading place can be explained when considering the Blackboard-owned Moodlerooms LMS, which recently has been rebranded as Blackboard Open LMS. However, the Edutechnica analysts have predicted that Canvas will surpass Blackboard by number of institutions in early-to-mid 2019, provided that the former maintains its current pace. Although Moodle continues to be adopted by new institutions, its growth cannot outpace its great losses. Sakai seems to be at the same condition, since it continues to lose further market share with more than one-third of the Sakai installed-base actively looking for an alternative solution. The researchers’ expectations are that the vast majority of Sakai users will migrate to either Blackboard Learn or Instructure Canvas during the next two years. Brightspace maintains its customers and is placed 4th in the figure. After the announcement of D2L in late 2016 about its movement to Amazon Web Services as to host its Brightspace LMS infrastructure, it has been making significant progress. ANGEL and Pearson LearningStudio (eCollege) have been gradually removed from the Market. There is not even a single remaining institution using either of these LMSs. Some of these LMS environments are certainly running in an archive like state even today. Finally, “Other” LMSs, such as Schoology, continue to see success, but they are being chosen by fewer institutions.

To sum up, the LMS Higher Education Market seems to have consolidated around a handful of major vendors: Blackboard Learn, Instructure Canvas, Moodle, D2L Brightspace and Sakai.

The market share that each one of the vendors possesses is not worthy of attention, because it is affected by financial dynamics, and therefore it is something less stable over the years. The instance of Blackboard and its competitors is quite enlightening. In early 2006, Blackboard and WebCT were combined into a single company that owned approximately 70% of the US and Canadian market, while their next largest competitors were very far behind (Feldstein, 2018a). Blackboard seems to have established an unbreakable market dominance since 90s. Its merger tactic has been quite effective (acquired ANGEL Learning in 2009 and Moodlerooms in 2012). However, nowadays, its leadership seems to be threatened by the gradually increasing progress of Instructure Canvas. The future will show how vulnerable is the market to change. All in all, for all this uncertainty that surrounds the Market, we shall concentrate on the presentation of the five major LMS vendors. When did they emerge? Who was the initiator? Which technical characteristic distinguish the one from the other? Why do they have an active presence in the LMS market reality? Do they share any common characteristics? The rest of this study is dedicated to answer these questions.

2.4. The most recent and ubiquitous LMS / Presentation of the LMS under investigation

2.4.1. Moodle

Moodle is built by Martin Dougliamas, a programmer, who has been based on the theory of social constructivism in order to develop an educational platform that is learning-oriented, rather than toolsets built (Wright et al., 2014). Moodle HQ, the firm that leads and coordinates Moodle, is financially supported by Moodle Partner service companies that are spread in more than 40 countries. To date, it has attracted over 142,106,528 users from around the world and has been translated into more than 130 languages. Adopters can either pick the self-hosted version of Moodle that is downloaded onto their own web-server or the cloud-hosted solution (MoodleCloud), which also encompasses supplementary features. The LMS is compatible with every major browser and device (Fenton, 2016). There are also free mobile and desktop apps that can be accessed on- and off-line (Fenton, 2016).

13 https://mfeldstein.com/canvas-surpasses-blackboard-learn-in-us-market-share/
14 More information on the official website: https://moodle.org/
The acronym Moodle stands for Modular Object-Oriented Dynamic Learning and indicates that the free, open-source LMS can be modified by modular and interoperable third-party plug-ins and add-ons (Fenton, 2016). Users have also the ability to distribute commercial or non-commercial courses without any licensing fees (Fenton, 2016; Ingwersen, 2017). Administrators can use the Moodle plug-in directory to install additional features or do it manually at server level (see picture 2.3.1.1.) (Fenton, 2016; Ingwersen, 2017).

![Plugin installer](Picture 2.4.1.1. Moodle’s plug ins15)

Its exceptional plug-in based design can support myriad activities that mainly promote collaborative learning. Among the two dozen course-related activities, we shall emphasize the Workshop, an activity that supports peer review and is not present in many LMS alternatives

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15 Source: [https://www.pcmag.com/feature/346906/moodle-lms](https://www.pcmag.com/feature/346906/moodle-lms)
Roza Micha - The Current and Future State of LMSs

(Fenton, 2016). In that setting, students can receive feedback regarding their work or their assessments of colleagues’ work. In picture 2.4.1.2., a recently released Workshop planner tool is displayed, which filters students’ submission using different phases and visualizes their progress. Moreover, Moodle’s tracking-reporting capabilities are outstanding (Sood, 2018). Administrators can greatly expand progress tracking through optional plug-ins that provide access to user activity graphs and tables (Fenton, 2016).

2.4.1.2. Workshop planner on Moodle\textsuperscript{16}

However, despite the 1,300 plug-ins that are available and the worldwide network of partners that can extend Moodle’s functionality, it surely contains limitations. Since it is not turnkey, administrators need to perform configuration. It has been criticized as extremely complex and difficult for someone, who is not technically knowledgeable and/or has not practiced configuration beforehand (Ingwersen, 20017). Fenton (2016) characteristically assists that the process is more challenging than just drag-and-drop. For that reason, educators could be assisted by the IT department or the Faculty Technology Center, which could undertake the

\textsuperscript{16} Source: https://www.pcmag.com/feature/346906/moodle-lms
configuration, support and administration of the LMS. Moreover, another Moodle’s drawback is that, unlike paid alternatives, its User Interface (UI) lacks finesse to the point that its style reminds of Wikipedia (Fenton, 2016).

All in all, although Moodle includes additional administrative duties, its free distribution, its customizable type and its rapid advancement popularize it among other solutions (Fenton, 2016; Sood, 2018).

2.4.2. Sakai

Sakai Project begun in 2004, when four leading US universities (University of Michigan, Indiana University, MIT, Stanford University) collaborated as to turn their assorted learning software into an array of integrated, open-source tools that could compete proprietary alternatives. A year later, the Java-based Sakai project, having been based on the ‘‘CHEF’’ LMS of Michigan University, was freely released (Panagiotidis, 2012). Since it is an open source software, users can deploy, modify and distribute it at no cost. The active Sakai community, with contributors originating from academic institutions and commercial affiliates has aimed to the continued sustainability and evolution of Sakai. Interestingly, the direction and the feature set of Sakai have been powered by Higher Education in order to improve it. Otherwise stated, Sakai addresses academic institutions, instead of corporate training. That is the fundamental difference among Sakai and all the other LMSs (Ingwersen, 2017). More than 350 leading institutions from all over the world constitute Sakai community, which serves approximately four millions students. The software can be deployed in two schemes: self-hosted by institution’s server or cloud-hosted by commercial companies partnered with Sakai17.

Since its inception, Sakai has been delivered multiple releases. Sakai 12.5, the latest version of the software, apart from the core tools, offers a cleaner, more beautiful and responsive interface for each app (see picture 2.4.2.1.), an improved gradebook tool (see picture 2.4.2. 2.) and enhanced lesson modules with additional design tools (Ingwersen, 2017). However, unlike Moodle, Sakai lacks a broad community of support, plug-ins and add-ons (Ingwersen, 2017).

17 Find more information on the official site: https://www. sakaiproject. org/
Welcome to Sakai 11!

Picture 2.3.2.1. Sakai’s new interface

Picture 2.3.2.2. Sakai’s upgraded Gradebook tool

18 Source: https://blog.capterra.com/top-8-freeopen-source-lmss/

19 Source: https://blog.capterra.com/top-8-freeopen-source-lmss/
2.4.3. Canvas

Alongside Moodle, Instructure has struck Blackboard’s domination over Higher Education (Fenton, 2017a). Since 2011, Instructure has created and supported Canvas, a proprietary LMS that offers users open access to Application Programming Interfaces (APIs) in order to build their own tools. Although Canvas belongs in the corporate space, it is a native-cloud LMS, hosted by Amazon Web services (AWS) as opposed to Blackboard (Fenton, 2017a; Sood, 2018). Interestingly, Instructure also offers Canvas Studio, an open-source software, which is as capable as the hosted version, but lacks some paid services (Fenton, 2017a; Sood, 2018). Moreover, it launches Bridge, an LMS oriented to corporate market. To date, the aggregate number of educational institutions and corporations having employed Instructure products exceeds 300020.

Picture 2.4.3.1. Blueprint Courses 21

Reviewers have argued that Canvas User Interface (UI) has been thoroughly overhauled over the past years and today offers an easy-to-use and modern experience (Fenton, 2017a; Sood,

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20 Find more information on the official site: https://www.canvaslms.com/
21 Source: https://www.pcmag.com/feature/347674/instructure-canvas-lms/11
2018). Unlike Moodle, its set up is extremely simple as well (Sood, 2018). Canvas’ developers underline the importance of an easy and fast communication among learners and educators; in this sense they have introduced new features. Namely, “Blueprint Courses” enable administrators to design standardized content or course templates, which can easily and quickly result in complete courses (see picture 2.4.3.1.) (Fenton, 2017a). Furthermore, some refinements have been made in platform’s exceptional Gradebook and therefore instructor’s routine actions can decrease by one or two clicks (Fenton, 2017a). As a result, using the Gradebook across multiple sections or courses turns out to be less exhausting.

Educators can also use SpeedGrader (see picture 2.4.3.2.) to access students submissions and preconfigured learning outcomes and rubrics in a parallel manner (Fenton, 2017a). Finally, over the years, Instructure has enhanced Canvas’s feedback capabilities with additional annotation tools: such as highlights, text strikeouts and freehand drawing. All these tools are available to students for peer-review activities on all the devices (see picture 2.4.3.3.) (Fenton, 2017a; Sood, 2018).

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22 Source: https://www.pcmag.com/feature/347674/instructure-canvas-lms/11
“Canvas Commons”, a Learning Object Repository, enable administrators to supplement classes with hundreds of resources either omitting their content and using them as a course template or generally adopting them. Canvas also interoperates with Edu App Center, a library of apps. We shall emphasize that Canvas’ interoperability feature, compared to other LMSs, is significantly boosted. For instance, although Sakai integrates with Google Doc, Canvas takes that integration a level deeper and precludes the access to G suite from pop-up tabs and/or windows (see picture 2.4.3.4.). Finally, Instructure has added two innovative integrations to Canvas: ePUB support and Arc. The former allows students to download course materials for offline viewing, whereas the latter provides them with the opportunity to comment on video directly in the timeline (Fenton, 2017a).

23 Source: https://www.pcmag.com/feature/347674/instructure-canvas-lms/11
2.4.4. Blackboard

Blackboard Inc - a business combination consisted of Blackboard LLC and CourseInfo LLC - released its first LMS in 1998, because of the strong need of e-learning Market for an easy-to-use and economical-to-buy educational platform (Panagiotidis, 2012). Blackboard Inc gradually merged with some of its competitors. More specifically, it acquired WebCT, ANGEL Learning and Moodlerooms (the largest US Moodle support company) in 2006, 2009 and 2012 respectively (Feldstein, 2018a). It should be emphasized that Blackboard Inc promotes various products addressed to educational environments related not only to Higher Education Institutions and K-12 schools, but also to governmental organizations or private businesses. However, for the purposes of the current study we shall focus on Higher Ed. Institutions.

24 Source: https://www.pcmag.com/feature/347674/instructure-canvas-lms/11
Apart from its primary LMS, which is named Blackboard Learn, it also provides solutions that can cover a wide variety of institutional requirements; these solutions are platforms specialized in certain areas. For example Blackboard Collaborate can be seamlessly integrated with Blackboard Learn and allow the realization of massive synchronous sessions with up to 1,000 participants (see picture 2.4.4.1.). Moreover, Blackboard Ally, a recently released tool, can improve accessibility by generating materials even in electronic Braille, assisting in that way special needs students (Fenton, 2017b). Other specialized platforms that can be integrated with Learn and expand its capabilities are: Blackboard Connect, Blackboard Intelligence, Blackboard App, Blackboard Transact. Consequently, it becomes overt that Blackboard Inc provides an unrivalled ecosystem of educational resources that are continuously evolving, rather than an obsolete platform. In Fenton’s view (2017b), the Blackboard Learn version 9.1

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26 Source: https://www.pcmag.com/feature/354489/blackboard-learn-lms
has especially refreshed the original view courses with a responsive design that adapts to all mobile devices (tablets & smartphones) and platforms.

Picture 2.4.4.2. Original Courses

It has also offered an Ultra view for new ones. The Ultra course view has been appealed to instructors, as it boasts a new interface providing easy access to courses, grades and reporting (see pictures 2.4.4.2 & 2.4.4.3.). However, it should be underlined that in order someone to enable the Ultra course view, they need to adopt the cloud-based Software as a Service (SaaS) configuration. Besides, cloud based SaaS configuration limits the great expenses that are associated with server maintenance and support in the case of self- and managed-hosted configurations (Fenton, 2017b).

27 Source: https://www.pcmag.com/feature/354489/blackboard-learn-lms
Although Learn is a proprietary LMS, adopts an open extension, since its functionality can be augmented by a vast repository of open content (Building Blocks, see picture 2.4.4.5.). Except for community-created Building Blocks, partnerships with the largest academic publishers are offered on Blackboard’s extension website (Fenton, 2017b). Finally, Institution’s Student Information System (SIS) can be integrated with Learn.

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28 Source: https://www.pcmag.com/feature/354489/blackboard-learn-lms
29 Find more information about Blackboard’s Partners on: https://www.blackboard.com/partnership/index.html
2.4.5. Brightspace

Desire to Learn (D2L) founded in 1999 and launched Brightspace, one of the very first LMSs. To date, it remains one of the most popular platforms among education institutions\(^3\). According to recent Market reports, which have been analyzed on the section 2.3., compared to Brightspace, only Blackboard, Canvas and Moodle are ahead in terms of Market Share possession. Since it is a proprietary system, its pricing policy is not being publicized, similar to Canvas and Blackboard Learn. However, Learn is considered to be the priciest LMS according to institutional comments online (Fenton, 2017c).

In 2006, the company thoroughly renovated User Interface (UI) and made it more responsive and competitive with Blackboard Learn and Canvas and definitely superior to Moodle (Fenton, 2017c).”’ Daylight’’ is the name for Brightspace’s refreshed UI, which has been quite simplified, due to the fact that it minimizes user’s clicks by functioning intuitively (Hill & Spicer, 2018). In addition, it precludes the need for dedicated mobile apps (Fenton, 2017c).

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\(^3\) Source: https://www.pcmag.com/feature/354489/blackboard-learn-lms

\(^3\) Find more information about D2L’s technology on https://www.d2l.com/higher-education/products/
Contrary to Canvas’ third-party integrations, which are intended to solve some of the more specialized use cases, D2L’s features are guided by Progressive Disclosure (Hill, 2018b). In short, features are getting progressively disclosed from simple to complex depending on user’s needs and requests (Hill, 2018b). The recent changes in product design are depicted in picture 2. 4. 5. 1. Undoubtedly, the cloud deployment move of the LMS constitutes a further breakthrough. It is noteworthy that the AWS-based cloud hosting will be gradually their primary delivery model, which will eliminate software configurations and versions that make difficult to diagnose and fix bugs and to release new features (Hill, 2018b).
learning; from their ‘artifacts’, presentations and awards to their learning objectives and reflections (see picture 2.4.5.2.). Its portable nature allows graduate students to keep that record of learning. As for CBE, D2L has promoted Release Conditions, a feature that creates learning paths through a course and therefore enables or not a student to proceed depending on their achievements.

![Picture 2.4.5.3. Brightspace ePortfolio](https://www.pcmag.com/feature/346896/d2l-brightspace-lms/6)

**Picture 2.4.5.3. Brightspace ePortfolio**

Although Canvas includes Modules, a feature similar to Brightspace’s Release Conditions, it lacks an innovative feature that appears to support early interventions and consequently lowers attrition rates in large courses. This automated feature is named Intelligent Agents and can be found in few LMS, including Brightspace (Fenton, 2017c). In more details, Intelligent Agents are created by instructors and aim to detect at-risk patterns with regards to student behavior.

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34 Source: https://www.pcmag.com/feature/346896/d2l-brightspace-lms/6
and act. For example, if a student neglects to sign into a course, tutor’s specifically designed Agent will e-mail them into a predefined time frame.

![Image of Brightspace's Release Conditions](https://www.pcmag.com/feature/346896/d2l-brightspace-lms/6)

**Picture 2.4.5.3. Brightspace’s Release Conditions**

Furthermore, Brightspace’s suites of add-ons deserve careful consideration. Unlike in the past, the additional online learning tools that are now offered, they are not complex, since they have been streamlined into three packages: (a) Brightspace Core, (b) Engagement Plus, (c) Performance Plus. The first one includes all the prerequisites of the online learning setting: Learning Object Repository, Virtual Classrooms, video assignments and ePortfolios. The

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35 Source: https://www.pcmag.com/feature/346896/d2l-brightspace-lms/6
second one addresses universities willing to develop rich multimedia courses. For instance, “Capture” add-on, enables institutions to broadcast live lectures. Finally, the third package enhances company’s predictive modeling and performance analytics featuring three valuable add-ons. LeaP is an adaptive learning tool related to prior knowledge assessments, self-study and test-prep. Insights analytics is a variety of reporting information and visualization tools, whereas Student Success System is a standout tool that employs predictive modeling technology in order to anticipate which students will dropout or fail in a course based on their prior behavior and performance (see picture 2.4.5.4.) (Fenton, 2017c).

![Brightspace Insights Analytics](https://www.pcmag.com/feature/346896/d2l-brightspace-lms/6)

**Picture 2.4.5.4. Brightspace’s Insights Analytics**

To sum up, Brightspace is a rapidly evolving LMS and a compelling alternative to Learn. The changes that have been done in its design and deployment model are noteworthy. Nonetheless, it is neither a free, open-source like Moodle, nor offering extensive third-party integrations like Canvas.

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36 Source: https://www.pcmag.com/feature/346896/d2l-brightspace-lms/6
2.5. Advantages and Disadvantages of LMSs

Involving in an online learning/teaching setting entails advantages and disadvantages, both of which have been analyzed in section 1.3. At this point, we shall confine our thoughts to LMSs. Educational institutions that have decided either to implement an LMS or just replace it, are confronted with positive and negative consequences.

Generally speaking, nowadays, the Higher Education Organizations (HEOs) are getting challenged, more than ever before, since they have to deal with more complex issues (Dobre, 2015). Firstly, the number of students enrolled in their programs has been continually increasing, whereas the available infrastructure and the curriculum classes have been imposed limitations on accommodating the students (Dobre, 2015). Secondly, many HEOs have been affected by a shortfall in financial resources, due to the fact that there is a decline in support provided by government and enterprise society (Marks et al., 2016). Thirdly, today’s reality asks from educators to respond both in a timely and efficient manner (Katsileris & Dimopoulou, 2013). The ICT developments achieved over two decades ago can respond to all the aforementioned challenges and bring some hope. The HEOs have been focused on searching for the LMS that corresponds with their needs or wishes (Dobre, 2015). In more details, the inception of LMSs usage has enabled large groups of students to easily access learning environments (Dobre, 2015). LMSs constitute a suite of tools for learning and teaching online and thus eliminate temporal and geographic boundaries (Katsileris & Dimopoulou, 2013). Almost all the currently available LMSs can be used to support traditional face-to-face instruction, as well as blended and online educational environments (Wright et al., 2014). LMSs proponents concentrating on the cases of face-to-face and blended learning have highlighted LMSs potential to reduce the hours of face-to-face classroom interaction and to promote remote, autonomous work (Bri, et al., 2009).

Furthermore, LMSs assist educators to fulfill an efficient, quick and educationally informed teaching process (Katsileris & Dimopoulou, 2013). Especially, they have been presented as time-saving and convenience promoting technological tools, due to the fact that their content is easily maintained, and consequently reusable (Katsileris & Dimopoulou, 2013; West, Waddoups & Graham, 2007). In addition, the great majority of LMSs can be accessed through a mobile app. The mobile learning and the cost-effective wireless infrastructure or even the offline mobile app function, are very promising because they tend to down costs, efficiently
engage learners and increase adoption and participation rates (Crane et al., 2011). Moreover, Crane et al. (2011) have asserted that LMS usage can augment students’ engagement with their field of study and enhance their attained knowledge by allowing for increased flexibility in their access to learning. Although students are encouraged to study autonomously, they are not precluded from support during the entire learning process (Katsileris & Dimopoulou, 2013; Watson et al., 2015). Depending on the features available in each platform, the support tools might be more or less advanced and therefore establish a more or less rich student-student or student-instructor interaction. Finally, the reporting-tracking features available for teachers can lower dropout rates or prevent student underperformance (Watson et al., 2015).

To sum up, a concentrated presentation of the positive effects that stem from LMS usage would require from us to refer to the followings:

- engaging, efficient and contemporary course development
- enhanced communication and collaboration
- absence of temporal and regional constraints
- flexible and autonomous learning
- reduced cost.

However, since nothing good comes without something bad, we cannot omit to elaborate on the disadvantages that the LMS usage entails. An essential deficiency of the original LMS design is their course-oriented nature, which is obvious in the grouping of students into classes and the division of knowledge; practices that are trying to replicate the teacher-centered paradigm of the traditional education (Bush & Mott, 2009). The learners have little control over their learning environment, due to the fact that they have to follow specific learning paths. As a result, they are prohibited from defining their own objectives. Moreover, LMSs have been severely criticized for being used as static repositories whose only function is storing syllabi, assignment descriptions and lecture slides (Watson et al., 2015). While they include many communication tools such as discussion boards, wikis, blogs and chat rooms, which support interactive learning, only experienced educators try to open the communication support channel (Kemp & Livingstone, 2006; Watson et al., 2015). It can be deduced that the mismanagement of the offered tools is related to misunderstanding of constructivism, the theory on which LMSs have been built. Constructive learning promotes the idea that people learn by constructing new ideas based on their current and past knowledge (Cavus & Ibrahim,
2009). All in all, the evolution of LMSs, presented in section 2.2., has demonstrated that every next generation surpasses the deficiencies of the previous one.

Furthermore, the UI of some LMSs is inefficient and difficult for the average teacher (Watson et al., 2015). Besides, the majority of tutors lack advanced computer literacy skills. It has already been pointed out that a basic user might need the assistance of IT personnel. Otherwise, training of instructors and students is needed. Except for them, instructional designers and IT specialists are required to get trained with regards to the specific features of the implemented LMS in order to be able to support it (Wright et al., 2014). In addition, the HEOs should consider the deployment plan that are eligible for. As we have mentioned, proprietary LMSs that are self-hosted in institution’s servers, entail more expenses for the customer, since they have to invest in hardware infrastructure, backup storage, backup power supply, air conditioning for the hardware, and computers/digital terminals (Wright et al., 2014). Moreover, the rapid technological developments lead to obsolete LMSs that need to be replaced (Mc Lain, 2017). Consequently, the implementation and efficient and effective usage of a LMS seems to be time and money-consuming process.

To conclude, it is worth mentioning that some skeptical researchers doubt the fact that the continuous evolvement and upgrade of LMSs is able to surpass their limitations. For that reason, they have emphasized the need for interconnection with other platforms, such as Virtual Worlds (VW) and Social Networks (SN). Besides, the third-party plug-ins that are offered by traditional LMSs, such as Moodle, Blackboard and Canvas, do extend their functionality, but entail additional workload for tutor and learners (Blackmon, 2018). In the
3. LMS comparisons and evaluations

3.1. Related Studies

There are several LMS studies and comparisons in the literature. The large array of the available LMS has created the need for their systematic evaluation (Cavus, 2013). Some studies have aimed to evaluate the usability and the user acceptance of these platforms and others have performed comparisons of their educational and technical features. However, all are sharing a common vision: to help those interested in using an LMS. These may be individuals that are associated with educational organizations, such as instructors, administrators, faculty members or students (Cavus, 2013). Besides, implementing or replacing an LMS is such a daunting task that should involve all the stakeholders (Fenton, 2018). The selected LMS should also reflect institution’s mission, goals, values and culture (Fenton, 2018). In this section, we shall refer to the studies that have been done since the begging of the decade. The continuous metamorphosis of the LMS due to rapid technological advances does not allow us to go further back than that. The instability presented in the LMS market and stems from LMS merger or emerge, poses an additional shortcoming to our literature review. For these reasons, we should clarify that the results illustrated in this section are not completely compliant with today’s reality.

To begin with, Al-Ajlan and Zedan (2008) have proposed a framework of LMS features and capabilities, which has been widely employed by subsequent researchers. In more details, they have divided the detailed matrix of CMS/LMS features and criteria posted on WCET’s WebTools website, into learner tools, support tools and technical specification tools. In “A Comparative Study of MOODLE with other e-Learning Systems”, Kumar, Gankotiya and Dutta (2011) compared Moodle, Desire2Learn 8.1, KEWL, ANGEL 7.1, eCollege, Blackboard (V.7), Claroline, Dokeos 2.1.1., OLAT and Sakai in terms of learner tools, support tools and technical specification tools. The overall comparison has pointed out that Moodle is the strongest platform, since it has missed only 2 out of 40 features. A year later, Al-Ajlan (2012) compared five proprietary LMS -Desire2Learn 8. 1, ANGEL Learning Management Suite

37 For more information visit: https://www.pcmag.com/article2/0,2817,2488347,00.asp
38 WCET’s WebTools website: https://wcet.wiche.edu/initiatives/past-projects/edutools
(7.1), TeleTOP Virtual Learning Environment, The Blackboard Learning System (V7) - and five Open sources - LON-CAPA, Sakai 2.3, dotLRN/OpenACS, ATutor 1.5.4, Moodle 1.8. - in terms of the same criteria. These findings have also shown that Moodle outperforms all the others, since it has missed just 2 out of 40 features and capabilities. Desire2Learn 8.1, ANGEL Learning Management Suite (7. 1) and Sakai 2.3 have missed 3 out of the 40 features and capabilities, whereas Blackboard Learning System (V7) has missed 4. In “An Evaluation of Open-Source LMS for e-Learning courses”, Kumari and Thakur (2015) have concentrated on the open source LMS Moodle, Sakai, eFront and Forma and evaluated them in terms of language support, video conferencing, scorm compliance and other advanced features. The results, which are based on literature reviews, have indicated that Moodle ranks higher than the others. Subramanian, Zainuddin, Alatawi, Javabdeh and Hussin (n.d.) have aimed to compare the leading proprietary solution, Blackboard, with the leading open source solution, Moodle. They have been based on previous studies and compared the basic functionality features of each platform. In other words, they have offered a detailed presentation of communication tools, productivity tools, and student involvement tools. Their deduction is that Moodle is the LMS that gets better results.

Usability is an essential factor, since it can affect the overall acceptance and success of a platform. For that reason, there are several researches investigating this issue. Hock, Omar and Mahmud (2015) have evaluated the usability of three open source LMS platforms (Moodle 2.8.1., ILIAS 4.4.6. and Atutor r2.2.). This study involves usability testing and user’s acceptance test of these LMSs on behalf of 18 volunteer students. In order to establish indisputable results, the researchers uploaded the same content into the LMSs and had all the subjects testing out all the platforms. The results, obtained from the students’ comments in the online survey, have shown that Moodle is the easiest to use, followed by Atutor. Peneva (2015) has also determined Moodle as the most easy to use LMS. In more details, she has conducted a comparison between Blackboard (v9.x) and Moodle (v2.x) concerning their easiness and usability. The comparison is based on her experience using both systems as a university lecturer. She has emphasized on the features of each LMS and deduced that Moodle is intuitive and easy to use, whereas Blackboard requires training for instructors and students. Kasim and Khalid (2016) based on a literature review, have compared Moodle, ATutor, Blackboard, SuccessFactors and SumTotal. Among others, they have considered characteristics such as flexibility, ease of use, accessibility and user friendliness. They have indicated that Moodle, Sakai and Atutor miss 6 features out of 15, whereas Blackboard misses 10. A study that has been recently conducted by Demir,
Alenezi, and Bruce-Kotey (2018) with regards to the usability of Blackboard, Moodle, Sakai, and Canvas shows particular interest. The subjects of the research, who were preservice teachers, after participating in an LMS training course in one of the offered platforms, were asked to respond to an LMS usability questionnaire and reflect on the LMS functionality and ease of use. Since the Sakai training course was selected by an inadequate number of subjects, the platform was excluded from the research. Among the rest of LMSs, a significant difference has been noted. Specifically, Canvas performs 70.6 in the System Usability Scale, Blackboard 65.3 and Moodle 52.2. It is noteworthy that these results are revolutionary because refute Moodle’s predominance. However, we should highlight that they are debatable, because all the subjects experienced only one platform.

Furthermore, accessibility of e-learning tools is also an important factor, because it insures a better learning environment for people with impairment, as well as elderly or people with temporary health problems. Acosta and Luján-Mora (2016) have presented a comparative study of three LMSs: Moodle, Sakai, and a homegrown platform. Their aim has been to evaluate the levels of accessibility of these platforms by collecting data via a 138-question questionnaire. The questionnaire, which covers visual, mobility, learning and cognitive disabilities, has been answered by two system engineers with experience in using LMS. Based on the analysis of the collected results, researchers have concluded that the open source platforms outperform the developed in house platform in terms of accessibility features.

Interestingly, Bakhouyi, Dehbi and Talea (2016) have adopted a Multi-Criteria Decision Making (MCDM) method in order to analyze the interoperability of 4 LMSs: Moodle, Atutor, Blackboard and D2L. Specifically, they have defined 8 criteria of analysis, which could reveal weaknesses and problems located at the LMS interoperability. Overall architecture and implementation, Internationalization and Localization, Accessibility, Conformance, Design and Usability, Extensibility, Adaptability and Portability are the criteria of analysis which have been hierarchically structured through the Analytic Hierarchy Process (AHP). The findings indicate that the overall score of Moodle (Q = 0.691) is the highest among all the others. Blackboard Learn with a score of Q = 0. 618, comes next in line. An LMS evaluation process that is also appealing due to its innovative nature, is the one proposed by Cavus (2013). The researcher has achieved to automate the evaluation by developing a computer-aided system; entitled Easy Way to Evaluate LMSs (EW-LMS). He has carried out an investigation with 88 higher education instructors, who have taken part voluntarily. The developed system has included 43 LMSs and 52 features, from which instructors should choose those that satisfy
their needs. The results obtained by the system, have shown the following instructors’ preferences: 39.47% Moodle 1.9, 31.40% WebCT 4.0, 27.35% Blackboard 6.0, and 1.78% others.

3.2. Limitations of the previous works

Looking at the literature, anyone can easily conclude that Moodle is presented as the most powerful platform, since it has dominated the first place of the majority of researches. The fact that should be underlined is that the number of the conducted researches available in the literature has been reduced, compared with those conducted a decade ago. We suspect that this is a result from LMSs features converging. Besides, Blackmon has stated that although “LMSs, like Blackboard, Canvas, and Moodle [...] present a number of different features, their basic appearance and functionality are quite similar” (2018, pp. 33). This could explain the declining trend in features comparative studies and therefore the remarkable absence of Instructure Canvas among the scholarly works. As we have already mentioned in section 2.3., the latest market trends in the higher education field have shown a breakthrough of Canvas in terms of user adoption (Feldstein, 2017a).39 This phenomenon could be justified by a comparison of Canvas with other, powerful LMSs.

3.3. The aim of the research

Our study compares leading LMSs solutions, which are either open source or proprietary products. In order to gain a deep understanding of the current state of LMSs, we have thoroughly studied the features and tools of Instructure Canvas 2019, Sakai 12.5., D2L Brightspace 10.8.9, Moodle 3.5.2.+ and Blackboard Learn 9.1.. This systematic comparison is available in the Appendix of the current work, where the five popular platforms are being compared in terms of six functional areas. Generally speaking, the LMSs under investigation do not present significant differences regarding the delivered features. The wide array of addons and plug-ins, which they support, compensates for the missing functionalities. However, it

39 https://mfeldstein.com/why-moodle-supporters-should-be-concerned/
is noteworthy that they encompass capabilities that deserve attention, because they strongly express the current technological era. As mentioned earlier, we are now found ourselves within the 3rd generation of the web. Therefore, our main purpose is to suggest the “ultimate LMS”, which aligns with the technological trends that dominate today’s world.

In order to familiarize ourselves with the interface, the features and tools of the platforms, we have studied the relative literature, researched the official websites and the documentation of each product and traced helpful information in the conversations of the respective online communities. Apart from those, it was necessary to sign up for a free trial of Canvas, Sakai and Brightspace and visit the demo site of Moodle and Blackboard. In that way, the comparison results are more consistent, because they are based on first-hand information.

Since this study provides an overview of the current status of popular e-learning platforms, it is significant to higher education institutions, which look for an LMS solution that fulfills their needs. Besides, a quick search on the net gives many results of migrating institutions. Moreover, it addresses researchers, who are interested in the field of educational technology and specifically in LMSs evaluations.

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40 Try Canvas for 30 days on: https://www.canvaslms.com/try-canvas
41 Try Sakai on: https://sakaiproject.org/try-sakai
42 Try Brightspace for 30 days on: https://www.d2l.com/trial/
43 Moodle demo: https://moodle.org/demo/
44 Blackboard demo: https://mwcc.edu/academics/online-learning/mwcc-blackboard-demo/
### 3.3.1. Comparison results & Discussion

<table>
<thead>
<tr>
<th></th>
<th>Canvas 2019</th>
<th>Sakai 12.5</th>
<th>Brightspace 10.8.9</th>
<th>Moodle 3.6.2 +</th>
<th>Blackboard Learn 9.1</th>
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</thead>
<tbody>
<tr>
<td><strong>Language delivery</strong></td>
<td>It supports more than 30 languages</td>
<td>It supports more than 20 languages</td>
<td>It supports more than 15 languages</td>
<td>It supports more than 130 languages</td>
<td>It supports more than 25 languages</td>
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<td><strong>WebDAV</strong></td>
<td>It is not supported.</td>
<td>It is supported.</td>
<td>It is supported.</td>
<td>It is supported.</td>
<td>It is supported.</td>
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<tr>
<td><strong>Teaching/Learning Tools</strong></td>
<td>6 activity types, 7 resource types</td>
<td>7 activity types, 11 resource types</td>
<td>6 activity types, 6 resource types</td>
<td>14 activity types, 9 resource types</td>
<td>10 activity types, 6 resource types</td>
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<tr>
<td><strong>Communication Tools</strong></td>
<td>Conversations, Chat</td>
<td>E-mail (+email archive), Messages tool, Chat room tool, Commons, Contact-Us, Sign-Up</td>
<td>Email, Chat</td>
<td>Chat</td>
<td>Email, Messages, Spaces, Organizations</td>
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<tr>
<td><strong>Grading Features</strong></td>
<td>Students can create hypothetical or what-if grades, Speedgrader, Instructors can record their audio/video feedback</td>
<td>Post’Em</td>
<td>Instructors can record their audio/video feedback</td>
<td>Instructors can record their audio/video feedback</td>
<td>Instructors can record their audio/video feedback</td>
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<td>Canvas 2019</td>
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<tr>
<td>Customizability</td>
<td>Notifications can be delivered through: email, SMS text, Twitter, Studentapp</td>
<td>Notifications can be delivered through: email</td>
<td>Notifications can be delivered through: email, SMS text</td>
<td>Notifications can be delivered through: email, web, mobileapp</td>
<td>Notifications can be delivered through: email, text message, web, text-to-voice, Bb app</td>
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<tr>
<td>Content Collection residing in the LMS</td>
<td>“Blueprint Courses” are master courses, generally created by an account admin or an instructional designer. They include locked and unlocked content and sync to one or more associated courses. “Canvas Commons” is a digital library that enables educators to find, import, and share resources with those belonging in the Canvas network.</td>
<td>“My Workspace” provides a secure storage location, where users can privately save material. Optionally, they may decide to make it public (but with no restricted access)</td>
<td>Brightspace Learning repository: stores, manages &amp; shares learning objects. Instructors can review, rate &amp; provide feedback on learning objects to ensure high quality.</td>
<td>Each user has a private files area for uploading and managing a set of files. Administrator may enable users to email files to their private files area.</td>
<td>“Content Collection” contains personal (i.e. user’s) files and folders, course related files and folders &amp; institution related files and folders (e.g., library items), Portfolios, Learning Objects. Users can share their own files or search for files generated by others.</td>
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### Learning Analytics

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<th>Canvas 2019</th>
<th>Sakai 12.5</th>
<th>Brightspace 10.8.9</th>
<th>Moodle 3.6.2</th>
<th>Blackboard Learn 9.1</th>
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<td>If allowed, students can view their own analytics in any active course: by default analytics are shown in a graph-format. There are 4 types of graphs that can be displayed in a table format as well: a) The activity by date graph shows page views &amp; participation in activities. b) The communication graph shows the conversations made within “Inbox”. c) The submissions graph shows the status of assignment submissions (eg on time, late, etc).</td>
<td>Instructor can view summary reports displaying information for visits (total number of site visits, average percentage time per visit etc), activity events (most active tool, most active users etc) &amp; resources (the most opened file, users that opened the most site files etc). Moreover, instructor can create custom reports, in the form of charts, for more detailed information (visit details by date, user etc). Reports can be exported in an XLS, CSV, PDF file, or just printed.</td>
<td>Brightspace Insights 10.4. is a data mining &amp; reporting service that offers 30 different report types regarding learner behavior, grade achievements and usage patterns. Due to their graphical nature, they can be exported only to PDF.</td>
<td>Available reports: a) Competency Breakdown report: teachers can view their students’ competencies in the course, along with ratings. b) Logs either live or not, are available at both site &amp; course level.</td>
<td>EAC Visual Data: displays how students are going on tests &amp; rubrics (Original view). Course instructor can also view student activity for Kaltura multimedia content. (Original view)</td>
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<td>Brightspace Insights 10.5 offers reporting visualizations that provide a complete, near real-time picture of learners across tools. The 4 types of reports can be exported for further analysis in 3rd party tools.</td>
<td>c) Course activity report: shows the number of views of each activity &amp; resource. If enabled in the course management, students can access reports of their contributions, logs and a statistic report.</td>
<td>Analytics reports: a) course – at-a-glance (interactions, submissions, time in course), b) activity &amp; grade scatter plot, c) activity matrix (graph of submission trends over the semester), d) course submission summary report for each student for all graded items,</td>
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<td>Students can check their course progress using the</td>
<td>d) Complete report: shows an individual student’s</td>
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<td><strong>d)</strong> The grades graph shows the median, high &amp; low scores of all the assignments.</td>
<td>“class progress tool”. It tracks assignments &amp; feedback and measures 9 progress indicators: grades, objectives, discussion, content, assignments, quizzes, checklist, surveys, login history.</td>
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<td>In addition, instructor can run a report that shows attendance data. It can be generated for the entire course or for a specific student and is sent to instructor’s email and can be downloaded as a CSV file. Outcomes result report. Access report for all users in a course. Interaction report with an individual user and Student Grades report are also available to instructors.</td>
<td>full activity &amp; contribution in a course.</td>
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<td>e) Participation report: generates a list of those, who have participated in a given activity and how many times.</td>
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<td>f) Activity completion report: indicates the activities completed by each student.</td>
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<td>g) Grader report: is an overview report that shows the position of student in relation to the rest of the class for each grade item.</td>
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<td>h) The number of hits that have been made on various parts of the site is displayed on graphs and tables.</td>
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<td>e) Comparative activity report showing submissions &amp; time spent in course.</td>
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<td></td>
<td>f) Course Activity Related to Grades report. It is a printable report that presents statistics of performance (min/max values, range, average, median, standard deviation, variance).</td>
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<td></td>
<td>Canvas 2019</td>
<td>Sakai 12.5</td>
<td>Brightspace 10.8.9</td>
<td>Moodle 3.6.2 +</td>
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</tr>
<tr>
<td><strong>Automated Intervention system</strong></td>
<td>It is not supported</td>
<td>It is not supported.</td>
<td>Instructor can create Intelligent Agents that send emails to users, who have not completed a required quiz or assignment.</td>
<td>It is not supported.</td>
</tr>
<tr>
<td><strong>Course evaluation reports</strong></td>
<td>Apart from the learning analytics reports that can be used by instructors as to evaluate their work, Instructure partners with 3 external tools (EvaluationKIT, EvaSys, eXplorance) that are specialized to course evaluation reporting and can be integrated with Canvas.</td>
<td>Instructors can assume ineffective course material by considering site use statistics and user activity events.</td>
<td>Amongst the 30 different report types that are available in Brightspace, there are 4 of them related to Learning Outcome Evaluation and Competency Achievements.</td>
<td>Except for viewing learning analytics reports, instructors can be based on a 3rd–party tool (eg E-Thinking Reporting tool) as to gain a more indisputable insight into course effectiveness.</td>
</tr>
<tr>
<td><strong>Open source (OS)</strong></td>
<td>Commercial- Open API</td>
<td>Free-OS</td>
<td>Commercial- Open API</td>
<td>Free-OS</td>
</tr>
<tr>
<td>Supported Specifications</td>
<td>Canvas 2019</td>
<td>Sakai 12.5</td>
<td>Brightspace 10.8.9</td>
<td>Moodle 3.6.2 +</td>
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<td>---------------------------</td>
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<tr>
<td>Deployment</td>
<td>Native Cloud hosted</td>
<td>Self-hosted</td>
<td>Software as a Service / Cloud</td>
<td>Self-hosted Cloud-hosted</td>
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<tr>
<td></td>
<td>Cloud-hosted</td>
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As mentioned in the previous section, nowadays, the capabilities of the LMS slightly differ from one another. This is a result from the widely adoption of IMS Learning Tools Interoperability (LTI) standard, which allows specialized tools, created by 3rd-party developers, to integrate with LMS and enhance the educational experience (Feldstein, 2017b). Adaptability/Personalization, Artificial Intelligence and Automated Interventions, Socialization that exceeds the classroom walls, extensive Learning Analytics reports and Customizability are some of the features that we shall lay emphasis on, due to the fact that they echo Web3.0 technologies. In the next paragraphs, we are going to underline the assets of the LMS under investigation, with which we could build the “ultimate online learning platform”.

Instructure Canvas has been emerged as having a cloud-native architecture; something that functions as an added value, because it makes LMS easy to be used. In short, LMS is regularly (every 3 weeks!) updated on the cloud with no need for user’s involvement\(^45\). Moreover, it is noteworthy that Canvas launches its own app Center. It is an app store with an open application programming interface (API) that can significantly assist LMS by improving its functionality with outside tools. This LMS also presents “Blueprint Courses” and “Canvas Commons”, two exceptional, time-saving features that help instructors enrich their courses with reliable objects, and also promote knowledge sharing\(^46\). Lastly, there is a grading characteristic that should be mentioned: students’ potential to create hypothetic or what-if grades and avoid –in that way– any failure.

As far as Sakai is concerned, we shall acknowledge that despite its obsolete interface, it can address certain types of stakeholders. The fact that it offers the largest variety of native tools (more than 30)\(^47\) amongst the other solutions, appeals to those, who are less tech-savvy or are newly introduced into the online learning setting and looking for a standard platform with straightforward tool function. Furthermore, less populated education institutions or economically disadvantaged ones may tend to prefer its free of cost source code.

Regarding the latest version of Brightspace, we shall profess that D2L has invested in expanding platform’s adaptability and predictive modeling capabilities. The LMS considers student’s aptitudes and weaknesses and suggests personalized learning paths related to learning.

\(^{45}\) For more information visit: https://community.canvaslms.com/thread/17395-current-version-of-canvas-lms
\(^{46}\) For information on their differences visit: https://s3.amazonaws.com/tr-learncanvas/docs/BlueprintCoursesandCanvasCommonsComparison.pdf
\(^{47}\) For more information visit: https://www.longsight.com/technologies/sakai-features-benefits
goals. In that way, it caters individual needs and avoids the “one size-fits-all” approach of education that has serious limitations. The adaptive learning technologies act as real-time remediation, since they are based on data on students’ interaction with the material and predict the appropriate content and resources (Maravanyika & Dlodlo, 2018). Therefore, learning is automatically adapted to student’s profile. Undoubtedly, we should not omit to refer to “Student Success System”, which offers predictive charts on students’ potential to succeed. However, in case of a student being at risk of failure, “Intelligent Agents”, created by the instructor, can interfere and prevent any negative outcome. Finally, the wide array of learning analytics provided by Brightspace can be used in combination with the aforementioned tools and enhance students’ learning outcomes.

With regards to the latest version of Moodle, we shall firstly refer to a really competitive feature: the multiple language support. To date, it is offered in approximately 130 languages and the number keeps increasing. In addition, it has got the largest variety of activity tools, compared to the other LMS under investigation. All the tools are accompanied with succinct pedagogical advice that may be quite helpful for a novice online learning instructor. This feature in conjunction with its easy-to-use interface makes Moodle quite competitive amongst the other solutions. Definitely, the fact that the source code comes at no cost and allows a great deal of customizability makes it more attractive.

Last but not least, we shall refer to Blackboard Learn, a powerful LMS that holds a large market share, perhaps the largest one, even today, more than 20 years from its first release. The most prominent features are “Spaces” and “Organizations”, two communication tools that enable group collaboration. The important thing is that both instances surpass course-level walls and establish communication with the whole Blackboard network. Any of the other LMS under investigation does not include such a tool that enhances connectivity amongst peers and builds a strong sense of community. Apart from that, it is worth mentioning that the delivery methods of notifications are not only multiple, but innovative as well (check text-to-voice method). They give students the opportunity to customize the way they are being notified in accordance with their personal needs. In other words, we are talking about a user-driven process.

To sum up, the aforementioned excellent tools and features could be injected into the “ultimate” LMS, whose base consists of all the common attributes that are met across platforms (see Appendix).
4. Conclusion and Future Directions of LMS

In this section, we aim to summarize the important points of the current work, draw a conclusion regarding the subject matter of our interest and suggest areas that require further analysis.

First of all, this study’s foundation goes back in the mid-1980s, when the personal computer, the Internet and the World Wide Web were widely adopted. Definitely, education settings could not remain unaffected by the advent of ICT. Distance learning and e-learning/online learning are two distinguishable teaching/learning methods that emerged at that time. Our interest has been focused on online learning and more specifically on its asynchronous delivery mode through the assistance of LMS. These are platforms that can support any activity executed in a traditional face-to-face education environment; from content distribution and quiz creation to real-time conferences and peer-review assignments. And all these without any temporal or geographic limitations. Nevertheless, the capabilities of LMS have not been so advanced since their first release. The evolution of the Web has revolutionized and changed them. In other words, the different generations of the Web have equipped LMS with different technologies. At this point, we shall highlight that LMS usage has been largely criticized for entailing disadvantages, naming the need for tech-savvy teachers and their curriculum-oriented nature. However, as years go by and technology advances, the positive consequences of their use, such as their time-saving features and the cultivation of learning autonomy, seem to outreach their drawbacks.

Today, we are found ourselves within the Web 3.0 generation, whose technologies offer a more flexible and personalized learning, adapted to students’ profile. Although, there is a sea of LMS solutions available, the LMS Market seems to have consolidated around five major vendors: Canvas, Blackboard Learn, Moodle, Brightspace and Sakai. Amongst them, there is no need to discover the one with the largest Market Share, but it is more interesting to compare their tools and characteristics and point out their biggest assets. The thing that has triggered us to run such a comparative analysis has been the gradually increasing progress of Canvas. Many LMS Comparison and Evaluation Studies have been done, based on different set of criteria and following a different methodology. The great majority of them have tried to compare proprietary LMS with Open source as to find out which software model encompasses more positive aspects. In order to gain an informed insight into that issue we have searched related
studies, conducted since the begging of the decade. Almost all of them have deduced that Moodle is the most powerful platform in terms of its tools and their capabilities. Nonetheless, this finding cannot be firm, because LMSs features and tools tend to evolve during the years. We should not omit to refer to the declining trend that we have traced in features comparative studies the recent years, something that could be explained by the LMS features converging.

After experiencing the free trial of Canvas, Brightspace 10.8.9. and Sakai 12.5., visiting the demo site of Moodle 3.6.2.+ and Blackboard Learn 9.1. and reading through their official sites, we have formed a detailed idea of their current state. As we have mentioned many times, their differences are minor, and thus we have concentrated on presenting their biggest assets, which, if aggregated, could build the “ultimate LMS”. To sum up our findings we could refer to Canvas’ powerful repository, Brightspace’s extensive adaptive capabilities, Sakai’s large variety of offered tools, Moodle’s strong activity tools and Blackboard’s multiple group communication tools. All the aforementioned features and tools echo the Web 3.0 technologies.

At this point, it would be really useful to depict the future of these platforms. Although the idea of Web 4.0 is quite vague, there are some implications of the condition of the post-LMS era. In the literature, some scholars, frustrated with LMS lack of openness, have suggested alternatives, which can build connections with the outside world and enhance learning experience (Kipp, 2018). Personal Learning Environment (PLE) and Open Learning Network (OLN) are two of them. As far as PLE is concerned, it can be described as an ecosystem of tools combined into one platform. This conception can be highly customized by the students, who are able to build an online presence and connect with the world. However, because PLE lacks administrative functions and private spaces, OLN has been proposed. It is a modular network that is based on both the university’s built system for the course administration and the cloud for the diverse collaboration tools. Despite the significant PLE and OLN potential for improved pedagogy, they are mostly theories. For that reason, teachers need to adopt a hybrid teaching approach that allows deeper learning (Kipp, 2018). Since neither LMS, nor interactive collaboration tools, in isolation, offers a perfect solution, there must be a symbiosis between LMS and tools that are connected to the real world. Besides, Web 4.0 is termed as “symbiotic web”. Some practical instances of such a symbiosis have been proposed in the literature. In “The Evolution of e-Learning in the Context of 3D Virtual Worlds”, Kotsileris and Dimopoulou (2013) have stressed the efficacy of VWs in educational procedure. More specifically, immersion, cooperation between users, realistic simulations and multi-channel communication are some of their characteristics that can advance teaching and learning.
processes. Nonetheless, due to the fact that VWs have not been designed in order to serve educational purposes, their interconnection with LMSs is inevitable. The researchers have concluded that Sloode software would be the desired solution, since it gathers a rich set of tools in order to interconnect LMS (in particular Moodle) with VW (in particular OpenSim). Furthermore, in “E-learning in the evaluation of students and teachers: LMS or social networks?”, Mozhaeva, Feshchenko and Kulikov (2014) confirmed the necessity of an integrated approach to the application of LMS and SN in learning process. LMS can supplement classroom lessons with individual work, whereas collaborative work can be achieved in a SN.

All in all, it becomes overt that online learning researchers and educators should not be concerned about the features available in the LMS anymore. Their primary focus should be on the adopted pedagogy and the way that LMS can gain a more significant level of openness towards the real world. More studies should be done with regards to the effective practical symbiosis of LMS with other more student-centered tools.
Bibliography


Farber, D. (2007, February 14). From semantic Web (3.0) to the WebOS (4.0) [Online]. https://www.zdnet.com/article/from-semantic-web-3-0-to-the-webos-4-0/


https://www.pcmag.com/review/337442/instructure-canvas-lms

https://www.pcmag.com/review/335674/blackboard-learn-lms

https://www.pcmag.com/review/346900/d2l-brightspace-lms

https://www.pcmag.com/article2/0,2817,2488347,00.asp


Hill, P. (2016a, September 6). Exclusive: Worldwide LMS market size expected to triple in 5 years... or get cut in half. [Online]. https://mfeldstein.com/lms-market-triple-5-years-or-get-cut-half/


https://mfeldstein.com/d2l-bets-on-the-cloud-and-advances-in-user-experience/


https://blog.capterra.com/top-8-freeopen-source-lmss/


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**Greek Bibliography**


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**Web Resources**


Appendix

The following tables provide a systematic comparison of the tools and features available in the latest versions of Canvas, Sakai, Brightspace, Moodle and Blackboard Learn.

1. Teaching and Learning Features

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<tbody>
<tr>
<td></td>
<td>A Course can be defined by term, course or section dates. Students may be restricted to view the course before the start date or after the end. Instructor may decide to conclude an enrollment and store it, before the end date. Self-enrollments can be enabled with a join code or a secret URL. Students can</td>
<td>Courses sites can be defined by an academic term. “Lesson tool” allows instructor to organize the course by unit, module, week, topic, or any other grouping option. Instructor can decide if the site can be accessed: (a) only by official course members,(b) by those added manually, or (c) by anyone Sakai user of a particular origin or role.</td>
<td>Course-visibility can be defined by start/end date. It encompasses release conditions. Course items that support release conditions are: awards, checklist, content modules &amp; topics, custom widgets, discussion forum &amp; topics, assignments, grade items &amp;</td>
<td>Course availability can be defined by start-end date. There are 4 course formats options for the instructor: topics format, single activity format, social format &amp; weekly format. Regarding the course lay out: may all sections are shown on one page or each section occupies one page.</td>
<td>Course availability can be defined, based on start-end date. Otherwise, instructors can specify available days from the date of enrollment, or set continuous availability. If term dates are defined by institution, courses can be organized using these preset dates. Self-enrollment method can be enabled by setting a start-end date, or using an access</td>
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<tr>
<td>Feature</td>
<td>Description</td>
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<tr>
<td>Drop self-enrolled courses</td>
<td>Users can drop self-enrolled courses while they are in progress.</td>
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<tr>
<td>Course visibility</td>
<td>Course visibility can be set to enrolled course users, the whole institution or anyone with a URL.</td>
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<tr>
<td>Sections</td>
<td>Sections can be added to the course, so instructors can manage student section enrollments. Apart from section, grading periods can also be set and weighted by the admin.</td>
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<tr>
<td>Course association</td>
<td>The course may be associated with a Blueprint course and updated through course syncing. Blueprint Courses are course design templates and components deployed, maintained and updated by admins or designers.</td>
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<tr>
<td>Unauthenticated access</td>
<td>Unauthenticated users may also be allowed to access the site.</td>
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<tr>
<td>Course unjoin</td>
<td>Users can unjoin sites if they have self-enrolled to them using the “Membership tool”.</td>
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<tr>
<td>Instructor management</td>
<td>Instructor may decide to manage large course sites by creating sections and/or groups, that is subsets of students.</td>
<td></td>
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<tr>
<td>Parent sites</td>
<td>Parent sites can be used in managing populous child courses with many sections.</td>
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<tr>
<td>Instructor permissions</td>
<td>Instructor may be allowed to change participants’ roles.</td>
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<tr>
<td>Conditional release</td>
<td>Conditional release of items &amp; content may be enabled.</td>
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<tr>
<td>Instructor control</td>
<td>Instructor can set a time zone &amp; a language.</td>
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<tr>
<td>Existing material re-use</td>
<td>Existing material from other sites can be re-used.</td>
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<tr>
<td>Multiple language support</td>
<td>Multiple language support is provided (+20)</td>
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<tr>
<td>Unenrolled self-access</td>
<td>The maximum upload size ranges from 10KB to 256 MB.</td>
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<tr>
<td>Available enrollment methods</td>
<td>Available enrollment methods: manual enrollment-instructor can define enrollment duration, starting day, assign roles and even rename roles. Self-enrollment that is valid for a specific length of time and secured by a key can be enabled. If students do not access the course for a long time, they are automatically unenrolled.</td>
<td></td>
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<tr>
<td>Guest and observer access</td>
<td>Guest access accompanied by a password can be permitted. The “Cohort sync enrollment plug-in” and the ”Publish as LTI tool” allow site-wide groups and individuals,</td>
<td></td>
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<tr>
<td>Code</td>
<td>code. Guest and observer access can be permitted, as well.</td>
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<tr>
<td>Roles</td>
<td>Roles can be assigned to users and determine which content they see.</td>
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<tr>
<td>Adaptive release</td>
<td>Adaptive release rules for content items can be set, based on date, membership, grade, review status.</td>
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<tr>
<td>Ultra view</td>
<td>Ultra view: complete courses can be accessed by students, but students cannot participate in them.</td>
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<tr>
<td>Multiple language support</td>
<td>Multiple language support (+25).</td>
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<tr>
<td>File management system</td>
<td>HTLM Editor with accessibility checker. Users can record audio/video files. It supports import of course content by copying another Canvas course or using content from other LMSs.</td>
<td>WebDAV: allows instructors to upload multiple files &amp; folders from their local computer to their site.</td>
<td>WebDAV HTLM Editor with accessibility checker &amp; ready-to-use templates. Instructor can access the Brightspace community, download</td>
<td>WebDAV repository &amp; audio/video record “Atto”: HTML editor allows audio/video recording and has an accessibility checker.</td>
<td>HTML WYSIWYG editor, which predicts non-printing characters. It is accompanied by Launch Math editor. Course content can be imported from Bb’s partner publishers, instructor’s cloud</td>
</tr>
<tr>
<td><strong>Gradebook</strong></td>
<td>It shows students’ scoring details, comments, rubrics. The total grade, displayed in point values or percentages, may be enabled. A predefined grading schema has been applied at the course management level.</td>
<td>There are 2 types of gradebook: points-based &amp; percentage-based. Its editable spreadsheet view is handy for users who are familiar with modern spreadsheet applications (eg Excel). Grades can be displayed in letters, percentages, points or a</td>
<td>It displays grade items that may be associated with activities or exist independently. Instructor sets the grading scheme by default (numeric, letter, text), or creates their own. Only numeric grades are displayed.</td>
<td>Instructor sets the gradebook as available to students at the Course Management level. There are the following grade types: no grading, numerical value, scale, text feedback only. The grade value may refer to maximum, minimum or “Grade Center.” Grades may be displayed in categories: letters, points, percentages. Instructors decide how items &amp; categories are weighted. Apart from creating rubrics, instructors can import-export them, sharing with their colleagues.</td>
<td></td>
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</tbody>
</table>
Customizable rubrics related with institution’s/state’s outcomes may be used to define learning mastery. It supports input/output file of grades.

Instructor can mute & unmute an assignment. By muting an assignment, they set all grades to be released at the same time.

Instructor can leave annotated feedback or inline comments, or even comment on the added rubric. Audio/video feedback on assignments is also supported.

SpeedGrader, accessed through Gradebook, allows instructors to easily and quick evaluate assignments by viewing submitted combination of all. The final course grade may be displayed or not. An item can be excluded from course grade calculations. Instructor may add rubrics, categories and weighting. Rubrics can be added to all the activities that are graded. The categories allow dropping highest/lowest grade or keeping highest grade. A category or an item can be designated as extra credit.

A printer-friendly version of individual student grades can be exported. Instructor’s feedback can be in the form of comments and file attachments. Grades & comments can be imported from CSV files and exported in XLS format.

Items can be associated with a course activity. Moreover, instructor can select to automatically release the final grade and keep it automatically updated. The final grade can be set as calculated or adjusted. The grading system determines how grade items contribute to the final grade (weighted, points, formula).

Grades can be entered for many grade items & learners at once (spreadsheet view), or individually (standard view). They can also be entered using a CSV or TXT file.

Grade to pass. Grades may be displayed as percentages, letters or real-actual grades.

Instructor adjusts the weight for each graded item.

Grades can be imported from a CSV file or pasted from spreadsheet/XML file. They can also be exported in an open document spreadsheet/plain text file/excel spreadsheet/XML file.

Feedback types: markers may just leave feedback comments, create annotate PDF files with comments/draws/stamps directly on top of students’ work, comment inline by being able to edit the applying color to the cells in the gradebook, based on grade or status, facilitates quick interpretations.

‘Attendance grades”: instructor can mark students as present, late, absent, excused for each class meeting. Each status is assigned to a percentage out of 100 and may be used in the calculation of the overall grade.

If enabled by the institution, instructors can annotate and grade student assignments directly within the browser.

Except for comments, instructors may leave audio/video recordings as additional feedback to students.
| Assignments and grading and/or commenting on the same interface. SpeedGrader also enables anonymous instructor annotations. Students can create hypothetical or what-if grades (approximate grades for both graded & ungraded assignments). Students are allowed to print their grades. Instructor may choose to use “Roll Call Toll” for grading (absent, late, present). They can edit the values, create a seating chart and add badges. | Instructor may use the “PostEm tool” to present individual feedback and/or grades to students in a CSV format (downloadable). Students can see only their own feedback & grades. “PostEm tool” does not interact with the gradebook. Grade exemptions—even multiple for an individual—can be set for learners with different needs. Rubrics can be created at the organization, department or course level. There are 2 types available: holistic & analytic. They can be attaches to competencies, discussions, assignments, e-portfolio, grade items, and surveys. Rubrics created at the course level cannot be shared with other courses. Feedback to assignments may be text, audio or video files. Instructor can save original text, upload files with feedback—even audio ones—, or select to grade offline by downloading and uploading a worksheet. | Grade exemptions—even multiple for an individual—can be set for learners with different needs. Rubrics can be created at the organization, department or course level. There are 2 types available: holistic & analytic. They can be attaches to competencies, discussions, assignments, e-portfolio, grade items, and surveys. Rubrics created at the course level cannot be shared with other courses. Feedback to assignments may be text, audio or video files. Instructor can save original text, upload files with feedback—even audio ones—, or select to grade offline by downloading and uploading a worksheet. | Instructor can work offline with grade data and import grades or just upload them from external sources (eg. Spreadsheet). Ultra view: gradebook can be presented in item list or student grid. Grading periods based on a period of time (semester) or shared characteristics (group project) can be created and allow easier and more quick execution of tasks (eg. create a report). |
Gamification
Certificates, badges

Assignment
The assignment may be assigned to everyone in a course, a course section, a course group or an individual student.
If group assignment is enabled, students can be graded individually.
Peer review may be enabled. Peer review can be set to be assigned manually or automatically. Intra group peer review and anonymous may be enabled.
Instructor can specify availability dates & time (open/due date, accept until date), add attachments and an optional honor pledge, set to receive notification email for student submissions, allow re-submissions and add a model answer. Regarding grading, instructor has to choose the grade scale, enter the maximum possible grade and enable anonymous grading.
Instructor sets assignment type: individual or group assignment.
Instructor can specify availability dates, add rubrics, add release conditions, allow re-submissions and enter value. An assignment can associated only with numeric grade items in the grade book. Categories may be.
Instructor specifies assignment availability (start-due date & completed date) A cut-off date may be set. A reminder for instructor to grade by a specific date may be enabled. Graders may also be notified about (late) submissions.
Instructor can define a pass grade, enable blind marking to reduce bias, use marking workflow to
Instructors determine the grading schema.
They may decide to add a time limit, a grading rubric, align assignments to goals, enable email notifications for submission receipts.
They may enable group assignments, where all members receive the same grade.
Multiple attempts may be allowed.
<p>| Instructor selects a grading type among: percentage, complete/incomplete, points, letter grade, GPA scale, not graded. | Peer evaluation (maybe anonymous) &amp; group submission can be enabled. Access to assignment may be allowed to site or selected groups. Students’ submission formats: (1) inline &amp; attachments, (2) inline only, (3) attachments only, (4) non-electronic, (5) single uploaded file only. Instructor can submit an assignment on behalf of a student. Assignments can be downloaded, graded offline and then uploaded again in conjunction with feedback comments. Instructor may decide to add comments and/or attachments as feedback to students’ added as to make the assignment management easier by the instructor. 4 submissions types are available: file submissions (instructor sets the number of files allowed), text submissions, on paper submissions, observed in person submissions. Submitted file assignments cannot be deleted by students. For on paper and observed in person submissions, completion can be set to be marked manually by learner, automatically on evaluation or on due date. | release all the marks at the same time or allocate different markers to particular students. Tags &amp; Competencies may be added. Students’ access may be restricted because of grade, date, user profile or a set of nested restrictions. Activity completion can be set to be tracked either manually by students or automatically based on certain conditions. Grades may be in points or scale. Students can submit any digital content or type text directly into the text editor. For the online text submissions, instructor may set a word limit | Anonymous and delegated grading can be enabled. If allowed, instructors can annotate (highlight text, draw etc) assignments right in the browser or use the Bb instructor app. Students may submit texts or attach files. Offline submissions may be chosen by the instructor (eg. Oral presentations) Supported file types: multimedia, audio, video, text, executable, images, web page, movie, spreadsheet, Slideshow, graphic. Original view: SafeAssign may be enabled. Assignments submissions may be downloaded (zip file). Ultra view: conversations can be allowed. Respondus &amp; |
| Groups of different assignment types (assignments, discussions, quizzes, external tool), which may be weighted or not, can be created. The entire assignment group may follow rules that impose the dropping of the highest or lowest score. Submission types: Online submission through a file upload from Google Drive, Dropbox or another 3rd – party service, a text entry, media recordings or a website URL. On paper submission, mobile submissions, or with an external tool. Finally, no submission may be an instructor’s option. Resubmissions may be allowed. | Assignments, apart from entering grades. Dropbox per course, file uploads, mobile submissions. | Instructor may select to receive email message for any newly uploaded assignment. Instructor can record audio to add feedback, or add comments. eRater Grammar feedback and Turnitin (an integration that checks originality of assignment submissions) may be enabled. | Examity Online Proctoring may be enabled. |</p>
<table>
<thead>
<tr>
<th><strong>Search within course for learning content</strong></th>
<th>It is supported.</th>
<th>The “search tool” performs basic and advanced research.</th>
<th>It is supported.</th>
<th>It is supported by a course-search plug in, which offers extra features.</th>
<th>It is not supported.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adaptability features</strong></td>
<td>Differentiated assignments, quizzes, discussions with regards to due dates and available dates can be created in Mastery Paths. 5 requirements can be set by instructor as far as content release: view item, mark the item as complete, contribute to a page or post to a</td>
<td>The site owner/instructor and the system administrator assign roles to users that grant access to certain features. The “Lesson tool” allows instructor to apply conditions to the release of items &amp; content. If the item is a resource, they can ask to be opened. If the item is a</td>
<td>The extensive release conditions 37 release condition types are offered) that can be applied to all course items, allow instructors to create a custom learning path through the course materials.</td>
<td>Access to activities and resources may be restricted by instructors, based on: completion, date, grade, group, fields within student’s profile or a restriction set. With “Lesson”, teacher can deliver content or activities that offer a</td>
<td>Release content based on 4 types of criteria: dates, membership, grade, review status.</td>
</tr>
<tr>
<td>discussion, submit an assignment, score at least X. Depending on the type of the content item, the relevant requirement is set.</td>
<td>forum/quiz/assignment/question comment/student page, they can ask to be completed.</td>
<td>Additionally, Brightspace Leap: is an adaptive learning tool that builds personalized learning paths for learners, based on course-specific, standard or school-specific learning objectives. It recommends the most effective content per learning objective, while it considers user’s personal strengths &amp; weaknesses. It also generates 4 reports that measure learners’ outcomes against objectives and learners’ engagement, activity and progress with regards to the learning path.</td>
<td>variety of paths or options for the learner.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiz creation</td>
<td>It offers 4 Quiz types (graded quiz/practice quiz, graded survey/ungraded survey). It includes multiple question types (10), but quizzes can also be imported from QTI packages. From a course, quiz content can be exported. Availability dates can be defined by the instructor, who also defines if the quiz is available to all students or not. The quiz may be set up to sent to institution’s SIS. Instructor may also decide to shuffle question, set a time limit, allow multiple attempts, show one question at a time, require an access code, and filter IP addresses. Additionally, the types of quiz results that are being “Test &amp; Quizzes tool”: Assessments may be subdivided into parts/sections, where questions are authored one-by-one, or are randomly drawn from a question pool. Instructor can share their question pool with others. It offers multiple question types (13). Instructor may enable self-/peer assessment, allow email notifications for submissions, randomize answers, set re-submissions, require rationale, set a time limit, apart from availability dates &amp; time, enable IP address filter, require a password or enable Respondus LockDown Browser. In addition, they can adjust the lay out and appearance and select the kind of feedback that will get Questions can be added from Question Library, another Collection, a CSV or Zip file, or Brightspace Learning Repository. It offers various question types (9), allows question/answer randomization, prevents users from moving backwards through pages, allows hints, prohibits users from copying/printing questions, disables instant messages &amp; alerts while the quiz is in progress, requires a password, filters IP addresses, can be timed. If instructor allows multiple attempts, they additionally have to It offers multiple question types (16), which are all automatically marked, apart from essay questions. Teacher may allow multiple attempts with the questions shuffled or randomly selected from the question bank. An enforced delay may be enabled for the subsequent attempts. Each new attempt can contain the results of the previous ones. A time limit may be set. Hints, feedback &amp; correct answers may be set to show to students at a particular moment. Navigation method may be set as free or sequential. “Test”: It offers multiple question types (original view: 17) &amp; question randomization. Questions can be added from other tests, surveys or pools. Conversations within tests can be enabled. Tests can be aligned to one or multiple goals. Rubrics can be added too. Instructor may force completion or set a timer. IP addresses can be filtered. Students may be allowed to access a test by providing a password. Anonymous scoring can be enabled. Self-assessment options can be enabled.</td>
<td></td>
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</tr>
</tbody>
</table>
shown to students depend on instructor’s preferences. Extra attempts and extra time for timed quizzes may be set for specific individuals.

If instructor accidentally publishes the quiz results, quiz can be regraded. Quiz results can be downloaded. Quizzez.Next is an upgraded quiz tool.

<p>| Available to students (correct answers, their answers etc). Graders may not see students’ names when grading and grades may not sent to gradebook. Offline grading is available. The assessment can address the entire site, an anonymous user or selected group(s). Moreover, exceptions can be set to time limit and delivery dates for selected user(s) or group(s). Assessments and question pools can be exported in 3 formats (IMS QTI 1.2, IMS Content Packaging, Markup Text). Likewise, such external files can be imported. Instructor can access the following information: Statistical information about student submissions (average specify the calculation method for them. Students may be allowed to view their past quiz submissions. Instructor may select to receive a notification email each time a user completes a quiz. General release conditions and advanced release conditions can be set. The advanced release conditions grant alternative due date, availability dates, time limit and/or quiz attempts to individual users or groups. Respondus LockDown Browser may be enabled. (= it prohibits skipping questions or going back). For security reasons a password and a network address may be required. In invigilated quiz instances, user’s picture may be shown on screen during the attempt and on the review screen. Restrict access, tags, activity completion prerequisites and competencies may be added. Options for grading schema, scoring (eg. partial credit, negative scores), metadata (i.e. tags, level of difficulty, topics, categories) and extra credit can be set. Group tests can be enabled, allowing different grades to group members. Individual students or groups can be excluded from particular settings. Results and feedback options can be defined. SafeAssign can be enabled. Original view: tests can be exported and imported. |
| <strong>Peer review for assignment submission</strong> | It is supported | It is supported | With the “Bongo Assignments” integration, learners can peer review one another’s assignment submissions. | Assignments cannot support the peer review teaching/learning method. However, it offers “Workshop”. This activity enables peer assessment of students’ work. | Peer assessment is a distinct assessment type option. |
| <strong>Self-assessment for</strong> | It is supported with a LTI tool. | It is supported. | Self-assessment is a distinct assessment type option. | Self-assessment can also be enabled with the | Self-assessment is a distinct assessment type option. |</p>
<table>
<thead>
<tr>
<th>assignment submissions</th>
<th></th>
<th></th>
<th>“Workshop” activity, not with the assignments.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customizable UI</strong></td>
<td>Instructor can choose among 5 different lay outs regarding the Course Home Page: Course Modules, Recent Activity Dashboard, Pages Front Page, The Assignment List &amp; The Syllabus. Depending on the lay out the content of the side bar differs. The links that are shown at the Course Navigation can be modified by the instructor. Students can enable User Feature Options (eg. High contrast UL, Underline links etc). They can also add a nickname or customize the color of course card in the Card View Dashboard.</td>
<td>In case of the existence of installed themes or “skins” in the Sakai instance, instructor can determine the banners, colors and images displayed in the site, by selecting a theme. Moreover, the tool menu is customizable, since instructor decides the links that appear in that. However, they may use an available template that gives a pre-configured site, which already contains a collection of tools. Students can choose what widgets are shown on their profile.</td>
<td>Users can change settings for fonts, HTML editor, language, email, discussion etc. Instructor organizes content in modules and topics, customizes themes, navigation and widgets. Links to activities can be added or not in the course navigation.</td>
</tr>
<tr>
<td>Survey</td>
<td>It is a type of QUIZ. It can be graded or ungraded. Instructor defines the availability dates, may set a time limit, shuffle questions, require an access code and filter IP addresses. Anonymous submissions can be enabled, but for a fully anonymous survey there is a third-party tool.</td>
<td>2 types of surveys: (a) basic survey-ungraded, (b) Survey matrix of choices-graded or ungraded. Instructor can select the desired answer format from the list (Yes-No, Agree-Disagree etc), add attachment and provide feedback. Instructor can also add in-line question to a page. In more details, a Multiple Choice Question or a Short Answer Question can be added directly to a Lesson page and be in poll form or in graded form. Students may be allowed to show a graph of how others responded.</td>
<td>Instructor may specify availability dates and include release conditions. Instructor may set it as anonymous. In that case, it cannot be associated with learning objectives. The responses to survey are available to all users, It offers 3 verified survey tools that are prepopulated with questions. The teacher, who wish to create their own survey should use the following activities: ‘Feedback’= a custom survey for collecting feedback from course participants using a variety of question types. Responses may be anonymous and results may be shown to all participants or to teacher only. Availability based on dates can be set.</td>
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</tbody>
</table>
Teachers may enable to be notified of submissions. A link to the next activity can be added. Group mode can be enabled. Access may be restricted based on release conditions. Tags & competencies can be added.

<table>
<thead>
<tr>
<th>2. Communication Tools</th>
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<tbody>
<tr>
<td><strong>Canvas 2019</strong></td>
</tr>
<tr>
<td><strong>Calendar</strong></td>
</tr>
<tr>
<td>A custom color may be assigned to each one of them. Users can view it by day, week, month or agenda list/format. If the Scheduler tool is enabled by the institution, students can sign up for any appointment created for their course (eg. Office hours). Canvas calendar can be exported to another Calendar program (eg. Outlook).</td>
</tr>
</tbody>
</table>
### Announcements

<table>
<thead>
<tr>
<th>Announcements can be copied and imported from another Canvas course.</th>
<th>They can be shown immediately or during specific dates. They may be delivered to the entire class, to groups or to specific sections within the class. The can also be viewable by people outside the course, or even outside instructor’s instance of Sakai.</th>
<th>Students can subscribe to an RSS feed and receive daily updates of all announcement items in an RSS reader.</th>
<th>The Announcements forum is automatically created in a new course. Announcements forum is enabled or not in the course management. By default only teachers can post on it and forced subscription is set.</th>
<th>Announcements with no date restriction can be enabled. Announcements can be set to be posted automatically in a defined date and time. Students may receive them through email. Ultra view: they can be pinned at the top or reordered.</th>
</tr>
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<tbody>
<tr>
<td>The posting may be delayed until a specific date. Instructor can add course announcements, attach files to them or add an external RSS feed. Students may be allowed or disallowed to reply to course announcements and like each other replies. However, in their group home page, they are allowed to perform all the actions that have been described previously as instructor-related.</td>
<td>Instructor may enable email notifications for new announcements. Instructor can add attachments to them and push out announcements to other courses. Students may be allowed to create, delete or edit all announcements or just their own.</td>
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</table>
| **E-mail** | Instead of e-mail, Canvas presents “Conversations”. “Conversations” residing in “Inbox”, allow users to communicate with one or multiple users in the same course. In concluded courses, students can only message instructors or Teacher Assistants. Messages can be filtered by course, or group and type (starred, unread, sent, archived, submission comments). Supplementary files and even audio/video recordings can be uploaded as part of the conversation. In group messages, users can privately respond to another individual. Students can directly reply from conversations to users can send emails to site participants (filtered by role, group, section), or to non-site participants (unenrolled users).
Users can choose to receive copies from their emails and store them to the email Archive tool, as to be visible to all site participants.
“Messages tool”
Users can send & receive private messages to other members enrolled in the course site. Multiple recipients can be set.
Any added attachments can be downloaded.
Message copies can be sent to recipient’s external email addresses.
 | It allows you to send email from within the learning environment. Received emails can be organized in folders or set to be sent to an alternative email account.
Email addresses can be stored in the Address book.
 | It is not supported.
 | It is supported.
It is a send-only tool: users can send emails to other course members’ external email accounts, but they cannot receive emails.
Users can attach files.
A copy of the email is sent to the sender.
“Messages” (=internal mail tool)
It allows file attachments and multiple recipients. Students can communicate with users from the whole Bb network or just with those from their class. They can also simultaneously send an email copy of their message to their inbox (Ultra view).
**Forums**

“Discussions”

Instructor may decide to specify availability depending on dates (& maybe time), or leave them as open. Discussions may be in a read-only state if instructor manually have closed them or the due date has been passed.

They may be set as graded or ungraded. Only graded ones can have a due date and be associated with a rubric.

Group discussions may be enabled by the instructor. Peer reviews may be assigned to students, which cannot be anonymous.

<table>
<thead>
<tr>
<th>Instructor can modify the following forum settings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- specify availability dates</td>
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<tr>
<td>- lock forum (disable forum postings)</td>
</tr>
<tr>
<td>- select post before reading option</td>
</tr>
<tr>
<td>- enable email notifications</td>
</tr>
<tr>
<td>- enable post as anonymous</td>
</tr>
<tr>
<td>- set group discussions</td>
</tr>
<tr>
<td>- require moderation</td>
</tr>
<tr>
<td>- specify grading details</td>
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<tr>
<td>- set permissions based on roles</td>
</tr>
</tbody>
</table>

Instructor can specify availability with regards to forums depending on start/end dates (& time).

It can be graded or not.

Instructor can enable: anonymous posting, moderator approval, users start a thread before they can read, rating with 5 stars/Upvote-Downvote/Upvote only, subscription to a discussion.

Settings of threads: they can be pinned at the top, posted anonymously, users can subscribe to threads as to receive notifications, attach a file or upload an audio/video recording, post.

It offers 5 forum types, which feature different capabilities: standard forum, standard forum with a blog-like format, Q & A forum, a single simple discussion and a forum where each student can post exactly one discussion.

A discussion may be automatically locked after a specified time has elapsed since the last reply.

A subscription mode for participants may be set as forced, optional, auto or disabled.

File attachments may be allowed.
| If allowed, students can create a discussion in a group or in a course, edit/delete their own posts and attach files, embed an image or add a YouTube video into replies. Instructor may impose students to start a thread before they can read. Automatically, users are subscribed to any discussion they reply to. Discussion podcast feed, liking discussion posts, threaded replies can also be enabled by the instructor. A discussion may be set up to sort automatically with regards to the number of likes. Instructor may choose to pin discussions. | their thread to more than one topic. | Read tracking may be set as optional. In that case students will be able to easily check unseen posts. Teachers can restrict students from dominating discussions and allow them to create a certain number of posts in a given time period. Forum posts can be rated. Restrict access & tags & competencies & activity completion prerequisites can be added. Forum Preferences can be set with regards to: a) the type of email digest b) the auto-subscription availability c) the tracking of seen posts. Ultra view: instructor can set a participation deadline (date & time), choose grading type (points, letter, percentage), set up zeros for unsubmitted work, associate rubrics to grading posts, align a discussion with goals and reveal discussion activity to students as soon as they post. Apart from forums, communication can be achieved through Spaces, Organizations, Journal, Conversations (built within documents, group/assignments, group/test, offline submissions, external content). |
### Journals

<table>
<thead>
<tr>
<th>Students can change the settings and manually mark posts as read.</th>
<th>Students may be allowed to add their own content page, which can act as a journal.</th>
<th>A blog that is set to be private can work as a journal for individual’s reflection.</th>
<th>A wiki, set in the individual mode, may be used as a personal journal. Students can keep examination or revision notes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A tool that supports collaboration, such as Google Drive, can work as a journal. Definitely, each student should have their own page. Alternatively, a discussion can also work similarly.</td>
<td></td>
<td></td>
<td>In the Original view only: It is a private space, where students can communicate with their instructor or use it as a self-reflective tool. Only an instructor can create a journal, students can create only journal entries. Instructor may set journal entries as public. Group journal can be enabled. It may be graded and associated with a rubric or not.</td>
</tr>
</tbody>
</table>

### Notifications

<p>| Users define their notification preferences. Notifications can be set to be sent right away, as a daily or weekly summary, or not at all. The available delivery methods are | They are sent via e-mail. They are related to many tools, but gradebook. Users set up how often they want to receive email notifications of site activity. | They are sent daily/weekly by e-mail or SMS for due dates, announcements, grade release etc. | They can be delivered through the web or the email address. Both solutions can be activated even if the user is not logged into Moodle. There is also a Message output plugin that enables | They are delivered in these ways: via email, text message (SMS) or text-to-voice, Blackboard app, Notification Dashboard, activity stream (: Ultra view). SMS &amp; text-to-voice are delivered every 20 |
|---|---|---|---|</p>
<table>
<thead>
<tr>
<th>Features</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chat</td>
<td>It offers real-time conversations with all course users. Any user can participate in a chat conversation and view all chat content. Students cannot delete chat messages. Instructor may enable alerts from new messages to be sent to students. Inline chat, if enabled, can appear everywhere within a course.</td>
</tr>
<tr>
<td>Chat room tool</td>
<td>It offers real-time, text-only communication. Chat room for student groups can be set up as a space that promotes collaboration. Instructor specifies the display options of message history and may allow chat participants to change the display options of their own chat window. “Contact Us tool” allows users to quickly and easily reach the appropriate contact for system issues. They are enabled to report problems or make a feature request.</td>
</tr>
<tr>
<td>Chat</td>
<td>It offers real-time, text-based collaboration. Students can create a personal chat room, enter an alias and enable sound settings. Users coming from different courses can be added. Each chat session is stored in the chat archive.</td>
</tr>
<tr>
<td>Chat</td>
<td>Chat allows users to determine who can message them: only their contacts or their contacts and anyone in their courses. Email notifications for chat messages may be enabled. Conversations may occur in a private or group mode. Users determine if clicking the “Enter” their messages are sent. Frequently visited conversations may be starred to appear first.</td>
</tr>
<tr>
<td>Chat</td>
<td>“Chat” is also called an activity that enables text-based, real-time discussions. It may be repeated at the same time each day or week.</td>
</tr>
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</table>

Since 2016, “Chat/Virtual Classroom tools” have been removed from Bb Learn. Real-time, text-based communication can be enabled only in Bb Collaborate.
| **Poll** | Can be created with “Conferences”, which are executed via BigBlueButton. | “Polls tool” Instructor can post multiple choice survey questions. The responses are always anonymous and the results can be presented to students immediately after voting, after the closing date or never. Students may be allowed to post & manage poll questions. | In Brightspace core there is not something similar, but “Brightspace Wiggio” supports poll creation. | It might adopt a group mode. Access restrictions and competencies may be added. |
| **Virtual Classroom** | With the assistance of “BigBlueButton” | With “WIZIQ”Virtual Classroom extension | With add-ons”Capture”and “Bongo Virtual Classroom” | Poll can be created with Bb Collaborate. |

It is an interactive web conferencing environment with asynchronous voice authoring capabilities.
### 3. Users

<table>
<thead>
<tr>
<th>Student/ Faculty profile</th>
<th>Canvas 2019</th>
<th>Sakai 12.5</th>
<th>Brightspace 10.8.9.</th>
<th>Moodle 3.6.2. +</th>
<th>Blackboard Learn 9.1.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If “Profiles” are enabled by the institution, both instructors and students can update their name, preferred contact methods and any personal link for their account (biography, pictures, social network links). In addition, students may be allowed to change the language preferences, time zone. The profile information is available to all users in a course. Canvas is integrated with a number of 3rd-party web services: Google Drive, Skype, LinkedIn, Twitter, Delicious, but students can use the Canvas open API to create additional</td>
<td>Users can add a profile photo, additional pictures in the profile gallery and post a status message. They can specify their contact information (email, home phone etc.), basic information (nickname, birthday etc), staff/student information (position, department etc/ degree, subjects etc), personal information (favorite book/ TV shows etc) and social networking URLs (Facebook, LinkedIn, MySpace, Skype, and Twitter). More specifically, Twitter can be linked to Sakai profile and posts</td>
<td>Both instructors &amp; students can add: pictures, social network links, contact information, personal information, education information, work information.</td>
<td>Both students and instructors can edit their profile information (personal information, timezone, interests, Skype-Yahoo-MSN ID). They can also add a picture and links to further pages.</td>
<td>Basic profile: a profile page with picture &amp; “about me section” and an area for posts. Students can turn on their Facebook &amp; Twitter picture, description, and email address. Enhanced profile (it can be kept through students academic &amp; professional life): may include tiles (institution, major, projects, internships etc), competencies (techniques/ skills learned), project activity (with links to project images &amp; videos), work experience (company, job title, duration etc). Users can follow others and see their posts or block those</td>
</tr>
</tbody>
</table>

- Both instructors & students can add: pictures, social network links, contact information, personal information, education information, work information.
- Both students and instructors can edit their profile information (personal information, timezone, interests, Skype-Yahoo-MSN ID). They can also add a picture and links to further pages.
- From the user profile page, a wide range of preferences can be set (regarding language, forum, editor, course, calendar, security keys, messages notification).
- Badges earned may be displayed at this page.
<p>| Course-level groups with private files, forums etc. | Groups have their own calendar, discussion board and collaboration tools (e.g. Google Docs). Students may be allowed to create their own groups and invite other users. “People page” shows all the users enrolled in the course and allows them to communicate through any | Instructor or site owner can group students in the following ways: manually creates &amp; assigns users to a group creates joinable groups that students can elect to join automatically generates groups by role, number of groups per site etc import groups from a file. | Groups have their own discussion forums, assignments &amp; locker area to work. Group members can be graded individually or not. Sub-groups based on section or group enrollment can also be created. Instructor may enable auto-enrollment, | There are 3 group modes: no groups, separate groups-each group can see only their own group, visible groups-each works in their own group, but they can also see others. Instructor can create groups by manually adding users, or decide to create them automatically, based on the number of groups and the number of members per group. Group members may presenting abusive content (“People tool”). Users may set their profile as available to all Bb users, to institution users, to their classmates or decide to hide it. An institution may not allow students to change their personal information. | ‘‘Spaces’’: enable group collaboration. Students can create-for example-a study group and enroll students. Tool’s availability (blogs, email, file exchange etc) for each group is determined by the instructor. They can also search and request to join to someone else’s space. ‘‘Organizations’’: follow the course structure and offer similar tools &amp; features. |</p>
<table>
<thead>
<tr>
<th>See online users</th>
<th>social media site they have registered.</th>
<th>Assignments and tests/quizzes can be assigned to particular groups. Private announcements can be made available to a group. Group members may be allowed to upload content to a group resources folder.</th>
<th>randomization of users and self-enrollment in groups.</th>
<th>be allocated randomly, alphabetically or by their ID number. It is also possible that instructor enroll students into groups by using a group enrolment key. Finally, groups can be imported via a CSV file. Group messaging can be enabled by the instructor and the access to a particular activity, resource or topic section can be restricted to specific groups or groupings (i.e. a collection of groups).</th>
<th>Students can create or find and join organizations in order to have discussions, share files, post information. Both cases are not restricted to course-level though. They can include the whole Bb network.</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the chat page.</td>
<td>It is supported.</td>
<td>At the classlist.</td>
<td>It is supported.</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
### 4. Content

<table>
<thead>
<tr>
<th>Blogs</th>
<th><strong>Canvas 2019</strong></th>
<th><strong>Sakai 12.5</strong></th>
<th><strong>Brightspace 10.8.9.</strong></th>
<th><strong>Moodle 3.6.2. +</strong></th>
<th><strong>Blackboard Learn 9.1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students can create blogs with Google’s Blogger tool</td>
<td>With an LTI tool.</td>
<td>Users’ blog can be linked with their profile, so blog visitors can also view their profile. It promotes interaction with other users by finding and following their blogs. Blog entries can be automatically shared with other users (public blogs), even with those who are not logged into Brightspace (through an external URL). A blog writer may enable comments on their blog and the others may select to comment anonymously. Only the blog owner can delete comments from their blog.</td>
<td>Blogs in Moodle are user based - each user has their own blog. Users can also register their external blogs, such as Blogger or WordPress, so that entries are automatically included in their Moodle blog.</td>
<td>It offers 3 types of blogs: course blog, individual blog &amp; group blog. Block’s availability can be specified by date &amp; time. Students may be allowed to edit, delete entries. Anonymous posting may be enabled. Blog entries can be saved as drafts and posted later. Grading can be enabled. Different grades can be assigned to group members. Instructor can add a rubric.</td>
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</table>
An email can be sent to blog writer, when new comments are added.

If allowed by the institution, users can publish their blogs as an RSS feed.

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<thead>
<tr>
<th><strong>Glossary</strong></th>
<th>It is not supported.</th>
<th>It is not supported.</th>
<th>It is enabled at the administrator level.</th>
<th>It is supported.</th>
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<tbody>
<tr>
<td><strong>Database</strong></td>
<td>It is not supported.</td>
<td>It is not supported.</td>
<td>It is not supported.</td>
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<tr>
<td><strong>Linking to external web, internal LMS tools/content</strong></td>
<td>It is supported.</td>
<td>It is supported.</td>
<td>It is supported.</td>
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<td><strong>Wiki</strong></td>
<td>The wiki activity can be achieved through a student editable content page.</td>
<td>Wiki has 2 levels of permissions: site level &amp; page level. Users may be allowed to read pages, create pages, update/edit pages. Instructor can make wiki pages available to the outside world, beyond the course.</td>
<td>With an external wiki tool. It is supported. The wiki mode may be set as collaborative (everyone is able to edit the wiki pages) or as individual (everyone possesses each own wiki, which only they can edit)</td>
<td>Only in the original view: Only an instructor can create wiki, but students can create pages. Wikis can be graded or ungraded. Instructor can define date-time availability, associate rubrics, add alignments, and set wikis as closed to editing by students or open. Links can be added to wikis consisting of at least 2 pages. Group wikis can be enabled. An individual group member can be assigned a different grade.</td>
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<td><strong>Content Bookmarks</strong></td>
<td>Bookmarks can be added in the questions at the question bank.</td>
<td>It is not supported. Users can add bookmarks in the course content.</td>
<td>Bookmarking is offered only to administrators, who can bookmark site admin pages for easy access.</td>
<td>Bookmarks can be added in the Content Collection and in a (group) folder.</td>
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<tr>
<td><strong>Student Portfolios</strong></td>
<td>It is supported</td>
<td>With an external tool. Otherwise, the “DropBox tool” can act as a Portfolio, because it is supported and integrated with all the resources and activities.</td>
<td>Administrators determine which portfolios (i.e. Box, Flickr, Google Drive, Picasa, Mahara ePortfolio) are supported.</td>
<td>It is supported via HMH Portfolio.</td>
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<tr>
<td><strong>Content Collection residing in the LMS</strong></td>
<td><strong>it offers a private folder for each student, where they can upload files.</strong></td>
<td><strong>are enabled on the site. Items that can be exported are: multiple/single assignment submissions, Chat sessions, Database activity module entries, Database activities, Forum posts, Glossary entries</strong></td>
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<td><strong>“Blueprint Courses”</strong> are master courses, generally created by an account admin or an instructional designer. They include locked and unlocked content and sync to one or more associated courses. “Canvas Commons” is a digital library that enables educators to find, import, and share resources with those belonging in the Canvas network.</td>
<td><strong>“My Workspace” provides a secure storage location, where users can privately save material. Optionally, they may decide to make it public (but with no restricted access) Brightspace Learning repository: stores, manages &amp; shares learning objects. Instructors can review, rate &amp; provide feedback on learning objects to ensure high quality.</strong></td>
<td><strong>Each user has a private files area for uploading and managing a set of files. Administrator may enable users to email files to their private files area. “Content Collection” contains personal (i.e. user’s) files and folders, course related files and folders &amp; institution related files and folders (eg library items), Portfolios, Learning Objects. Users can share their own files or search for files generated by others.</strong></td>
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### Course content provided by 3rd-party applications

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<th>Application</th>
<th>It is supported</th>
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It is supported and Canvas also holds its own app center.

- It is supported.
- It is supported.
- It is supported.
- It is supported.

5. Statistic Information

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<tr>
<th>LMS</th>
<th>Learning Analytics</th>
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| Canvas 2019 | If allowed, students can view their own analytics in any active course: by default analytics are shown in a graph-format. There are 4 types of graphs that can be displayed in a table format as well:  
  a) The activity by date graph shows page views & participation in activities  
  b) The communication graph shows the instructor can view summary reports displaying information for visits (total number of site visits, average percentage time per visit etc), activity events (most active tool, most active users etc) & resources (the most opened file, users that |
| Sakai 12.5  | Brightspace Insights 10.4. is a data mining & reporting service that offers 3 different report types regarding learner behavior, grade achievements and usage patterns. Due to their graphical nature, they can be exported only to PDF. Brightspace Insights 10.5 offers reporting visualizations that provide a complete, near real-time picture of learners across courses. |
| Brightspace 10.8.9 | Available reports:  
  a) Competency Breakdown report: teachers can view their students’ competencies in the course, along with ratings.  
  b) Logs either live or not, are available at both site & course level.  
  c) Course activity report: shows the number of views of each activity & resource. If enabled in the |
| Moodle 3.6.2.+ | EAC Visual Data: displays how students are going on tests & rubrics (Original view).  
  Course instructor can also view student activity for Kaltura multimedia content. (Original view)  
  Analytics reports:  
  a) Course –at-a-glance (interactions, submissions, time in course),  
  b) Activity & grade scatter plot,  
  c) Activity matrix (graph of submission trends over the semester), |
| Blackboard Learn 9.1 | |
conversations made within “Inbox”
c) The submissions graph shows the status of assignment submissions (e.g. on time, late, etc).

d) The grades graph shows the median, high & low scores of all the assignments.

In addition, instructor can run a report that shows attendance data. It can be generated for the entire course or for a specific student and is sent to instructor’s email and can be downloaded as a CSV file. Outcomes result report, Access report for all users in a course, Interaction report with an individual user and opened the most site files etc).

Moreover, instructor can create custom reports, in the form of charts, for more detailed information (visit details by date, user etc).

Reports can be exported in an XLS, CSV, PDF file, or just printed.

tools. The 4 types of reports can be exported for further analysis in 3rd-party tools.

Students can check their course progress using the “class progress tool”. It tracks assignments & feedback and measures 9 progress indicators: grades, objectives, discussion, content, assignments, quizzes, checklist, surveys, login history.

course management, students can access reports of their contributions, logs and a statistic report.

d) Complete report: shows an individual student’s full activity & contribution in a course.

e) Participation report: generates a list of those, who have participated in a given activity and how many times.

f) Activity completion report: indicates the activities completed by each student.

g) Grader report: is an overview report that shows the position of student in relation to the rest of the class for each grade item.

d) course submission summary report for each student for all graded items,

e) Comparative activity report showing submissions & time spent in course.

f) Course Activity Related to Grades report. It is a printable report that presents statistics of performance (min/max values, range, average, median, standard deviation, variance).
<table>
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<tr>
<th>Predictive information</th>
<th>Instructors can self-predict at-risk students by looking into “Student Analytics” that shows page view, participations, assignments, and current score for each individual student in the course.</th>
<th>Site use statistics and user activity events shown on “Statistics tool” help instructors identify unengaged, at-risk students.</th>
<th>Brightspace “Student Success System” can make predictions about the final grade of each student &amp; present those at risk. Instructor can view “assessments predictive chart”, “social learning predictive chart” &amp; “success index predictive chart”.</th>
<th>“Student at risk of dropping out”: is a built-in model that predicts students who have not participated in the last quarter of the course and thus are in danger of dropping out.</th>
<th>Retention center: it is being based on students’ engagement &amp; participation and indicates students at risk (original view).</th>
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<tr>
<td>Automated Intervention system</td>
<td>It is not supported.</td>
<td>It is not supported.</td>
<td>Instructor can create Intelligent Agents that send emails to users, who have not completed a required quiz or assignment.</td>
<td>It is not supported.</td>
<td>It is not supported.</td>
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<td>Course evaluation reports</td>
<td>Apart from the learning analytics reports that can be used by instructors as to</td>
<td>Instructors can assume ineffective course material by</td>
<td>Amongst the 30 different report types that are available in Brightspace,</td>
<td>Except for viewing learning analytics reports, instructors can be based on a 3rd party</td>
<td>Instructors can use 2 types of reports as to evaluate their course with regards to goals &amp; coverage: Course</td>
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</table>
evaluate their work, Instructure partners with 3 external tools (EvaluationKIT, EvaSys, eXplorance) that are specialized to course evaluation reporting and can be integrated with Canvas. considering site use statistics and user activity events. there are 4 of them related to Learning Outcome Evaluation and Competency Achievements. tool (eg E-Thinking Reporting tool) as to gain a more indisputable insight into course effectiveness. performance report & Course coverage report

<table>
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<th><strong>6. Technical Specifications</strong></th>
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<tbody>
<tr>
<td><strong>Canvas 2019</strong></td>
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<tr>
<td><strong>Latest Version</strong></td>
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<td><strong>Deployment</strong></td>
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<td><strong>Platforms</strong></td>
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<td><strong>Browsers</strong></td>
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<tr>
<td><strong>Open source (OS)</strong></td>
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<tr>
<td><strong>Installation- Maintenance Training / Support- Service</strong></td>
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<tr>
<td><strong>Costs</strong></td>
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| **M-learning (mobile apps)** | Canvas student app  | There is not a Sakai mobile app affiliated with Sakaiproject | Brightspace Pulse  
Brightspace Assignment Grader  
Brightspace Binder  
Brightspace ePortfolio | Mobile app (accessible offline) | Bb instructor app & Bb app for students |
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<td></td>
<td>Canvas Teacher app</td>
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<td>Canvas parent app</td>
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<td></td>
<td>Canvas poll app</td>
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