Differences of E-Learning Systems With the Focus on Moodle and Blackboard Systems

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ABSTRACT

With the development of new technologies and their implementation in all areas of life, especially education, it is important to understand and accept all the new educational/technological concepts and their benefits. Through the concept of virtual learning environment, educational institutions can improve the quality of the learning process, reduce costs, but also improve communication between students and lecturers. The main objective of this paper is to present characteristics of two most used e-learning systems (Moodle and Blackboard) and provide results of the literature review on the differences of these two systems. Based on the results of literature review, a comparison between Moodle and Blackboard based on ISO 25010 framework is made. Through this secondary research, it was concluded that Moodle is the best solution for introducing a learning management system, but there are numerous opportunities for improving the education system at all levels.

KEYWORDS

Blackboard, E-Learning, ISO 25010, LMS, Moodle

INTRODUCTION

New technology and new concepts of learning are transforming the existing learning system into the new virtual system that functions in a virtual learning environment. The integration of education and technology is present and almost every educational institution has adopted the e-learning concept into its educational services (Al-Fraihat, Joy, & Sinclair, 2019). New generations of students grow up with new technology, also referred to as digital natives (Suša, 2014), especially the Internet and social media, and digitization and virtualization of learning are not foreign to those new generations. Lecturers must adapt to new concepts and consider all the benefits that new ways of learning have to offer (Rodrigues et al, 2019). Using the Internet, mobile phones and other gadgets and devices for learning is the future and the Internet is a tool that can be used to replace traditional learning (Aloia & Vaporciyan, 2019). e-learning is a very popular subject among different scholars and there are many case studies made in this field. However, with many scientific papers already written, it is important to clarify the basic components of an e-learning system to differentiate parts of the virtual learning environment. Since the field of e-learning is relatively new and new concepts are emerging

every day, some specific problems, that are primarily related to not understanding the systems used for e-learning, are also emerging.

To understand the influence of e-learning, it is necessary to understand fully all the components of e-learning systems, especially learning management systems that are key to today's education. This paper presents an overview of the e-learning system components but focuses on one – Learning Management Systems. The biggest advantage of using Learning Management Systems in education is to develop autonomy, which can improve critical thinking among the students and improve the quality of the educational process. To consider all the advantages, educational institutions and their members must face one of the largest challenges of e-learning, which is learning management systems (Judge and Murray, 2017) or facing the transition from formal learning to new platforms. Learning Management Systems became a tool for managing educational material and there are many types such as Moodle, Blackboard, Canvas, and others (Elfeky 2019). Moodle and Blackboard are mostly used LMS's in practice and are also used as a focus of many types of research (Soykan and Şimşek, 2017). Although the comparison of Moodle and Blackboard systems are made in numerous scientific papers, it is important to highlight different perspectives that are made through those researches. Most of the papers regarding this subject offer a technological view on Learning Management Systems or present results of surveys based on LMS user's satisfaction. This paper offers a different view on Moodle and Blackboard systems that is based on quality.

With the comparison of the two most used Learning Management Systems, which is based on the conducted research, this paper offers a holistic view on the topic of Learning Management Systems in the context of e-learning. To carry out any further research into the topic of e-learning, it is important to distinguish all terms related to this concept. Through this paper, a foundation for understanding the virtual learning environment and its components as well as the comparison between Moodle and Blackboard is given. The focus of this research is the difference in the quality of Moodle and Blackboard systems, as the two most used systems. Through secondary research, it is necessary to gather all the information available on both systems, as well as all the information needed to conduct a comparison based on ISO 25010 model. ISO 25010 is based on ISO 9126 model that focuses on the quality of software and it gives a good overview of the overall quality of a system. The main question of this research is the level of quality of both systems and the correlation between the quality level of a system and the user's preference. Strugar, Pejic-Bach, Zoroja and Jaković (2019) conducted an online survey with the goal of investigating the relationship between the future intention of using LMS's and student satisfaction. What it proved to be relevant for satisfaction, as well as for future use is the quality of a system. Precisely that quality can be measured with this method.

The main objective of this paper is to compare Moodle and Blackboard, as the two most used LMS's. To make a comparison it is necessary to gather all conducted researches on the Moodle and Blackboard systems that will be used as an input to a comparative analysis between two systems. This paper shows a different perspective on Moodle and Blackboard systems through a conducted research on the difference in the quality of the two systems, but also through the noticed correlation between conducted surveys on the users' satisfaction and the overall system quality, as well as it gives a recommendation for improvement. The aim of this research is also to point out the link with the requirements of the quality management system and to recommend the applicability of the model to institutions seeking certification or quality management of the institution from every aspect and at different levels. One of the requirements of ISO 9001:2015 is to ensure competence. Institutions of higher education that wish to be certified, or to align their management with ISO 9001, can use ISO 25010 as a tool to ensure competence. Through ISO 25010, institutions ensure the quality of software systems they use to improve the teaching process and disseminate content and knowledge. Also, ISO 25010 ensures the reduction of risks associated with software used at high education institutions. This model ensures that the software used at an institution aligns with requirements defined by users - teachers and students. Evaluating the software avoids the risk of non-compliance as well as other risks such as information security. This paper presents an assessment of two commonly used systems

- Moodle and Blackboard. Through ISO 25010, a theoretical and practical approach compares the compliance of these two systems with the requirements set by educational institutions.

This paper is sectioned into three parts. The first part of the paper is dedicated to understanding basic terms related to the e-learning concept. In this first part, new learning concepts that emerge from using new technologies in education are described. The second part of the paper is focused on Moodle and Blackboard systems. In this second part, ISO 25010 model is closely described as the used methodology as well as the literature review on both systems. Through the second part, a comparison of these two systems is given, as well as the overall quality grade for each of those two systems. Lastly, the third part is a discussion about the conducted research, conclusion and recommendations.

BACKGROUND

LMS's in The Context of Virtual Learning Environment

To understand the connection between Learning Management System and Virtual Learning Environment, it is necessary to first understand the foundation and that is e-learning. E-learning or electronic learning systems are systems that involve the application of some information technology and information systems as an on-line or offline service. The application of an e-learning system can be through an Internet, computer, virtual and digital learning environment (Abdellatief et al., 2011). There is no clear definition of an e-learning system. The development of this type of system was influenced by the development of new technology that changed the learning style. New technologies made learning possible from any place at any time. Virtual Learning Environment is an environment in which e-learning is applied.

A virtual learning environment (VLE) includes components in which students and lecturers participate in "on-line" interactions of different types. Weller (2007) highlights that the concept of a virtual learning environment is often considered inadequate in relation to the traditional understanding of physical learning, and the reason is the use of the term 'virtual', which contrasts with 'real'. Despite the research carried out to counter this view, it still exists in society. In the context of the virtual environment, it is necessary to mention two concepts that are often misunderstood when it comes to understanding e-learning. Those two concepts are Learning Management Systems (LMS) and Managed Learning Environment (MLE). Stiles (2000) explains that it should be emphasized that the VLE and LMS are designed to work for managing and facilitating student activities, as well as the source of content and resources needed to successfully perform the set activities. In contrast, MLE includes all features of course management, student records and wider management, sharing, and content publishing.

Qwaider (2017) defines LMS as the technology used to plan, implement, and evaluate the learning process. This system allows lecturers to create and deliver content, monitoring and evaluation of the success and participation of a student. LMS provides the infrastructure through which content for learning is delivered and managed. It provides a set of software tools that perform various tasks related to e-learning management. There are many LMS's available, and two of them are already mentioned Moodle and Blackboard, but there are also many others like Edmodo, SumTotal Systems, Skillsoft and others. The other term considered extremely important in the context of learning in virtual environments, is Content Management Systems (CMS), which are news, discussion forums, file transfer centres, web directories, etc. CMS allows you to switch classic documents into web content. It also supports the effectiveness of distance learning through virtual classrooms. CMS also has its other version, which is LCMS, or learning content management systems. LCMS (Learning Content Management System) is used to store learning content. LCMS is an LMS upgrade, but it increases the author's ability to participate in creating, storing, using, and reusing the learning module. The content management system can be considered part of the e-learning structure. At the same time, LCMS is one of the kinds of Content Management Systems (CMS), which includes applications that facilitate the design, testing and dissemination of electronic content on the Internet (Qwaider, 2017).

VLE, LMS, and CMS together form the already mentioned MLE or managed learning environment. In general, MLE covers all university systems such as administrative systems. MLE can be defined as a whole set of information systems and processes of an institution that directly or indirectly contribute to learning and management of learning (Weller, 2007).

E-learning systems should be designed as an environment to enhance student autonomy, multimedia content learning, and problem-solving skills, with lecturers as mentors. Students should not passively accept information by mimicking the formulations or conclusions of others but should be encouraged to internalize and transform information through active consideration. Authors Liaw, Huang and Chen (2007) have concluded that with the help of formal authority and the use of e-learning system, students have more opportunities to develop complex cognitive or metacognitive skills such as organizing different information, formulating their own views or separating topics in subtopics. Such learning activities are effective in developing higher-order thinking skills, such as defining problems, judging information, and making appropriate conclusions. With this set of skills, students are developing their digital competence and digital literacy, which should enable a higher quality of education on the theoretical and practical level, because those competencies are a foundation for every individual progress but also scientific progress (Kovačević, Mesić and Mutavdžija, 2018).

MOODLE AND BLACKBOARD

Since developing an e-learning program requires major knowledge in design, programming and time domain, for educational purposes, an alternative to this can be learned within the existing LMS. One of these systems is world-wide-ranging Moodle (Modular Object-Oriented Dynamic Learning Environment). Authors Kotzer and Elran (2013) explain that Moodle is an open access system that allows system customization programmers to meet individual needs. This system has good communication with other web resources such as social networks and enables creativity to users. Moodle's design is based on socio-constructivist pedagogy. This means that its goal is to provide a set of tools that support online research-based and discoverable learning. Kumar and others (2011) explain that Moodle consists of six groups of modules, namely: communication modules, productivity modules, student engagement modules, administrative modules, course modules, and curriculum development module. Communication modules include file sharing, internal and external discussion forums via email and chat in real-time. Among other features, users can use images and direct URLs as well as various attachments. Productivity modules include a search module, a calendar module, a help module, a progress module, etc., while student engagement modules include a workshop module and a group work module, as well as a student portfolio module and self-assessment. It is necessary to pay attention to the administrative module because access to this module allows access to all other modules. In this module, the group enters an authorization for authentication, registration integration, and other hosting service modules. The modules of the course are, with administrative modules, vulnerable groups because they include assessment tools and exam modules. The last group of modules is modules for curriculum development, which are used to create performance courses.

Unlike the Moodle system, Blackboard's LMS system is particularly widespread in US universities. It is estimated that 20% of colleges in the United States use Blackboard software. The management learning software market has a huge potential since it is estimated that approximately 59% of the colleges in the United States currently do not use any learning management system (Machado and Tao, 2007). Blackboard LLC, founded in 1997 by two advisors for education, Matthew Pittinsky and Michael Chasen, as a consulting organization, which provided technical standards for creating applications for e-learning. The Blackboard vision was to provide an understandable way for the lecturers to submit information about courses, including curriculum, programs, and study guides, and more, to web platforms. Blackboard Inc. offers two comprehensive production lines called Network Transaction (NTE) and Network Learning Environment (NLE). The NLE platform integrates data and e-learning applications (Bradford et al., 2007). Blackboard is defined as a software package designed

to help educators create quality online courses. Blackboard can be accessed from the Internet at any time, from anywhere. Students through this system can get tasks, notes, presentations, or Internet hyperlinks. They can also publish their completed tasks themselves. Authors Al Meajel and Sharadgah (2018) highlight that Blackboard also allows professors to build electronic interactive courses and manage tasks like assignments, tests, scores, course outlines, sending and receiving emails, and announcements to students. The Blackboard system also enables the professors the ability to divide the students into groups and allows immediate live-chat among the members of the groups, with the ability for professors to manage these live-chats. Since Moodle and Blackboard are two leading learning management systems, a comparison of those two systems is conducted further on.

METHODOLOGY

The goal of the paper is to present a characteristic of two e-learning systems that are often used: Moodle and Blackboard, using observational and desktop research. Gathered data will be used as an input for systems comparison based on ISO 25010 model. ISO 25010 model is based on eight categories with 31 characteristics that are shown in *Table 1*. This model was presented by ISO 25010:2011. This model or framework, based on ISO 25010 was proposed and used by Hovorushchenko and Pomorova (2016), Rafique, Lew and others (2012), Acharya and Sinha (2013), Alves, Silva and Dias (2014), Iqbal and Babar (2016). This research will be conducted based on the proposed framework.

Since this comparison is based on previous conducted researches, a simple scale from one to five will be used to grade every characteristic of each category. Each category will be graded as a whole; subcategories shown in the previous table are used for understanding the model. For each category a detailed description will be given. Given grades are in accordance with gathered data. If there is no data available for a specific characteristic, a symbol "o" will be given. All given grades will be summarized at the end. All the grades were assigned by all three researchers based on the collected literature, ie theory and practice. Researchers assigned ratings of functionality, performance efficiency, compatibility, usability, reliability, security, maintainability and portability. In case of discrepancy between grades, medial grade was taken.

RESULTS

Through observational and desktop research, the conducted researches that are used as an input for the comparison based on ISO 25010 model are presented.

FUNCTIONAL SUITABILITY

Functional Suitability is related to the degree to which the set of factors are satisfying users of Moodle and Blackboard. Authors Kerimbayev and others (2019) conducted a study proving that LMS Moodle is a high-level strategic solution for planning, conducting and managing learning activities. Through that study, they concluded that all Moodle functions are in accordance with the user objectives. Other study made by Badia, Martin and Gomez (2018) conducted on a group of teachers, showed that teachers perceive that the only educational benefit of Moodle's use is to extend the limits of the physical classroom. Siekman (2017) compared Blackboard to WebCT. In that comparison, he stated that Blackboard is customizable but lacks in offering targeting language environment, which can be a problem for learning in foreign languages other than English. On the other hand, Larkine and Irvin Belson (2005) think that Blackboard is a multilingual platform with global reach. Both Moodle and Blackboard are functional, so to compare them in the context of functional suitability, it is necessary to focus on specific disadvantages of both systems. Mikulan and other (2011) conducted a survey where they defined positive and negative aspects of Moodle. Some of the positive ones were easy

Table 1. ISO 25010 model

ISO 25010 Software Product Quality model		
Category	**Characteristics**	**Description**
Functional Suitability	Functional Completeness	A degree to which the set of functions covers all the specified tasks and user objectives.
	Functional Correctness	A degree to which a product or system provides the correct results with the needed degree of precision.
	Functional Appropriateness	A degree to which the functions facilitate the accomplishment of specified tasks and objectives.
Performance Efficiency	Time Behavior	A degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements.
	Resource Utilization	A degree to which the amounts and types of resources used by a product or system, when performing its functions, meet requirements.
	Capacity	A degree to which the maximum limits of a product or system parameter meet requirements.
Compatibility	Co-existence	A degree to which a product can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product.
	Interoperability	A degree to which two or more systems, products or components can exchange information and use the information that has been exchanged.
Usability	Appropriateness Recognizability	A degree to which users can recognize whether a product or system is appropriate for their needs.
	Learnability	A degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use.
	Operability	A degree to which a product or system has attributes that make it easy to operate and control.
	User Error Protection	A degree to which a system protects users against making errors.
	User Interface Aesthetics	A degree to which a user interface enables pleasing and satisfying interaction for the user.
	Accessibility	A degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use.
Reliability	Maturity	A degree to which a system, product or component meets needs for reliability under normal operation.
	Availability	A degree to which a system, product or component is operational and accessible when required for use.
	Fault Tolerance	A degree to which a system, product or component operates as intended despite the presence of hardware or software faults.
	Recoverability	A degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the desired state of the system.
Security	Confidentiality	A degree to which a product or system ensures that data are accessible only to those authorized to have access.
	Integrity	A degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data.
	Non-repudiation	A degree to which actions or events can be proven to have taken place so that the events or actions cannot be repudiated later.
	Authenticity	A degree to which the actions of an entity can be traced uniquely to the entity.
	Accountability	A degree to which the identity of a subject or resource can be proved to be the one claimed.

Table 1. Continued

Category	Characteristics	Description
Maintainability	Modularity	A degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components.
	Reusability	A degree to which an asset can be used in more than one system, or in building other assets.
	Analyzability	A degree of effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified.
	Modifiability	A degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality.
	Testability	A degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met.
Portability	Adaptability	A degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments.
	Installability	A degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment.
	Replaceability	A degree to which a product can replace another specified software product for the same purpose in the same environment.

Source: Authors' work according to ISO/IEC 25010 available on iso25000.com

to use, good communication tools, free and available. On the other hand, some negative aspects of Moodle were that it was not systemized, meaning that some icons were not easy to follow. They also stated that Moodle has limited chat rooms and that it cannot import all types of files. Larkine and Irvin Belson (2005) did similar research where they introduced Blackboard into the classroom and measured students' satisfaction with interactive live chat. Blackboards chatroom showed great experience among the students and they were satisfied working in a group environment. Momani (2010) made a comparison between Moodle and Blackboard based on a set of different characteristics. This comparison showed that in the context of functional suitability, Moodle has a frame that shows course objectives and activities, as well as a feedback module for students that can be used to create surveys. Students can upload any kind of format on the system and teachers can track students time spend on the platform and other useful information that can help follow student's activities. Not so different from Moodle, Blackboard also offers a frame to view course objectives and activities, it also has a feedback module and lecturers get a Performance Dashboard to track students' grades or activity. Based on that comparison it can be concluded that both systems have a high degree in which the factors are satisfying the users, both teachers and lecturers, as well as students do.

PERFORMANCE EFFICIENCY

Authors Perez and others (2019) conclude through a study that instructional design of Moodle courses involving interaction with content resources and people have more impact on learning outcomes. Moodle enables users to manipulate with different content resources making it easier and more interesting to use. On the other hand, authors Dragulescu and others (2012) suggest that the default Moodle interface offers slow and laborious contact information extraction, leading sometimes to the alteration or loss of data. Hard, Bird and Farmer (2019) tested Blackboard Collaborative for supporting nursing student's placement learning. Through this pilot, they concluded that Blackboard

is efficient, easy to use technology. This pilot also showed how using virtual learning environment is good for training and gaining new skills. Authors Kokan and others (2014) concluded that virtual learning environments cannot replace teaches and that Moodle cannot function itself but that it would be the best if the learning process combines e-learning with traditional learning. In the Moodle and Blackboard comparison made by Momani (2010) performance efficiency and resource utilization are given. In the context of performance, for the learner, Moodle offers real-time chat rooms with saved conversations for later viewing, audio/video conferencing, whiteboard capabilities and different discussion forum activities. Students can submit different types of files on Moodle, they also have their internal e-mail address, but they can also choose to use their external e-mail address for receiving any kind of news and information. Moodle also offers an online journal as a great communication tool. Students can search on Moodle any information thorough keywords and they have a calendar of activities. Each student has its own profile and the can also use Moodle offline. When it comes to Blackboard, it also contains real-time chatrooms that lecturers and teachers monitor and manage, with the chat service, audio/video conference is available. Whiteboard supports PowerPoint presentations and different mathematical symbols, and discussion forums are available. Blackboard has a spell checker for every response that student or teacher make. Students are offered blackboard messages, but they can also use internal e-mail. There is no journal on Blackboard, but students can make their own notes. Just like Moodle, it also has a keyword search engine just like Moodle and students can search every class and use the calendar and set up their profile. Blackboard does not work offline, but students can download the content.

COMPATIBILITY

Compatibility is related to using the same virtual environment with different systems or products. Authors Kerimbayev and others (2019) conclude that Moodle environment contributes to flexible education based of ICT services, including different possibilities of connecting with different systems that enables Moodle to hold video conferences and use other useful educational and communicational tools. A useful survey connected to the topic was conducted in fall 2015 to 2016, by Caliskan and Bicen (2016). The survey consisted of 120 volunteer teachers and it was aimed at determining the efficiency of implementing Moodle in Remote Flipped learning environments. Through this survey, they concluded that Moodle enables more persistent learning than a traditional class. Authors Almansa-Martinez, Moreno and Haro (2019) highlights that Moodle can publish all kinds of resources, meaning it is compatible with different types of data. Momani (2010) showed that Moodle is compatible with different types of data and external systems. When making a questionnaire, lectures can make a databased, questions are randomized, and tests are automatically graded. For every course it is possible to use, a personal made template that can be uploaded thorough WebDAV. Moodle is completely customizable in accordance to the institution. Blackboard is also compatible with different systems and it supports MathML for mathematical formulas. Several different templates can be used when learning on Blackboard.

USABILITY

Usability relates to the degree to which users think that a specific system is appropriate for their need, in the context of e-learning, that need is education. One of the comparisons of Moodle and Blackboard systems, as the two-leading e-learning systems, was conducted by Machado and Tao (2007) through a survey on a sample of 77 students. Through this survey, authors wanted to find out which of those two systems is more preferred by the students. The results of the conducted survey showed that students in the pilot project prefer Moodle's system over the Blackboard system. Students evaluated the ease of using Moodle's system better than the Blackboard system. Comparative analysis of Moodle and Blackboard systems based on 3 types of comparisons was performed by authors Subramanian,

Zainuddin and Alatawi (2014). The first comparison was based on communication tools, the other on productivity tools, while the third comparison was based on the inclusion of students. A virtual learning environment that got better results is Moodle. Although both systems have different features, the choice depends on individual preference. The Moodle system is a basic tool that transforms and updates the existing education system but has room for upgrades and improvements. Moodle is educational software based on collaborative learning philosophy. Authors Martinez and Jagannathan (2008) point out that innovations in the Moodle system delight educators and that social constructivist pedagogy, which considers learning as a creative social process, the same as the individual, is the key reason why this system is rapidly spreading among the educational community. Using learning management systems in education is also related to the content presented in this system. Suša (2014.) conducted research where it was concluded that constant improvement of delivering knowledge is needed to keep a high level of digital competency. That kind of improvement can be made through LMS's where knowledge can be delivered in different formats. Fetaji and others (2017) conclude that using technology as well as interacting with students can really improve student's learning activities and the overall quality of their learning. Elmaadaway (2018) conducted a study on active learning approach in the context of a Blackboard course. This study showed that students are more engaged in the learning process when they have specific learning materials that they can access from home. In that way, they feel more active and they can prepare before they come to class. Alturki and Aldraiweesh (2016) through their research concluded that Blackboard is not properly designed to address the needs of students and lecturers. They also add that it also has usability problems because of the integration of new web authoring tools and languages.

RELIABILITY

Authors Perez and others (2019) conducted a study proving that Moodle provides a reliable, quick, stable and accessible system. Authors also concluded that such a system also encourage people to use it and increase their overall satisfaction. Siekman (2017) stated that Blackboard does have a pleasing aesthetic but does have some problems. For example. One of the problems is e-mail designations that are not automatic, which means that students must set up their own profiles and have an outside e-mail address. Momani (2010) compared Moodle and Blackboard and showed that Moodle has an online editor for course management and organization, and once made content can be reusable, meaning it can be used as a template for future lectures. Teachers can also make a database of different questions. There is also grade statistics that is a great benefit for teachers and lecturers. Blackboard also offers course organization, but it offers premade templates for future lessons. It does have a question database with randomizing the questions but with fewer possibilities than Moodle. It also offers grade statistics.

SECURITY

Through a comparative analysis of various e-learning systems, authors Kumar, Gankotiya and Dutta (2011) concluded that Moodle has great potential for creating a successful e-learning experience by providing a variety of tools that can be used to improve conventional teaching. The analysis was conducted in two phases. The first phase was based on the architecture of the e-learning system, while the second phase was based on the technical aspects of the system. According to research results, the optimal e-learning platform is Moodle. The authors emphasize that to create a safer and more confident environment for learning it is necessary to remove all the security shortcomings of Moodle. Moodle "can authenticate against an external LDAP server and also authenticate using Kerberos protocol (…) it also supports Shibboleth, the Central Authentication Service (CAS) and it can support multiple organizational units and virtual hosts within a server configuration" (Momani 2010:14). Momani (2010) says that Blackboard allows guest access to all courses and it can authenticate against LDAP server, IMAP, POP3 and NNTP. This system can also authenticate against an external LDAP server.

Blackboard also restricts access based on roles that means that students can access some data, but they cannot change it or influence it. Registration on Blackboard can be manual – added by administrators or the students can be allowed to self-register. Momani (2010) also shares that Moodle, indifference than Blackboard, also supports restricting access based on roles but it can also be customized by the service provider, which means that external organizations or people can have permission to access specific courses. Student can be manually added to specific courses by administrators or teachers, like in Blackboard or they can self-register. Moodle has a course backup and restores process.

MAINTAINABILITY

Abazi-Bexheti and others (2017) assessed that LMS users are nowadays mostly teachers and lecturers. They believe that LMS's must extend to a new, more student-oriented conception. That approach was made by Blackboard when Blackboard Collaborate Ultra was launched. According to Hill (2019) Blackboard Collaborate Ultra offers more flexibility and it is user-friendly with the whole set of different online teaching activities. Authors Kaya Keles and Emre Keles (2018) state that Moodle is more preferable LMS because it is easier to use. They also state "hundreds of extensions available in Moodle offer significant advantages to the Moodle users and administrators in the distance learning applications". The study by Tella (2012) showed that Blackboard has weak support services, which can then influence the bad user's experience.

PORTABILITY

Authors Teo and others (2019) highlight students' perception of Moodle regarding its performance, technology complexity and trialability. Users perceive Moodle easy and useful, which also affect their attitudes towards this kind of technology. Moodle can be adapted to different usage environments, which is the reason students find it easy and preferable to use than other learning management systems. Authors Casany and others (2012) initiated a Moodle project. This project was initiated to design a Moodle extension for mobile applications. Although Moodle is available on mobile phones, this project shows the adaptability of Moodle for different systems. Kokolek, Ćorić, Jaković (2015.) conducted a survey to test the environment for the development of e-learning in Croatia. That study showed that Moodle is already present in some classes and that it can be adapted to different user's needs. Another survey by Bucevska showed "that computer laboratory offers more possibilities to teachers and provides them with greater flexibility in performing their activities" (Bucevska, 2017). Momani (2010) shares that Moodle works fine with all web browsers, supports Oracle, MS SQL Server, MySQL or PostGreSQL. It is available for Linux, UNIX and Windows web servers. It offers over 70 languages and it is free. Blackboard only works with specific browsers and supports Oracle and MS SQL Server. It has UNIX and Windows version available. It offers seven languages but enables clients to create their own language packs. The price depends on the number of users.

SUMMARY OF COMPARISON BETWEEN MOODLE AND BLACKBOARD BASED ON ISO 25010

Through this comparison, it is shown that Moodle is a better-quality software. Both systems are reliable and functionable, but research have shown that most users prefer Moodle. Moodle is more compatible with different systems and browsers and it is free. Moodle can also be customizable for every organization and it offers a foundation for building individual learning environment.

Table 2. Moodle and Blackboard comparison based on ISO 25010

ISO 25010 Software Product Quality model			
Category	Moodle	Blackboard	Explanation
Functional Suitability	5	5	Both systems have pros and cons, but overall, they are functionable. When it comes to the learning process, both systems have all the basic components they need to fulfill the needs of students and lecturers.
Performance Efficiency	4	4	When it comes to performance, based on this secondary research, there are some issues with both systems. Moodle can experience loss of data because of its interface as suggested by Dragulescu and others (2012), while Blackboard does not work offline as explained by Momani (2010) but it can extract some data. Most of the parts meets requirements of users but they do experience some issues, which is why they are both graded this way.
Compatibility	5	4	There are more data about compatibility of Moodle (Kerimbayev and others (2019), Caliskan and Bicen (2016), Almansa-Martinez, Moreno and Haro (2019)), than Blackboard, which shows that Moodle can function with different systems. The main difference here is the ability of making templates on Moodle in the opposite of using the existing ones in Blackboard.
Usability	5	3	In the context of usability, many case studies and surveys presented in this paper show that most users are more satisfied with using Moodle. Those studies were made by Machado and Tao (2007), Subramanian, Zainuddin and Alatawi (2014), Martinez and Jagannathan (2008), Elmaadaway (2018) and Alturki and Aldraiweesh (2016). They grade Moodle as the easier one to use. Moodle also has more functions, such as different languages that showed to be important to the users.
Reliability	5	4	Studies have shown that Blackboard has some issues regarding to database, but also some functions are better set on Moodle. Perez and others (2019) and Siekman (2017) stated that Moodle is more reliable than Blackboard.
Security	4	5	Blackboard showed better results in security according to Momami (2010), with different servers it can authenticate against.
Maintainability	o	o	There are not many data that can be used to conclude which one of these two systems are more maintainable. To conclude it a technical review needs to be done.
Portability	5	3	Authors Teo and others (2019) and Casany and others (2012) support the fact that Moodle can work with all web browsers and it is free to use. Blackboard has specific web browsers it works with; it only works with Unix and Windows and it is not free..
TOTAL:	33	28	

Source: Authors' work

CONCLUSION

In this paper, a comparison between the two most used learning management systems, as well as the literature review on the topic of e-learning was presented. Through this paper, new concepts and ways of transforming the formal learning process are highlighted. With the comparison of Moodle and Blackboard systems, we wanted to summarize the specifications of those systems, as well as the preference of students and lecturers, to conclude which one of those systems is optimal in the context of education. With ISO 25010, we set eight parameters. All those parameters were measured with a simple scale from one to five that is in accordance with the collected literature review. The researchers assigned ratings based on theory and practice and a median rating was taken in case of difference. Through this comparison, it was concluded that Moodle is preferred LMS. The main advantage of Moodle is that it is easier to use, it is customizable, and it is free. Both systems are functional, but there are some specific issues with Blackboard that sets it apart from Moodle, such as price, available languages and compatibility. Of these differences, price is the biggest influence. Moodle is much more affordable than Blackboard, which users have recognized. To speak of quality at all, it is necessary to first identify the requirements set by the software user. In this case, institutions in the higher education sector are demanding the desired software to be easy to use, to have the possibility of personalization, to have as little cost as possible, or even to be free of charge, and to have compliance with other types of files. Through the research conducted, based on ISO 25010, the identified requirements are consistent with the settings offered by Moodle.

Previous research in the field of e-learning is focused on a specific sector and primary research, most likely a questionnaire, in a specific institution. Those primary researches are important for concluding and comparing different systems, but through this paper, the main goal was to gather all those relevant researches into one and use them as a foundation for making a systematic review using the ISO 25010 framework. That review helped to extract some specific differences in two similar learning management systems and decide on that specification which of these two systems have better results. This paper offers a wide range of different experiences with learning management systems, gathered and compared based on ISO 25010 characteristics. This comparison can be used as a foundation for an academic institution in their decision of using one of these two systems. This paper also suggests considering all the risks related to specific issues with both systems. Both systems have benefits and problems; it is up to the user to decide what is preferable for them and in accordance with their needs.

The aim of this paper was to present a comparison of two commonly used LMSs through the quality prism. Every higher education institution strives for quality management, as well as quality dissemination of teaching materials and knowledge. It is through the knowledge and skills acquired during education that competent people are created, but also a competent organization or institution. By comparing the Moodle and Blackboard systems, it is possible to see the application of ISO 25010 on the software used for dissemination, as well as the organization of the teaching process. The teaching process, as a fundamental process of higher education institutions, must meet all the requirements presented by stakeholders, which applies primarily to students and teachers. The LMSs are the basis for the creation of the teaching process and the quality of such a system must be defined, which is possible through the proposed and implemented model based on ISO 25010. This model is applicable to other systems, and through this work its application through two systems is presented. ISO 25010 can help institution in their certification process and can be used as a tool to comply with the requirements presented by ISO 9001.

Limitation of this paper is that this comparison was based on secondary research and the conclusion was based on available data and gathered research. It only shows the comparison based on literature references mentioned below, as well as practical use and experience with Moodle and Blackboard systems. Although, theoretical and practical knowledge is considered, there is a certain amount of subjectivity regarding given grades. There is also a difference in preference and availability

of learning management systems in different countries and different institutions. Future study recommendation is to gather information about the presence of different learning management systems in different countries or continents to compare what learning management systems are available and most used and where. In that way, a comparison between users' satisfaction of a specific system can be done. It should also be emphasized that there are other LMSs used in the teaching process that need to be considered, such as the increasingly popular Google Classroom. In future research, it is recommended that Classroom, as well as other relevant learning systems, be included in the analysis of the learning process based on proposed model.

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