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Vaughn Malcolm Bradley
Walden University, United States

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Vaughn Malcolm Bradley

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Abstract

Learning Management Systems (LMS) reinforce the learning process through online classroom environments. A standard LMS supports an inclusive learning environment for academic progress with interceding structures that promote online collaborative-groupings, professional training, discussions, and communication among other LMS users. Instructors should balance active learning with the use of LMS technological resources and the use of guidelines from the qualified curriculum. An LMS allows instructors to facilitate and model discussions, plan online activities, set learning expectations, provide learners with options, and assist in problem-solving with processes for decision making. An Instructor's presence within an LMS creates an engaging learning environment. Students can retain their autonomy, enthusiasm, and motivation with LMS use. Stakeholders of the educational community must find scientific studies to support their contributions in LMS platforms to assist scholars in learning mathematics and other academic subjects.

Introduction

Learning Management Systems (LMS) provide teachers and students with an online classroom that reinforces learning processes. In online classroom environments, Learning Management Systems (LMS) reinforce teachers and students in the learning process. A standard LMS supports an inclusive learning environment for academic progress with interceding structures that promote online collaborative-groupings, professional training, discussions, and communication among other LMS users (Dias & Dinis, 2014; Jung & Huh, 2019; Oakes, 2002). Nasser, Cherif, and Romanowski (2011) state that LMS usage provides online learners with consistent information regarding their performance. LMS usage allows online learners to become independent (Blau & Hameiri, 2010; Nasser et al., 2011; Strayhorn, 2010; Wood et al., 2011). Learner engagement is sustainable as online users use an LMS to monitor their progress (Al-Fraihat, Joy, Masa'deh, & Sinclair, 2020; Selwyn, Hadjithoma-Garstka S, & Clark, 2011).

Computer designers dating back to the 1950s believed in applying an LMS for educational purposes as conceivable and necessary (Watson & Watson, 2012). There were different strategies for using an LMS as an educational resource with multiple vocabulary words that relate to computer use (Kehrwald & Parker, 2019). Through time, the technology and tools which support online learning structures were progressing since the advent of online learning in the mid to late 1990s (Kehrwald & Parker, 2019). LMS compositions include a

variety of media and communications tools and promote learner choice (Kehrwald & Parker, 2019).

History and Definition of LMS

Watson and Watson (2012) list computer-based instruction (CBI), computer-assisted instruction (CAI), and computer-assisted learning (CAL), as general terms, to describe computer adoption throughout history. These terms apply to computer application programs, teaching, and design preparation. The terms also refer to monitoring, giving approval, and disseminating materials (see Appendix for the key terms and definitions).

An LMS has multiple online operations and behaves as a framework to capture numerous layers of progressive learning (Jung & Huh, 2019; Kuosa et al., 2016; Oakes, 2002; Watson & Watson, 2012). An LMS behaves as a platform to distribute and oversee pedagogical material (Watson & Watson, 2012). LMS functions include promoting specially designed information for capturing learner progress in meeting expectations (Oakes, 2002; Watson & Watson, 2012). An LMS platform cultivates an environment for engagement and learner achievement, allowing learners to register for classes, track their grades, and check updates and course announcements (Al-Fraihat et al., 2020; Oakes, 2002; Watson & Watson, 2012).

Watson and Watson (2012) recommend that as school districts integrate the use of an LMS, they should make LMS use a functional requirement. They discuss LMS administrative management techniques, including enabling profile features, guidelines for following the curriculum, guidelines for managing assignments, discussion boards, resources for writing, and updates from the instructor. LMS users gain access to material and information disseminated by the instructor in synchronous or asynchronous settings (Jung & Huh, 2019; Kuosa et al., 2016; Watson & Watson, 2012).

An LMS provides users with a productive learning environment to assimilate multiple components of systematic applications (Jung & Huh, 2019; Watson & Watson, 2012). In an educational setting, computer users have access to operations with non-traditional terms, and many computer users in education could have access to applications with non-traditional terms and confusing acronyms to understand (Kuosa et al. 2016; Watson & Watson, 2012). Thus, users may not understand which interpretations are suitable to use; it is fundamental to differentiate an LMS from similar technologies (Watson & Watson, 2012).

Course Management Systems

A *course management system (CMS)* provides users with an assembly of operation apparatuses that structure online interactions (Evolving Technologies Committee [ETC], 2003; Jung & Huh, 2019; Watson & Watson, 2012). It provides a process for governing information in a primary location (Jung & Huh, 2019; Watson & Watson, 2012). CMSs offer online and blended learning courses where users can access folders of course materials, along with tools and other materials that contain essential course information. Examples include checking progress, tracking grades, and communicative platforms for group discussions, chats, and posting information (Watson & Watson, 2012). While CMSs and LMSs have some features in common, a CMS

specializes in managing and creating learning content, whereas an LMS provides a system training platform that holds e-Learning classes to track course completion and assessment scores (Jung & Huh, 2019; Watson & Watson, 2012).

Learning Content Management Systems

Learning content management systems (LCMS) are a modern version of LMS (Watson & Watson, 2012). Both LCMS and LMS have different complementary applications, but as Watson and Watson (2012) declare, *content* is the term that separates an LMS from an LCMS (p. 36). An LCMS provides instructional designers with tools to create e-learning content more methodically (Jung & Huh, 2019; Watson & Watson, 2012).

According to Oakes (2002), an LCMS arrangement reuse can ~~–e~~reate, store, assemble and deliver personalized e-learning content in the form of learning objects" (p. 73). Watson and Watson (2012) state that an LCMS can integrate with an LMS to support the arrangement and presentation of learning objects (LO). An LMS serves as a base for providing guidelines for use, and it houses the LCMS content (Jung & Huh, 2019; Watson & Watson, 2012).

Learning Objects and Related Technologies

Learning objects or *LOs* are essential components in an LCMS or an LMS (Watson & Watson, 2012). An LO provides feasible options for users across different environments (Watson & Watson, 2012). The assimilation of LOs supports modern educational environments with tools that are adaptable to meet the specific needs of students, and operations to harbor conditions of larger and smaller audiences that could transform changes in disbursements (Al-Fraihat et al., 2020; Kehrwald & Parker, 2019; Watson & Watson, 2012). An LO may contain digital correspondence that supports students with learning objectives (Kehrwald & Parker, 2019; Oakes, 2002; Watson & Watson, 2012).

The LO may also follow standards that provide evidence to define the setting and material for enactment that attaches to a Shareable Content Object Reference Model or SCORM (Oakes, 2002; Watson & Watson, 2012). According to Al-Fraihat, Joy, Masa'deh, and Sinclair (2020) and Watson and Watson (2012), SCORM provides an assortment of stipulations for online technology use in education. There are multiple means for disaggregating how learners use LOs (Watson & Watson, 2012).

LCMSs, CMSs, and LOs can adjust and connect within an LMS to provide technologies that support a climate for learning (Watson & Watson, 2012). LOs act as meager types of material found within an LCMS to reinforce student attainment (Kehrwald & Parker, 2019; Watson & Watson, 2012). LOs that consist of recent work assignments and accomplishments to support defined instructional objectives are managed by an LMS (Watson & Watson, 2012). CMSs act as an academic structure to host pedagogical knowledge into classes that manage connections among other students and other professors (Jung & Huh, 2019: Watson & Watson, 2012).

Asynchronous vs. Synchronous Structures

An LMS provides a structure for asynchronous delivery methods that include emails, discussion groups, audio discussion presentations, and newspapers to cultivate positive interactions (Alzahrani, 2019). Asynchronous delivery methods allow learners to communicate with each other without the distraction of being separated through distance and time (Alzahrani, 2019). Asynchronous environments enable learners to work in conjunction with other commitments and responsibilities (Alzahrani, 2019). Additionally, in asynchronous structures, learners must navigate their way through an LMS to explore course materials, engage in effective communication, and manage the technologies of the course (Alzahrani, 2019).

An LMS also provides a structure for synchronous delivery methods with the use of video and online conferences (Alzahrani, 2019). Learners can see their instructors through video, online discussions, live chat, in addition to presentations and word files (Alzahrani, 2019). Videoconference communication through synchronous structures facilitates interaction between students and their instructors (Alzahrani, 2019).

Both asynchronous and synchronous methods use an LMS to provide learners with positive effects to facilitate their learning (Alzahrani, 2019). In comparing asynchronous learning with synchronous learning, Hrastinski and Keller (2007) state that in a distance learning environment, synchronous learning is essential for developing a student's critical reflection abilities. Asynchronous learning systems do not provide learners with instant feedback (Hrastinski & Keller, 2007). Asynchronous learning systems can also leave learners feeling isolated and distant from their social environment (Al-Fraihat et al; Hrastinski & Keller, 2007). However, Alkhasawnh and Alqahtani (2019) emphasize the focus on expanding the use of asynchronous tools in an LMS. Alkhasawnh and Alqahtani (2019) believe asynchronous learning provides flexibility as learners can reflect and complete tasks.

Blended learning environments provide students with an environment to achieve from both synchronous and asynchronous methods Alzahrani (2019). Students who use both methods are achieving better grades in contrast to a traditional learning style (Alzahrani, 2019). Alzahrani (2019) implemented an experimental design with 49 students using the LMS Blackboard with both asynchronous and synchronous methods to take a physics course. Within the course, students were to use the synchronous videoconference method for lectures with their professor and course discussions for the first semester, and asynchronous video conferencing with Blackboard for the next seven weeks (Alzahrani, 2019). At the end of each seven weeks, the students took an exam (Alzahrani, 2019). At the end of the two seven-week sessions, their grades were compared (Alzahrani, 2019). The results showed that 46.6% of the participants preferred the synchronous videoconferencing method, and 53.4% of the students preferred the asynchronous video conferencing method with Blackboard (Alzahrani, 2019).

The results from Alzahrani's (2019) study indicate that student performance is affected by videoconferencing with Blackboard. The results from the study could be due to factors that impact student performance, such as perceived quality of the teaching, amount of content, teaching style, and instructor confidence (Alzahrani, 2019).

Student responses indicate they prefer to use the asynchronous video conferencing with Blackboard technology for their course (Alzahrani, 2019). An online setting with a qualified instructor who can manage and facilitate the LMS resources will help students gain knowledge and experience beneficial outcomes (Alzahrani, 2019). There are also technical issues that can impact student performance and impair learners to believe that online LMS structures can be a barrier to interacting with their instructors (Alkhasawnh & Alqahtani, 2019; Alzahrani, 2019).

Nuances to LMS – Proprietary vs. Open-Sources

School organizations face the decision in selecting an LMS with a proprietary system or open-source system (Kimmons, Hunsaker, Jones, & Stauffer, 2019). The decision depends mainly on the resources available and the knowledge or level of expertise of LMS users within school organizations (Turnbull, Chugh, & Luck, 2019). A proprietary system uses an exclusive code where school organizations purchase a subscription or license to access and use the LMS features (Kimmons et al., 2019). Some examples of proprietary systems include Blackboard, PowerSchool, SchoolWires, Edline, eSchoolView, and SchoolPointe (Kehrwald & Parker, 2019; Kimmons et al., 2019). Open-source systems use a free license at no cost where users have the freedom to access and use the system (Kimmons et al., 2019; Turnbull et al., 2019). Examples of open-source systems include Moodle, Wordpress, and Drupal (Kehrwald & Parker, 2019; Kimmons et al., 2019; Quinn & Gray, 2020).

Fifty-nine percent of school organizations select proprietary systems where vendors charge a service fee based on the number of LMS users in cloud-based proprietary systems (Kimmons et al., 2019; Turnbull et al., 2019). Turnbull, Chugh, and Luck (2019) state that school organizations who select proprietary systems receive advantages of working with a company that practices in the construction and distribution of online solutions to support learning. Clients who use proprietary systems also receive end-user training that does not require any configuration (Turnbull et al., 2019). The disadvantage of using a proprietary system is clients have limits and can only access designated LMS features from the school organization (Turnbull et al., 2019). School organizations with proprietary systems are starting to integrate cloud-based LMS solutions where the LMS merchant maintains the client's data online (Turnbull et al., 2019). Cloud-based LMS solutions allow users to maintain the physical infrastructure for running an on-site LMS (Jung & Huh, 2019; Turnbull et al., 2019).

Educational entrepreneurs are promoting open-source systems to drive online learning environments that use a variety of media and communication tools and support learner choice in the selection and use of tools for online learning (Kehrwald & Parker, 2019; Quinn & Gray, 2020). These open-source systems continue to evolve to accommodate the possibility of their system existing only in web-based settings (Turnbull et al., 2019). School organizations can use open source systems to suit their circumstances (Kehrwald & Parker, 2019; Turnbull et al., 2019). Open-source systems allow users to extend system functionality and use community source plugins (Kehrwald & Parker, 2019; Turnbull et al., 2019). College and University students are among the most abundant users of open source systems (Turnbull et al., 2019). IT expertise is available in most college settings to support the use of open-source systems (Turnbull et al., 2019). This article explores several LMS topics and aspects of learning. Table 1 provides an overview of the LMS studies for review.

Table 1. Overview of Studies

LMS Topic	Aspect of Learning
THE ROLE OF LMS IN EDUCATION	• An LMS provides expectations for learners • An LMS allows students to monitor their learning progress continuously • Professors can prepare constructivist arrangements with adaptable pedagogical intentions
TOWARD AN ENHANCED LMS TO SUPPORT STUDENT LEARNING	• Najmul Islam (2016) conducted a study using partial least squares to show anticipated compatibility controlled the union among educational issues and e-learning system use and did not necessarily support learner outcomes • Dias and Dinis (2014) conduct a study on learner profiles and found that learner styles conform to reciprocal learning conditions which include Information and Communication Technologies (ICT) instructors' assurances, and learners' preparation • You's (2016) study with Howell's (2001) endorsement includes the use of an LMS to find observable approaches of course learning attainment
WHAT CURRENT LMS(S)OFFER	• LMSs provide several learning resources • Nasser, Cherif, and Romanowski (2011) found that student engagement increased when instructors provided rewards for using the LMS resources • Selwyn, Hadjithoma-Garstka, and Clark (2011) found middle school students are using an LMS to submit assignments, view their grades and progress, post questions, etc.
USING AN LMS TO FOSTER AN ONLINE LEARNING ENVIRONMENT	• Constructivists approaches to learning • Online instructors support learner engagement through maintaining their presence in the LMS environment • An LMS technology infrastructure supports media use and the integration of online learning materials (Al-Fraihat et al., 2020; Kehrwald & Parker, 2019)
HOW INSTRUCTORS USE AN LMS TO SUPPORT ONLINE STUDENT LEARNING	• In Wong's (2016) study, 21 U.S. middle school instructors use a resource called iSMART to integrate science strategies into their instruction to foster learner autonomy • Volitional functioning accentuates the premonition of autonomy support of the self-determination model from new theories to affiliate autonomy and promotes independence (Murcia, 2016. • As instructors promote learner independence, students can autonomously complete assignments and tasks without influence from their instructor (Murcia, 2016; Shukla & Verma, April 2019)
LMS TECHNOLOGICA RESOURCE TO SUPPORT LEARNERS ONLINE	• Reynolds (2016) conducts a study to support LMS online educational environments including social constructivism as a collaborative strategy to support knowledge construction • Louwrens and Hartnett (2015) and Prior, Mazanov, Meacheam, Heaslip, and Hanson (2016) believe that cognitive engagement is more likely when learners receive and give their instructors feedback in addition to participating in learner engagement activities
HOW LMS RESOURCES IMPACT TEACHING AND LEARNING	• Student Response Resources • LMS Technology Resource Implementation • LMS Use to Support Learner Outcomes • LMS Personalization

The Role of LMS in Education

There is a purpose in differentiating other LMSs from similar technology resources from LMSs (Watson & Watson, 2012). These distinctions impact the learning needs of modern-day learners (Watson & Watson, 2012). There is a significant transformation among learners in society in going from a revolution of the industry to the 21st-century Age of Information (Kehrwald & Parker, 2019; Kimmons et al., 2019; Reigeluth, 1994; Toffler, 1984; Watson & Watson, 2012). In an LMS setting, teachers are facilitators, providing a learning environment where students can conduct research and engage with technological resources to become Information Age professionals (Kehrwald & Parker, 2019; Reigeluth, 1994; Toffler, 1994; Watson & Watson, 2012). Student progress among learners using an LMS varies where low-achieving students may struggle in meeting deadlines with submitting assignments, and high-achieving students have limits in getting beyond meeting deadlines (Reigeluth, 1997; Watson & Watson, 2012). Al-Fraihat et al. (2020) and Watson and Watson (2012) believe a challenge for LMS instructors is to make managerial and pedagogical adjustments from a homogenous plane of deficiency to a classification of progress to support all learners.

Online professors can use an LMS for communicating precise expectations to learners (Kehrwald & Parker, 2019; Reigeluth, 1994; Watson & Watson, 2012). An LMS supports students by monitoring learning progress, continuously providing essential knowledge, and implementing assessments (Watson & Watson, 2012). Today, an LMS can evaluate a learners' current levels of accomplishment and attainment (Branch, 2015; Watson & Watson, 2012). Professors can also use a reserved record of achievement, sustain agreements, and produce descriptions to govern intelligence that magnifies the progressive attainment of learners in the online environment (Kehrwald & Parker, 2019; Watson & Watson, 2012). An LMS allows learners to check their educational progress, assess their learning, gain online support from professors, and immense access levels of materials and specialized operations (Kehrwald & Parker, 2019; Watson & Watson, 2012).

LMSs allow online professors to prepare constructivist arrangements with adaptable pedagogical intentions (Al-Fraihat et al., 2020; Branch, 2015; Kitchen & Berk, 2016; Reigeluth, 1994; Turnbull et al., 2019; Watson & Watson, 2012). An LMS allows online learners to participate in group-chats, monitor their grades and progress, participate in online discussions, and take assessments (Reigeluth, 1994; Turnbull et al., 2019; Watson & Watson, 2012). An LMS also allows online professors to cultivate an educational environment for learning and continuous improvement (Kitchen & Berk, 2016; Watson & Watson, 2012). LOs provide valuable resources for efficient information access that is adaptable for specific student needs (Turnbull et al., 2019; Watson & Watson, 2012).

Toward an Enhanced LMS to Support Student Learning

As students learn to use LMS features, they can assess their learning progress better. Najmul Islam (2016) conducted a study with LMS usage data collections from 179 university students using the Moodle LMS to collaborate in a blended-learning course. The study focused on learner outcomes, online application, and

rapport. More specifically, the learner outcomes through online measures could develop with the use of pedagogical expectations, predictable academic means, and predictable support with association construction. Najmul Islam explored the use of partial least squares (PLS) to analyze the quantitative data. Qualitative measures were used to substantiate the analysis of the PLS data. The findings from the study showed that anticipated compatibility controlled the union among educational issues and e-learning system use and did not necessarily support learner outcomes (Najmul Islam, 2016). Najmul Islam (2016) believed that teacher training on the applications of LMS features could further motivate students to use e-learning tools. Future research could also give an adjacent view to comprehending what other assets an LMS provided to create an improved concept of e-learning performance (Najmul Islam, 2016). Najmul Islam called for professional development initiatives to use LMS applications and features properly (p. 54). By doing so, online instructors could also motivate students to use more online resources. Najmul Islam recommended further studies to assess other resources that allow learners to improve their productive use of online resources (p. 55).

As a strategy, learners can commit and use an LMS to work collaboratively on educational learning assignments. In a study conducted by Dias and Dinis (2014) focusing on learner profiles, instructors gave students comments on their performance through their learner profiles. The investigation included 36 students from a higher education institution and used online and face-to-face exercises. The study included a combination of qualitative and quantitative data collection methods, including semi-structured interviews and standardized multivariate content analyses. Dias and Dinis (2014) indicate three types of learner profiles conformed to a reciprocal learning condition, Information and Communication Technologies (ICT) instructors' assurances, and learners' preparation. As practitioners use an LMS within an online learning environment, consideration should go toward levels of interactions with students, supporting learners' ICT associates, and facilitating further professional development. Results from the study show that student profiles can correlate with online learning cultures, ICT teachers' expectancies, and learner preparation. Dias and Dinis (2014) and Najmul Islam (2016) maintain that supporting learners with training is efficient towards fostering collaboration and discourse online. Najmul Islam (2016) encourage learners to use LMS features to enhance cooperation with student discussions that will also increase student intrinsic motivation and learning. Through enlisting learners' profiles within an LMS, instructors gain a systematic strategy towards supporting learner abilities (Dias & Dinis, 2014; Kimmons et al., 2019).

Students who use LMS features will begin self-regulating their progress. You (2016) conducted a study using an LMS to find observable approaches to course learning attainment. The study included specifications for gathering information on self-controlled knowledge with LMS specifications and learner attainment. There were 530 college students as participants taking an online course. Similar to Dias and Dinis (2014), You (2016) included Howell's (2001) endorsement for instructors to use LMS essential resources including assignments, syllabi, schedules, tips, discussion forums, relevant links, and support from the instructor. Howell's (2001) investigation showed that students would refer to the course website if they thought it was useful. You (2016) showed learners' rates of universal application, login sessions, delay, frequency, and checklists to make sure students were reading and reviewing information packets. The latter results also help predict student course attainment.

Similar to the Dias and Dinis (2014) study, the You (2016) study collected data that includes students monitoring and self-regulating their course learning. Students who kept track of their online assignments by continually logging into the online course and reading course materials frequently performed well. The results reveal the benefits of self-attained knowledge and the ability to front-load specifications to support student attainment (Dias & Dinis, 2014; You, 2016). Although data logged by an LMS could support a progression of indicators, there is no guarantee it could increase the probability of the student's achievement (You, 2016). Thus, professionals and leaders in education should continue to analyze LMS resources that could accurately capture online student engagement and strategies that support students in their ability to self-regulate (You, 2016).

Online professors determine how an LMS can provide learners with an educational learning environment that is engaging and allows learners the autonomy to self-regulate (You, 2016). Gašević, Dawson, Rogers, and Gasevic (2016) conducted a study that reviewed the influence of learning environments on learner success. In the study, nine blended learning courses offerings to 4,134 college undergraduate students. The study illustrates the difference in "predictive power and predictors between course-specific models such as mathematics and generalized predictive models" (p. 68). It showed broader implications for students who identify as being at risk of failing academically. In future studies, analytics should consider learning conditions when constructing LMS resource models (Dias & Dinis, 2014; Gašević et al., 2016; You, 2016). Gašević et al. (2016) suggest reviewing instructional conditions before assigning the use of additional features.

What Current LMS(s) Offer

According to Jung and Huh (2019) and Watson and Watson (2012), LMSs provide several tools such as a network webserver to support an interface between the learner and the LMS. An LMS also provides a database to store information relating to user's learning and an LMS video on demand (VoD) database for storing multimedia files, including voice and video files (Jung & Huh, 2019). Additional support and care are necessary when considering the application of vocabulary terms with the research literature. Students can learn to use and interpret LMS online educational resources better. With experience, instructors and practitioners can learn to implement resources within LMSs.

Nasser, Cherif, and Romanowski (2011) studied the use of an LMS known as Knowledge-Net or K-Net for instructor and student middle school achievements. They investigated variables that influence learner adoption of the LMSK-Net in Qatari independent institutions. The quantitative study included questionnaire survey data from 1,376 learners in 37 schools and qualitative semi-structured interviews to support findings from the quantitative portion by contributing supplemental understanding of learners' views about LMSs.

Nasser et al. (2011) showed that while there are many attributes to consider, there are also premediating circumstances that can impact how students use the resource. Learners claimed that their instructors did not require them to adopt using the LMSK-Net system. Students with guardians who were not committed to supporting their children's learning were less willing to use an LMS than students with supportive parents. The

findings show that when instructors are reluctant to use an LMS, it impacts all students with communicating student progress. Student motivation and engagement increased when instructors provided rewards for using LMS resources. Nasser et al. (2011) recommended that professors and online instructors offer a system of rewards to help motivate learners. They could also model expectations in using an LMS to stimulate adoption.

Selwyn, Hadjithoma-Garstka, and Clark (2011) conducted a study to find how middle schools use an LMS to support online student engagement. The study included 12 schools and focused on using LMS resources to support teaching and learning, online student engagement, and management. Data included structured interviews with instructional leaders, ICT coordinator instructors, and parents. Instructors received professional training to support learners and parents in registering online accounts. The findings show that an LMS allows learners to submit assignments, view their grades and progress, post questions for social networking, and provides users with the possibility of using social media operations (Branch, 2015; Selwyn et al., 2011).

Selwyn et al., 2011 showed that an LMS can provide users with organizational assistance; however, questions arise if users find the resource helpful. They pointed out that few studies have examined how an LMS promotes support and engagement. Similar to Nasser et al. (2011), they also found that institutions could promote learner participation through premediating LMS features. School officials would share updates and information through announcements, online resources, and users could reciprocate by sharing information with other users. Unilateral distribution of resources and information proved to be a concern.

Learners can use an LMS to communicate, interact, and upload assignments. Currently, LMS users mainly use an LMS for receiving handouts and turning in work (Jung & Huh, 2019; Selwyn et al., 2011). Thus, LMS use appears to give learners a platform for updating and displaying their progress (Branch, 2015; Selwyn et al., 2011). School organizations can provide a culture with training to support learner and parental LMS engagement; Selwyn et al. (2011) suggest that trainers provide online users with LMS resources to use for discussions, communications, and continuous monitoring.

LMSs allow users to independently fill their emerging needs in communicating with others and checking their progress (Al-Fraihat et al., 2020; Kehrwald & Parker, 2019; Kimmons et al., 2019; Turnbull et al., 2019). School organizations and institutions are expected to support LMS structures (Turnbull et al., 2019). Current trends for LMSs are to expand learner interactions with course content that allow users to use their mobile and electronic devices (Jung & Huh, 2019; Turnbull et al., 2019). The term *mobile learning* refers to a learning system with the use of a mobile device such as a mobile phone, personal media players, and tablet PCs (Jung & Huh, 2019; Turnbull et al., 2019). Mobile devices allow learners to access learning content from different locations at any time (Jung & Huh, 2019).

Using an LMS to Foster an Online Learning Environment

As central and constructivist online learning environments develop, students learn to manage their academics independently (Al-Fraihat et al. 2020; Alkhasawnh & Alqahtani, 2019; Murcia, 2016). Constructivist approaches

allow learners to construct awareness through active participation and assign value to the learners' autonomy (Murcia, 2016; Wang, 2011). In online environments, teachers facilitate and model discussions, plan online activities, set learning expectations, provide learners with choices and options, and assist learners in solving problems and making decisions (Jung & Huh, 2019; Murcia, 2016).

According to Murcia (2016), online facilitators provide learners with opportunities to ask questions and use their previous knowledge to create new concepts. Facilitators allow students to retain their autonomy, enthusiasm, and motivation. Online instructors support learner engagement through maintaining their presence in the LMS environment. Examples include responding to questions from participants, participating in the LMS course discussions, and giving students feedback on their performance.

LMS integration into different forms of activities promotes student learning and self-regulation (Al-Fraihat et al., 2020; Alkhasawnh & Alqahtani, 2019). LMS use provides practitioners with modularity, customization, and flexibility (Kehrwald & Parker, 2019). Some enterprising online educators are supporting LMS use to promote user-driven online learning environments that utilize a variety of media and communications tools and promote learner choice in the selection and use of online learning tools (Kehrwald & Parker, 2019).

Similarly, the technology infrastructure evolves with faster internet connections, including the current National Broadband Network (Kehrwald & Parker, 2019). The technology infrastructure also creates new possibilities for the use of rich media in education and shifts the focus from the use of online text in combination with media packages toward more productive, integrated online learning materials with text, audio, imagery and interactive learning objects (Kehrwald & Parker, 2019). As the access to technology improves for users, advances in computing adjust to provide LMS users with access to powerful computing devices, including affordable desktop and laptop computers, powerful yet mobile tablets, sophisticated mobile phones and, more recently, wearable technology (Kehrwald & Parker, 2019).

How Instructors Use an LMS to Support Online Student Learning

Wong (2016) believes teachers should emphasize student learning in science, technology, engineering, and mathematics (STEM). Thus, defining teacher's beliefs on how they integrate STEM areas into their online lessons are essential to know. In Wong's (2016) study, 21 U.S. middle school mathematics and science instructors participate in an Integrated Science Mathematics and Reflective Teaching program called iSMART. It was a two-year master's LMS online instructional program. Participants used an LMS to learn about pedagogies and theoretical perspectives of research-based mathematics and science methods of teaching. They could access and scaffold their assimilation of mathematical and scientific learning areas throughout the program. The participants would practice using the iSMART course strategies with their mathematics or science classes.

According to Wong (2016), iSMART program participants could use LMS features to access inquiry-based instruction that could impact students and their beliefs. As participants learn to define their belief-systems, they

could better distinguish strategies to support student learning and achievement. Findings showed that instructors' expectations could fluctuate tremendously through years of experience. In the study, science instructors would change their beliefs over time, while mathematics instructors would maintain their same beliefs. Wong (2016) concluded that mathematics instructors could integrate science strategies into their instruction to foster learner autonomy by expanding their student-centered ideas to support inquiry-based instruction. These findings also promote the sentiment that academic proficiency could influence instructor beliefs. Both mathematics and science instructors should grasp learner-centered beliefs that would align with inquiry-based instructional practices to support learners in creating concepts from existing prior knowledge (Murcia, 2016). Instructors can give learners their autonomy to investigate and develop their ideas of understanding (Murcia, 2016; Wong, 2016).

Advocacy of a course of action or volitional functioning is a belief to differentiate Deci and Ryan's self-determination theory (SDT; Deci & Ryan, 1985) and it the differentiation from new intentions to affiliate autonomy with advocating interdependence (Murcia, 2016). Volitional functioning accentuates the premonition of autonomy support of the self-determination model from new theories to affiliate autonomy and promotes independence (Murcia, 2016). Alkhasawnh and Alqahtani (2019) and Haerens, Vansteenkiste, Aelterman, and Van den Berghe (2016) found benefits through encouraging volitional functioning, which include a more in-depth level of learning, decisive influence, and observable and achievable perseverance. Instructors could advocate for voluntary operation through providing learners with the ability to make choices, giving students a rationale when an instructor says no to a learners' questions or inquiry, and using more connotative language that supports intrinsic motivation (Haerens et al., 2016).

Haerens et al. (2016) showed that instructors could set expectations for learners to monitor their progress independently. As instructors promote learner independence, students can autonomously complete assignments and tasks without influence from their instructor (Murcia, 2016; Shukla & Verma, April 2019). There is a different perspective from the viewpoint of SDT, where instructors emphasize answering and responding to learners' questions and interests (Murcia, 2016). Instructors can encourage learners to engage in collaborative strategies to research their interests (Murcia, 2016; Reynolds, 2016).

LMS Technological Resource to Support Learners Online

LMS resources can support learners in online environments. Reynolds (2016) conducted a synchronous game learning discovery-based guided study with U.S. middle school students. It included collaborative research information seeking and practices that support learners in gaining perspective and building their prior knowledge. Participants used a wiki as an LMS for providing curriculum, designing activities, accentuating aspects of social media, providing tutorials, and giving learners information-oriented assignments. Students participated in a constructivist online synchronous structure and work in collaborative groups. Measures for gathering data for the qualitative study include a video of six group cases of codes to categorize collaborative information seeking, problem-solving outcomes, and approaches to completing an assignment.

The findings from Reynolds (2016) support learners in assimilating knowledge acquisition with an entire cycle of cultural and fundamental suitable aspects to provide a framework for learning with gaming as the program's objective. The structure allows learners to collaborate in groups to seek information. The results show that LMS online educational environments should include social constructivism as a collaborative strategy to support knowledge construction. The approach can also apply in academic situations with inquiry learning.

Similar to Reynolds (2016), when seeking information collaboratively in synchronous online LMS settings, Haerens et al. (2016) found that premises to support behavior and cognition. Their information-seeking could intuitively rely on social factors that impact learners academically; for example, social influencers allowed learners to seek support autonomously. Potential influences include family members and peer groups (Haerens et al., 2016; Murcia, 2016). In online environments, instructors who support learner autonomy consider learners perspectives, feelings, thoughts, and encourage learners to develop self-regulatory practices that motivate and promote intrinsic motivation factors, provide learners with feedback, use instructional language, and present tolerance (Murcia, 2016; Shukla & Verma, April 2019).

Louwrens and Hartnett (2015) argue that LMS online learning environments are still in the developmental stage when it comes to establishing learner engagement among compulsory school settings. Seeing that many online engagement studies come from older students in tertiary education settings, Louwrens and Hartnett (2015) examined online student engagement among middle school learners in New Zealand. The analytical constructs of student engagement included behavioral cooperation, cognitive connections, and emotional engagement as part of the examination to look at how middle school learners engage in an online learning environment. Data sources included instructor and student interviews, online asynchronous discussion transcripts, and statistical LMS data sources.

Results indicate that learners engage behaviorally with all necessary activities. Similar to Jung & Huh (2019) and Reynolds (2016) regarding collaborative information seeking, Louwrens and Hartnett (2015) claim that cognitive engagement is more likely when learners receive and give their instructors feedback in addition to participating in learner engagement activities. Emotional attachments develop as learners interact and support the development of an online community of learners who feel safe to participate. The emotional attachments align with Reynolds' (2016) beliefs on how collaboration supports the increase with divulging assignment information that could also yield an increase with student learning.

In online distance education settings, learners can use an LMS to access knowledge with straightforward connections, and increasing academic competence also impacts self-esteem. Similar to Louwrens and Hartnett (2015) and Prior, Mazanov, Meacheam, Heaslip, and Hanson (2016) believe that face-to-face learning structures could positively impact self-efficacy. In distance online educational settings, instructors should provide learners with antecedents and digital literacy competency courses. Prior et al. (2016) showed that online learning environments could influence a learners' self-esteem in LMS collaboration, learner engagement, and course adoption. In their online study with 151 middle school learners, implementing digital literacy concepts and learner assurance approaches contributed to collaborative information seeking significantly — additionally, the

ideas and strategies emotionally engaged learners with activities, promoting self-efficacy and peer engagement.

Increasing participation among middle school learners is necessary to develop an online environment where students feel safe to contribute their ideas and thoughts (Louwrens & Hartnett, 2015; Reynolds, 2016). Online instructors provide learners with the ability to choose and make decisions regarding their learning. The choices increase learners' ability to engage behaviorally and cognitively (Kimmons et al., 2019; Louwrens & Hartnett, 2015; Murcia, 2016; Prior et al., 2016). Online middle school instructors who include activities that promote interactions among learners along with scholarly information stemming from connections with learning sciences and information sciences can give learners new knowledge and understanding (Louwrens & Hartnett, 2015; Reynolds, 2016).

How LMS Resources Impact Teaching and Learning

Studies on how LMS resources support student achievement are emerging steadily. Simplicio (2002) believes that instructors promote change in their teaching methodologies. Kehrwald and Parker (2019) and Pásztor, Molnár, and Csapó (2015) also believe creativity is essential when instructors use an LMS to support 21st-century learning. As part of an online instructors' role within the LMS, contemporary skills were fundamental to solving dilemmas, collaboration, metacognition, and literacy in ICT (Al-Fraihat et al., 2020; Kimmons et al., 2019; Pásztor, Molnár, & Csapó, 2015).

Student Response Resources

A technological resource within an LMS to support online communication is a classroom response system. According to Barth-Cohen et al. (2016), during synchronous online classroom sessions, learners can use a response system in the form of clickers. In their study, they collected data from students taking a middle school online physical science course. The instructor gave students clicker questions to answer individually and set up online groups where students could discuss the issues collaboratively. Online instructors who allowed learners to use the instructional tool noticed that learners became willing to share questions with fellow students. Clicker use supported online discourse among learners.

Barth-Cohen et al. (2016) believe that instructors who foster online discussions among learners can allow learners to construct and adapt their interpretations of concepts. They also found the communications have both a positive and negative impact on student performance in the co-construction of collaborative knowledge. Instructors played essential roles in moderating clicker discussions in online academic settings to enhance the probability of learner engagement. As online automation makes it more cost-efficient to use LMS technological resources, more instructors can give learners access to technical systems in the online environment (Downes & Bishop, 2015).

In the 21st century, schools are providing learners with one-to-one laptops for access to LMS technological tools that are continuously in use to support online instruction (National Middle School Association [NMSA], 2010).

Downes and Bishop (2015) conducted a qualitative case study that explored correlations between one-to-one system applications and successful middle schools. In the four-year investigation with 50 seventh- and eighth-grade students participating annually, instructors and learners received laptops for one-to-one wireless computing. Data sources included observations, structured interviews with instructors and learners, meeting transcripts, and student work samples. According to the results, three areas align with the most effective middle schools: (a) ability and society identifications; (b) instruction, curriculum, and testing characteristics; and (c) organization and leadership characteristics (Downes & Bishop, 2015; National Middle School Association, 2010).

According to Downes & Bishop (2015), during the first three years of their study, instructors would not distinguish community and environment distinctions that did not honor the goals or the expectations. Thus, learners became upset by the instructor's testimonies to provide learner engagement with technology-rich lessons never taught. In year four, the professors began to place more effort into promoting online student instruction. Toward the end of the study, both instructors and learners acknowledged receiving open online classroom settings.

Results from the study show that online structures need to incorporate LMS technology integration to build interdisciplinary culture and mutual support among instructors and learners (Downes & Bishop, 2015; Kimmons et al., 2019; Toffler, 1984). LMS technology resource use by groups of learners encourages online collaboration, and team activities also allow instructors to construct useful team environments (Downes & Bishop, 2015). Technology-intensive settings for learning environments could also help support inquiry-based learning (IBL) as an inductive approach to academic knowledge. The technology-intensive settings that enable learners to enhance their aptitude increase their interpretation skills and encourage academic enthusiasm and motivation (Avsec & Kocijancic, 2016).

Avsec and Kocijancic (2016) examined how different technologies impact student learning outcomes in IBL environments that emphasize individual aptitude, perspectives, and behavior, in 421 learners from 11 Slovenian middle schools. Measures of attainment included pre- and post-assessments along with IBL scenarios and interpretations to review. IBL had a specific impact on technology with literacy assessment accountability with a course design that highlights the effects of numerous. Findings from the study show that course content was most distinctive among factors and that prior knowledge and learning affect IBL with a decrease in psychologically important mechanisms (Avsec & Kocijancic, 2016; National Educational Technology Standards [NETS], 2015). Also, IBL has a positive impact on student learning with the use of technology and design, and IBL activities support metacognition and allow learners to make decisions (Avsec & Kocijancic, 2016; National Educational Technology Standards for Students [NETS-S], 2015).

LMS Technology Resource Implementation

According to Downes and Bishop (2015), continual LMS technology resource changes and refinement can impact the implementation of pedagogical changes to support students in online settings. Educational leaders can

support the initiative by working with school instructional teams who support the effort. There is a balance that instructors should find with providing active learning with the use of LMS technological resources and using guidelines from the qualified curriculum (Kimmons et al., 2019). Opportunities for instructors to implement the official curriculum with the use of technical resources are diminishing (Downes & Bishop, 2015; Wenglinsky, 1998). Only recently have online instructors begun to use technological resources when implementing curriculum (Kimmons et al., 2019; Downes & Bishop, 2015).

Downes and Bishop (2015) conclude that one-to-one computing, along with guidelines of regular student training, can support the successful implementation of the curriculum with the use of LMS resources. Emphasis on pedagogy and content knowledge in education with the use of technology should match the instruction, teaming, and leadership practices that serve active learners in fulfilling their desire for responsive schools that use technology (Association for Middle Level Education [AMLE], 2013; Downes & Bishop, 2015; Mishra & Koehler, 2006).

Instructors can gain perspective as they examine the use of LMS technological resources through continuous professional development in online structures that support purposeful relationships (Bornstein, 2006; Downes & Bishop, 2015). Downes and Bishop (2015) recommend that attaching educational challenges with individual programs can increase support for learners with online learning. These examinations could combine to integrate technology acquisition, despite the demands, to face the expanding gap between in-school and out-of-school technology use among adolescents.

LMS Use to Support Learner Outcomes

One outcome for instructors is to design online lessons with the use of LMS technological resources that assess outcomes for learning with specific variables. Online instructors can encourage learners to make connections from the classroom to the real world (Kimmons et al., 2010; Downes & Bishop, 2015; Wenglinsky, 1998). In making connections, online instructors can begin to view themselves as part of an online instructional team with other online instructors, sharing ideas to support student learning (Dede, Honan, & Peters, 2005: Simplicio, 2002). Social and technological development requires innovative ideas and solutions (Pásztor et al., 2015). Examples set by professionals in the discipline of educational technology can inspire leaders to gather and analyze information that provides ideas into the effects of technology on student performance (Dede et al., 2005; Pásztor et al., 2015).

Technology resources for online teaching affect student learning and achievement positively (Eyyam & Yaratan, 2014; Kadosh & Dowker, 2015; O'Dwyer, Carey, & Kleinman, 2015). Eyyam and Yaratan (2014) conducted a quasi-experimental research design that examined learner attitudes towards technology use in a mathematics class and whether the use of technology, improves their academic achievement. The study included seventh-grade private school students with three experimental groups of 41 students and two control groups of 41 students. Each team completed a pretest and a posttest in which the experimental groups received online lesson designs using several LMS technological tools and the control groups used traditional teaching methods. At the

end of the study, the experimental groups completed a scale to investigate student preferences and attitudes regarding technology-based instruction. Most students reported positive attitudes toward educational technology.

Similarly, Jung and Huh (2019) and Sung, Chang, and Liu (2016) found that mobile devices can enhance educational effects. Their study examined the usage of electronic devices, which included laptops, cell phones, and personal digital assistants that support possibilities for achieving a blended classroom learning environment. The study consists of synthesis and meta-research analysis that focuses on how integrating mobile devices impacts teaching and learning. It also contains 110 quasi and experimental periodical articles for coding and analysis. Results indicate mobile learning programs have enhanced impact with longer intervention durations, integrated technology and curriculum, and assessment of higher-level skills.

LMS technological resources are also useful in online mathematical environments. According to O'Dwyer et al. (2015), comparable achievement occurs with students taking an experimental online course and learners taking a face-to-face class. Their study compared 231 seventh and eighth-grade learners taking an online Algebra course with 232 seventh and eighth graders taking a face-to-face Algebra course. Research instruments included a formative assessment to address general ability in mathematics, a summative evaluation that was comparable to the state's Grade Level Expectations (GLE) in Algebra 1, and a survey to capture synchronous and asynchronous information regarding students' experiences from both types of courses. Students in the online preparatory courses outscored students in the control courses in 18 out of 25 components. Students in the treatment courses indicated they enjoyed using technology as a resource for studying mathematics and that their access to use technology was effective.

Students have a positive attitude toward LMS technology resources, but many learners do not know how to apply LMS tools in a mathematics classroom and online environment. O'Dwyer et al. (2015) showed how learners in their experimental courses aim to outperform other learners. Eyyam and Yaratan (2014) state that a significant number of seventh-grade students were indecisive about their preferences to use LMS technology they rarely use. They showed that people resist change, so in their study, participants received mathematical lessons that require the use of educational technology for the first time. They believe that after students become acquainted technology-based instruction in the mathematics classroom, the indecisive students and even students who report they do not like to use technology could recognize how technology can allow learners to self-regulate and monitor their progress.

LMS technology use also applies to online mathematical environments. Likewise, Kehrwald and Parker (2019) and O'Dwyer et al. (2015) found that when the experimental groups of online students compare to the face-to-face groups of learners, a significant percentage of learners in the innovative online organizations indicate that their experience was not progressive due to learners' unfamiliarity with the online classroom environment.

O'Dwyer et al. (2015) state that although the summative outcomes were similar to the comparison trial, fewer learners from the experimental online courses expressed enthusiasm for acquiring Algebra 1 knowledge after completing the online course. Similarly, a meta-analysis by Bernard et al. (2004), including 232 distance

education studies and 688 independent-learning, behavioral, and retention-oriented outcomes, shows that many distance education students can outperform their face-to-face classroom counterparts. Participants in synchronous environments support classroom instruction, while participants in asynchronous settings support distance educational environments. O'Dwyer et al. (2015) also report that the online Algebra 1 model should require level changes on the relationships mathematics teachers establish with their online students.

LMS Personalization

O'Dwyer et al. (2015) also found that many students in experimental online classrooms feel they should have more interactions with their teachers. Studies on higher-level educational programs reveal that learners who enroll in online programs tend to isolate themselves as scholars. As studies in higher education show, online programs often separate students during learning (Bernard et al., 2004; O'Dwyer et al., 2015). O'Dwyer et al. (2015) found that students in experimental online classrooms reported more time interacting with other students using an LMS. However, learners' time allotted for social interactions, their ability to comprehend expectations with assignments, and their ability to collaborate with others was equivalent to face-to-face courses.

Over half a million learners enrolled in K–12 courses feel the impact of some form of online learning initiative (O'Dwyer et al., 2015). Høgheim and Reber (2015) examined the effect of context personalization and example choice on situational interest in adolescent-level mathematics. They studied 736 middle school students learning about probability calculus assigned to one of the several instructional conditions, including situational interest, value perception, and task effort. The results show that context personalization and example choice caught the attention of students with a low individual interest in mathematics and could support them in becoming more engaged in the software activity. Context personalization and example choice were particularly relevant for educators as well as LMS educational software developers (Al-Fraihat et al., 2020; Høgheim & Reber, 2015; Kehrwald & Parker, 2019).

O'Dwyer et al. (2015) found that 71.8% of students in an online Algebra 1 class identified that using technology was the aspect of the course they liked most. Such findings are significant as they indicate student engagement. Teachers who adopted the use of technology had a progressive effect on learner achievement in specific academic areas such as mathematics or science. Students in the experimental group articulated aspects of the Algebra 1 online courses that supported student achievement. A significant number of learners favored using the online Algebra 1 course. On the other hand, the Høgheim and Reber (2015) study showed that online learning environments were associated with the opportunity for educators to adapt to education, which entailed tailoring education for every student. Context personalization and choice represented instructional formats suitable for implementation in a digitalized classroom where the content changed to students' interest.

Stakeholders of the educational community must find scientific studies to support their contributions in LMS platforms to assist scholars in learning mathematics and other academic subjects (Høgheim & Reber, 2015; Kehrwald & Parker, 2019; O'Dwyer et al., 2015). There is currently a shortage of studies to mitigate the effect on learner achievement and efficacy levels on results in elementary, middle, and high school online

environments. (Bernard et al. 2004; O'Dwyer et al., 2015). Future studies could focus on the efficiency of LMS platforms in public school settings that highlight learner satisfaction and contentment (Jung & Huh, 2019: O'Dwyer et al., 2015).

Conclusions

In online classroom environments, LMS reinforces teachers and students in the learning process. A standard LMS supports an inclusive learning environment for academic progress with interceding structures that promote online collaborative-groupings, professional training, discussions, and communication among other LMS users (Al-Fraihat et al., 2020; Dias & Dinis, 2014; Jung & Huh, 2019: Oakes, 2002). Since the advent of online learning in the mid/late 1990s, the technology and tools which support online learning structures continue to progress (Kehrwald & Parker, 2019). LMS compositions include a variety of media and communications tools and promote learner choice (Kehrwald & Parker, 2019).

An LMS involves multiple online operations and behaves as a framework to capture several layers of progressive learning (Jung & Huh, 2019; Kuosa et al., 2016; Oakes, 2002; Watson & Watson, 2012). A course management system (CMS) is an assembly of apparatuses that structure online interactions (Evolving Technologies Committee [ETC], 2003; Watson & Watson, 2012). Learning Content Management Systems (LCMS) are current affiliates of an LMS, and both have assorted complimentary applications. Learning objects or LOs are fundamental components in LCMSs and LMSs, providing options for users across different environments (Jung & Huh, 2019Watson & Watson, 2012).

When selecting an LMS, school organizations can choose a proprietary system or open-source system (Kimmons, Hunsaker, Jones, & Stauffer, 2019). The decision depends on the resources available and the knowledge or level of expertise of members within school organizations (Turnbull et al., 2019). A proprietary system uses an exclusive code where schools purchase a license or subscription to access and use the LMS features (Kimmons et al., 2019). Open-source systems use a free license with no cost where users have the freedom to access and use the system (Kimmons et al., 2019; Quinn & Gray, 2020; Turnbull et al., 2019).

Online professors and learners can use LMSs for characterizing precise expectations (Jung & Huh, 2019; Reigeluth, 1994; Watson & Watson, 2012). An LMS supports students in monitoring learning progress, continuously providing essential knowledge, and implementing assessments (Watson & Watson, 2012). LMSs allow online professors to prepare constructivist approaches with adaptable pedagogical intentions (Branch, 2015; Kitchen & Berk, 2016; Reigeluth, 1994; Turnbull et al., 2019; Watson & Watson, 2012).

As students learn to use LMS features, they can assess their learning progress better (Alkhasawnh & Alqahtani, 2019; Najmul Islam, 2016). As a strategy, learners can commit and use an LMS to work collaboratively on educational learning assignments (Dias & Dinis, 2014). As practitioners use an LMS within an online learning climate, consideration should go towards levels of interactions with students, supporting learners' ICT associates, and facilitating further professional development.

Teachers' beliefs can impact decisions made within an online environment (Jung & Huh, 2019; Wong, 2016). A teacher's ideas can influence decisions with curriculum processes of implementation to support online academic success (Jung & Huh, 2019: Wong, 2016). In online environments, instructors use LMSs to facilitate and model discussions, plan online activities, set learning expectations, provide learners with choices and options, and assist learners in solving problems and making decisions (Jung & Huh, 2019; Murcia, 2016). Facilitators allow students to retain autonomy, enthusiasm, and motivation (Murcia, 2016). Online instructors support learner engagement through maintaining their presence in the LMS environment (Murcia, 2016).

Recommendations

Studies on how LMS resources support student achievement are emerging steadily. Continual LMS technology resource changes and refinement can impact the implementation of pedagogical changes to assist students in online settings (Al-Fraihat et al., 2020; Downes & Bishop, 2015; Jung & Huh, 2019). Educational leaders can support the initiative by working with school instructional teams who support the effort (Downes & Bishop, 2015). Instructors should balance active learning with the use of LMS technological resources and using guidelines from the qualified curriculum (Downes & Bishop, 2015). Opportunities for instructors to implement the official curriculum with the use of technical resources are diminishing (Downes & Bishop, 2015; Wenglinsky, 1998). Members of the educational community stakeholders must find scientific studies to support their contributions in LMS platforms to assist scholars in learning mathematics and other academic subjects (Høgheim & Reber, 2015; Kehrwald & Parker, 2019; O'Dwyer et al., 2015).

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Author Information

Vaughn Malcolm Bradley

http://orcid.org/0000-0002-9724-4882

Walden University

United States

Contact e-mail: *vaughn.bradley@waldenu.edu*

Appendix. Key Terms and Definitions

Asynchronous: Online learning communication that does not require time constraints.

Computer-Assisted Instruction (CAI): *Computer-assisted instruction (CAI)* provides an educational system of instruction performed almost entirely by computer

Computer-Assisted Learning (CAL): *Computer-assisted learning (CAL)* is the use of computers as a key component of the educational environment

Computer-Based Instruction (CBI): *Computer-based instruction (CBI)* is a teaching approach that integrates computer software programs with other teaching materials in the classroom

Course Management System (CMS): *A course* management system (CMS) *provides users with an assembly of operation apparatuses that structure online interactions*

Integrated Science Mathematics and Reflective Teaching (iSMART): An *integrated science mathematics and reflective teaching (iSMART)* is a two-year master's LMS online instructional program. Participants used an LMS to learn about pedagogies and theoretical perspectives of research-based mathematics and science methods of teaching.

Learner Autonomy: Refers to a student's ability at setting accurate learning objectives towards taking control of their learning.

Learning Content Management System (LCMS): *A Learning content management systems (LCMS)* provide instructional designers with tools to create e-learning content more methodically

Learning Management System (LMS): A *Learning management system (LMS)* is a technology tool that provides functionalities beyond the instructional context such as management tracking, personalized instruction, and facilitative learning

Learning Object (LO): A Learning object (LO) *provides feasible options for users across different environments such as digital correspondence that supports students with learning objectives. An LO can also provide evidence to define the setting and material for enactment*

LMS: A Learning management system is a technology tool that provides functionalities beyond the instructional contest such as management tracking, personalized instruction, and facilitative learning.

Online Instruction: Learning that is available through a computerized system.

Open-Source: Open-source systems use a free license at no cost where users have the freedom to access and use the system.

Proprietary: A proprietary system uses an exclusive code where schools or school organizations purchase a license or subscription to access and use the LMS features.

Science Technology Engineering Math (STEM): *Science technology engineering math (STEM)* integrates science, technology, engineering, and math subject areas into a cohesive learning paradigm based on real-world applications

Self-Determination Theory (SDT): *Self-determination theory (SDT)* allows learners to discuss their inherent motivation and reflect on the presumption that internal motivation that catalyzes when learners are in conducive environments

Self-Efficacy: A belief or capability in self of accomplishing a task.

Shareable Content Object Reference Model (SCORM): A *Shareable content object reference model (SCORM)* provides an assortment of stipulations for online technology use in education

Student Motivation: A force that drives a learner to accomplish a goal.

Synchronous: Online learning communication that occurs at the same time.