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Using Online Learning Environments to Address Digital Literacy Competencies of Construction Management Graduates

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Abstract: Digitalization has become popular across various industries including construction. Construction industry involves unique outputs, complex processes and multi-disciplinary engagements. Digitization has introduced in the industry from electronic documents, email communication to automation and concepts such as Building Information Modelling (BIM). Construction professionals should possess sets of skills to cope with complex nature in the industry whilst conquering this modern digital era. United Nations Educational, Scientific and Cultural Organization (UNESCO) has proposed a set of digital literacy competencies for youth and adults in their 'Digital Literacy Global Framework'. Meanwhile, some professional bodies in construction also have acknowledged Information and Communications Technology (ICT) skills as core to their professionals. In this vein, digital literacy will be a competitive advantage for construction management graduates. Digital literacy practices are not emerging spontaneously but, education plays an important role in this context. Learning Management Systems (LMS) are widespread among higher education providers for both face-to-face and online offerings. LMS are tailored to cater various pedagogical strategies and can also be used to enrich digital literacy of students. This paper maps how the digital literacy competences proposed by UNESCO are addressed with online activities and resources used in first year courses in a construction management degree program operating in an online educational environment in Australia facilitated through Moodle Learning Management System. The core competencies recognized by major construction professional bodies were considered as the 'Career-related competences' in the UNESCO framework. The paper also presents which of the online activities are mostly implemented and engaged in the selected courses and which of the core competencies are mostly addressed. Findings suggest 'Assignment', 'Forum' and 'Quiz' as the mostly implemented and engaged activities, whereas 'Glossary' activity with less implementation but, higher engagement so, with a higher potential of addressing digital competencies. Information and data literacy, communication and collaboration, digital content creation and career-related competency of using standard computer packages are the mostly addressed competencies.

Keywords: Construction Management, Digital Literacy, Moodle Activities

1. Introduction

Digitalization in construction industry has evolved throughout the years moving beyond electronic document management (EDM) systems to advanced techniques of virtual construction prototyping with Building Information Modelling (BIM) (JR Jupp & Ramsey Awad, 2013). The resultant move from traditional ways to digital ways of working posed tensions on the construction manager's role demanding new knowledge and skill base (Harty & Whyte, 2010). Ezcan, Goulding, and Arif (2020) identified training and education as one of the drivers for technology diffusion-adoption in the construction industry.

The way construction management students learn have also changed from studying face-to-face, to blended learning, and increasingly fully online. While digital literacy skills facilitate students to engage in e-learning modes (Mohammadyari & Singh, 2015), conversely there are studies [e.g., Meurant, 2010; Martinez-Alcala et al., 2018; Patmanthara & Hidayat, 2018] investigating the role of digital learning modes in enhancing digital literacy skills of learners. There have studies that looked

at different approaches in developing digital literacy in construction management. Some studies looked at how design thinking can be used in developing digital literacy in construction management and looked at the use of BIM (Forsythe, Jupp, & Sawhney, 2013; Julie Jupp & Ramsey Awad, 2013). Given the increasing number of students studying construction management degrees online in construction management, there is a need to identify how online teaching and learning activities can address digital literacy competencies required by construction management students.

Computer-based, internet-hosted Learning Management Systems (LMS) provide online delivery platforms for educators and learners to share learning resources and engaging with useful techniques to foster active learning (Tang & Chaw, 2016). The free open-source Moodle is one of the fast growing LMS offering a range of tools for resource sharing, discussions, calendar planning, assignment submissions and grading (Deng & Tavares, 2013). The design and development of learning activities can be done with the use of these various functions effectively by considering skills and knowledge base required by learners. The standard Moodle offers seven (07) types of resources that teachers can use to support learning by adding content to their courses. In contrast, activities enable students to contribute directly, interact with other students or the teaching team and Moodle offers 14 types of such activities.

This paper aims to find the most relevant Moodle techniques to address digital literacy competencies required by the construction management undergraduate students. The paper maps online activities and resources offered by Moodle with competencies proposed by UNESCO including career-related ICT competencies recognized by major construction professional bodies.

2. Digital literacy competencies for construction managers

The United Nations Educational, Scientific and Cultural Organization (UNESCO) proposed six competence areas with digital literacy competencies under each area in their 'Digital Literacy Global Framework' (DLGF) serving the Sustainable Development Goal (SDG) thematic Indicator 4.4.2: "Percentage of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills" (Law, Woo, and Wong, 2018). These competency areas are namely; devices and software operations, information and data literacy, communication and collaboration, digital content creation, safety, problem-solving and career-related competences. For construction-specific careers, some major professional bodies in construction have specified core ICT skills and competencies for their professionals.

The Australian Institute of Quantity Surveyors (AIQS) specifies three competencies under 'computer services' as a core unit under 'support competencies' in their competency standards document for quantity surveyors, construction economists and cost engineers. The first competency serves general usage of computers including general skills in the use and care of computing hardware and software, using computers to access, enter and process information, and data between participants in construction activities. These are addressed in the UNESCO framework under competency areas of 'devices and software operations', 'information and data literacy', and 'communication and collaboration'. The second competency specified by AIQS addresses the usage of standard application packages such as word processing, electronic spreadsheets and statistical packages in the management and presentation of information related to construction activities. The third AIQS competency serves the usage of construction-specific computer packages. Second and third AIQS competency areas will be considered under career-related competences in this study.

'Requirements and Competencies guide' document published by Royal Institution of Chartered Surveyors (RICS) specifies 'data management' as a mandatory competency including; obtaining and using published sources of data, managing inhouse sources of data and the use of computerised central project databases or BIM. This will be considered under career-related competences in this study. Table 1 presents the detailed descriptions of the competencies considered in this study.

Table 1: *Detailed Descriptions of Competencies*

Competency 1 - Devices and software operations ▪ To identify and use hardware tools and technologies. ▪ To identify data, information and digital content needed to operate software tools and technologies

Competency 2 - Information and data literacy

- To articulate information needs, to locate and retrieve digital data, information and content.
- To judge the relevance of the source and its content.
- To store, manage and organise digital data, information and content.

Competency 3 - Communication and collaboration

- To interact, communicate and collaborate through digital technologies while being aware of cultural and generational diversity.
- To participate in society through public and private digital services and participatory citizenship.
- To manage one's digital identity and reputation.

Competency 4 - Digital content creation

- To create and edit digital content.
- To improve and integrate information and content into an existing body of knowledge while understanding how copyright and licenses are to be applied.
- To know how to give understandable instructions for a computer system.

Competency 5 - Safety

- To protect devices, content, personal data and privacy in digital environments.
- To protect physical and psychological health, and to be aware of digital technologies for social well-being and social inclusion.
- To be aware of the environmental impact of digital technologies and their use.

Competency 6 - Problem-solving

- To identify needs and problems and to resolve conceptual problems and problem situations in digital environments.
- To use digital tools to innovate processes and products.
- To keep up to date with the digital evolution.

Competency 7 - Career-related competences

- Use standard application packages in the management and presentation of information relating to discipline specific activities
  - Word processing programs to produce professional quality reports,
  - Electronic spreadsheets used to prepare schedules
  - Statistical packages use to manage and process statistical data)
- Use computer packages for construction-specific disciplines (e.g., CostX, Revit)
- Data management
  - Obtain and use published sources of data
  - Collect, analyze, store inhouse sources of data
  - Use of computerised central project databases or Building Information Modelling (BIM)

3. Methodology

3.1 Data

The online construction management degree is one of the most popular courses in University of South Australia (UniSA). UniSA is known as one of the largest providers of online learning in Australia. As part of its digital strategy, UniSA Online was created to offer a variety of degrees from different disciplines that are 100% online. For the construction management degree, around 70% of the students studying are working in the construction industry and would want to progress their career or shift their career in the field of construction management.

The data in this study was collected from seven first year courses in construction management degree program delivered from January 2019 to March 2020. These courses can be categorised under major steams of construction management, construction technology, construction cost management and construction law. These courses were developed with Moodle resources such as files, pages and URL. The Moodle activities implemented in these courses are forums, assignment, quiz, database, survey, glossary, lesson and Zoom. Although Zoom is not a standard Moodle activity, this is embedded in the Moodle and used in the online construction management courses. Since the online courses are designed to be asynchronous, Zoom sessions are recorded for students to view if they missed the live session or

for them to watch again for revisions. These activities and resources enable to generate reports of student engagement.

This study primarily used the student engagement reports which provide the percentage engagement in each activity and resource in a course based on views and/or contributions. The engagement activity of 781 online construction management students were collected. Each selected course was reviewed for the usage of various Moodle activities and resources in a focus group discussion with individual Online Course Coordinators. A total of 1248 records in the student engagement report were collected. Techniques dedicated to the online teaching team were omitted to filter only relevant activities and resources. Hence, out of 1248, 345 records of activities were removed. These include activities and resources that were hidden to the students (e.g., activities for the online academic staff, alternative activities that were not used) but still recorded in the student engagement report.

3.2 Focus Group

Online Course Coordinators from the seven online construction management courses participated in the focus group. The purpose was to identify how each of the activity and resources are used in the courses in the context of construction management. Feedback from the Online Course Coordinators were noted. Open coding was used to take note of margin of words, theories or short phrases to sum up what is being said. The words and phrases from the Online Course Coordinator's responses were collected and duplications were removed to eliminate overlapping of categories on how they use the activities and resources.

3.3 Data Analysis

The list of online activities and resources, taking into consideration the result of the focus group interviews, were mapped against digital literacy competencies defined by UNESCO and the construction professional bodies (AIQS and RICS). The student engagement reports were used to analyse the extent each activity and resource implemented and engaged in courses. Findings suggest which of the Moodle activities and resources were highly relevant in addressing digital literacy competencies of construction management students.

4. Results and Discussions

4.1 Online Activities and Resources implemented in selected courses

This section discusses implementation of Moodle activities and resources in the selected courses as identified by the Online Course Coordinators during the focus group discussion. Types of courses implemented each activity and resources with the intended purpose are presented in Table 2. In the study, the data for files, pages and URL are aggregated because these activities are used for the same purpose of providing information to the students.

Table 2: *Use of Online Activities and Resources in Online Construction Management Courses*

Online Activity/ Resource	Course/s	Purpose
Course website (Moodle)	All courses	• Course website is created using Moodle • Minimum computer requirements are specified by the university including; Strong internet connection, hardware (Webcam, Microphone, Headset, Speakers)
Moodle Files, Pages and URLs	All seven courses	• Used to share content with students
Moodle Forums	All seven courses	• Used as the major communication mode within course website

		• Allow students to have asynchronous discussions with peers or academic team
Moodle Assignment	All seven courses	• Used as a summative activity for students to submit assignments online (this activity is used as the major submission portal for most of the assignments)
	construction cost management courses	• Used as a formative activity for students to submit progressive hurdle activities and receive model answers
Moodle Quiz	All seven courses	• Used as a formative activity for students to test their understanding of a concept and get feedback automatically
	construction management, technology and cost management courses	• Used as a summative activity to assess competencies of students at a certain stage of a study period
Moodle Database	construction cost management courses	• Used as a formative activity to upload final output after following a series of tasks, view and comment on others works
Moodle Survey	Two courses construction cost management courses	• Used as a formative activity to survey the early preparedness of students with a software from an external provider
Moodle Glossary	construction management courses	• Used as a formative activity to contribute to a shared glossary defining key words found in weekly concepts
Moodle Lesson	One course in construction cost management	• Used as a formative activity to follow a series of tasks following examples and receiving answers automatically
Live sessions via Zoom	All seven courses	• Facilitate interaction between the online academic team and the students

It was found that some activities are commonly implemented in courses but, some are implemented occasionally. Only the commonly implemented activities and resources namely, files, pages, URLs, forums, assignment, quiz, database, glossary and Zoom were considered for mapping with competencies and further investigation with student engagement data.

4.2 Mapping of Competencies

This section maps the contributions of selected Moodle activities and resources (Table 2) in addressing digital literacy competencies specified by UNESCO and career related competencies specified by AIQS and RICS. This was performed through the Online Course Coordinator's focus group interviews and summary of results is presented in Table 3. This mapping considered which activities and resources can address each competency based on the detailed descriptions of each competency presented in Table 1.

It is evident that *competency 2* is supported by all Moodle activities and resources implemented in the courses. *Competency 3*, *competency 4* and the career-related competency on using standard computer packages are also mostly supported by Moodle techniques. Other competencies are supported with only two among different techniques. Online Course Coordinators' views on the contributions of each activity and resource towards identified competencies are discussed hereafter.

Table 3: *Contribution of Moodle Activities and Resources Implemented in Selected Courses.*

Digital Literacy Competencies	Moodle course site	Forums	Quizzes	Files, Pages, URL	Database	Glossary	Assignment	Live online sessions
Competency 1 - Devices and software operations	*							*
Competency 2 - Information and data literacy	*	*	*	*	*	*	*	*
Competency 3 - Communication and collaboration		*			*	*		*
Competency 4 - Digital content creation			*		*	*	*	
Competency 5 - Safety	*							*
Competency 6 - Problem-solving		*						*
Competency 7 - Career-related competences			*	*	*	*	*	

4.2.1 Files, page, URL

Apart from intext body of the course website, files, pages and URL are the mostly implemented Moodle resources to share course content in an organized manner in all courses. Students watch or download these contents from the course website and save for studying offline where necessary. Also, they download and save assignment resources which are mostly shared as files to work offline. These activities directly contribute to their information and data literacy (*competency 2*). Moreover, in this construction management program, most of the course resources are shared as Word documents, Excel spreadsheets and other files produced by construction-specific computer packages (e.g., CostX files). This has a direct contribution to career-related competencies where construction management students are expected to be competent in using standard application packages such as Word and Excel, and construction-specific computer packages. Moreover, RICS specified data management as a core competency and students in this program practice to access and use published sources of data via URLs provided in most courses for relevant contents.

4.2.2 Forums

As the major mode of communication with peers and academic team, students post and upload digital content (files, images) in forums, read posts to find relevant information and sometimes respond to the posts by peers or academic team. Meurant (2010) also explained forum activity as generating animated discussions and therefore, develop students' ability to navigate, engage, contribute in sustained written discussions and debate. Therefore, forums directly contribute to *competency 3*, communication and collaboration. At the same time, forums contribute to improve their information and data literacy (*competency 2*) through navigating and engaging to create posts, read and respond. Moreover, students can activate Moodle option to receive email notifications for each forum post or a daily digest for selected forums for receiving up-to-date information effectively thereby, judge the relevance of the source and its content as given under *competency 2*. Another popular use is dedicated forums for communicating the technical issues on accessing course contents or other course-related applications to seek solutions and to inform lessons learned. These applications include construction-specific computer packages such as CostX and Revit. Some issues are resolved collectively with peers and teaching teams thereby, contributing to improve the problem-solving skills under *competency 6*.

4.2.3 Assignment

As mentioned in Table 2, this Moodle activity is implemented in all courses as the major submission portal for most of the assignments requiring students to produce digital content offline in a specified file format (documents, files using other applications, photo images, videos or presentations) and upload to submit. Thereby, this activity has a direct contribution to improve their information and data literacy competencies (*competency 2*) and digital content creation competencies (*competency 4*).

These answer files can be in different file formats and similar to the findings discussed under files, pages and URL resources, construction management students are producing these answers using standard application packages and construction-specific computer packages. Thus, having a direct contribution to career-related competencies of construction management students. Moreover, students are monitored, and actions will be taken against academic integrity issues based on the Turnitin report created in Moodle assignment portal for these answer files. This process will inform and enhance understanding of students on how copyright and licenses are to be applied as also required under *competency 4*.

4.2.4 Quizzes

As can be seen in Table 2, quizzes are used as both summative and formative activities in the courses and as presented in Table 3, Online Course Coordinators pointed out a range of skills developed through quizzes by navigating over a quiz to read, understand, answer, flag and review various types of questions within a given duration. These types of questions require students to select answers using automated options; type answers online; and/or download resources and upload completed answer files.

Thereby, quiz activities can be used to address information and data literacy (*competency 2*) of students. Moreover, students need to give various commands in the online quiz environment to answer above types of questions, flag, review and to use submission options. Therefore, students will develop *competency 4* up to a considerable extent by practicing, creating and editing digital content, and by giving understandable instructions to the system. The resources and answer files can be in different file formats and similar to the findings discussed under files, pages and URL resources, construction management students are mostly required to use Word documents and Excel spreadsheets in these quizzes as required for essay type questions.

4.2.5 Database

This activity is implemented in few courses where students need to navigate over a series of tasks to produce a digital output (documents or photo images), upload, review other works and respond. Therefore, this activity can contribute to information and data literacy competency of students (*competency 2*). Also, it contributes to communication and collaboration (*competency 3*) due to the feature allowing students to review and respond to others works. While producing those digital output, students will be directly benefited by addressing *competency 4*. As similar to other activities in this program, most of these digital outputs contain Word and Excel files thereby, practice using standard applications as required to address career-related competencies. However, all the Online Course Coordinators found it is not user-friendly given the tasks in construction management courses.

4.2.6 Glossary

This activity is not implemented in many courses but, Online Course Coordinators agreed that it can contribute to *competency 2* and *competency 4* as students need to search definitions of key words, create own descriptions to share in a collaborative space. Given this collaborative environment it can directly contribute to communication and collaboration (*competency 3*) with contributions from all students. Moreover, Online Course Coordinators suggested that this activity can contribute to data management competencies in a collaborative environment similar to construction projects and thus, will contribute to career-related competencies.

4.2.7 Live sessions using Zoom embedded in Moodle course website

As the major active communication mode, students need to access Zoom application for all group and individual meetings and discussion sessions. During the sessions, they need to manage Zoom application as per their choice either to listen passively (video off, mute) or actively engage using required hardware (speakers, webcam, mic). Thus, it has direct contributions for students to improve their competencies to identify and use software and hardware applications (*competency 1*). Students who are not able to attend the live session or those doing revision with session, watch the recordings and seeking further information relevant to major course content and thereby, addressing information and data literacy up to some extent (*competency 2*).

These sessions are indeed the major mode to address communication and collaboration (*competency 3*) among online students where they interact in a live digital environment with peers and academic team through formal or informal discussions. At the same time, Zoom sessions are created within course website for one-off or recurring sessions throughout a study period, and use with password protection. In this process, students are informed the requirement of protecting privacy in digital environment and thus, contribute to the competencies under safety (*competency 5*). The academic team use Zoom sessions to assist students seeking solutions for technical issues on course-related applications via 'screen share' and 'remote control'. Some issues are resolved collectively in the presence of peers. This creates problem-solving situations in digital environments and contributing to the *competency 6*.

4.3 Implementation of Moodle Techniques and Student Engagement

This paper aimed to find the most relevant Moodle techniques to be implemented to address digital literacy of construction management students. Effectiveness of these techniques is not able to achieve through mere implementation of activities and resources in the courses but, student engagement is also important. Figure 1 presents average implementation of each technique in the selected courses and overall student engagement.

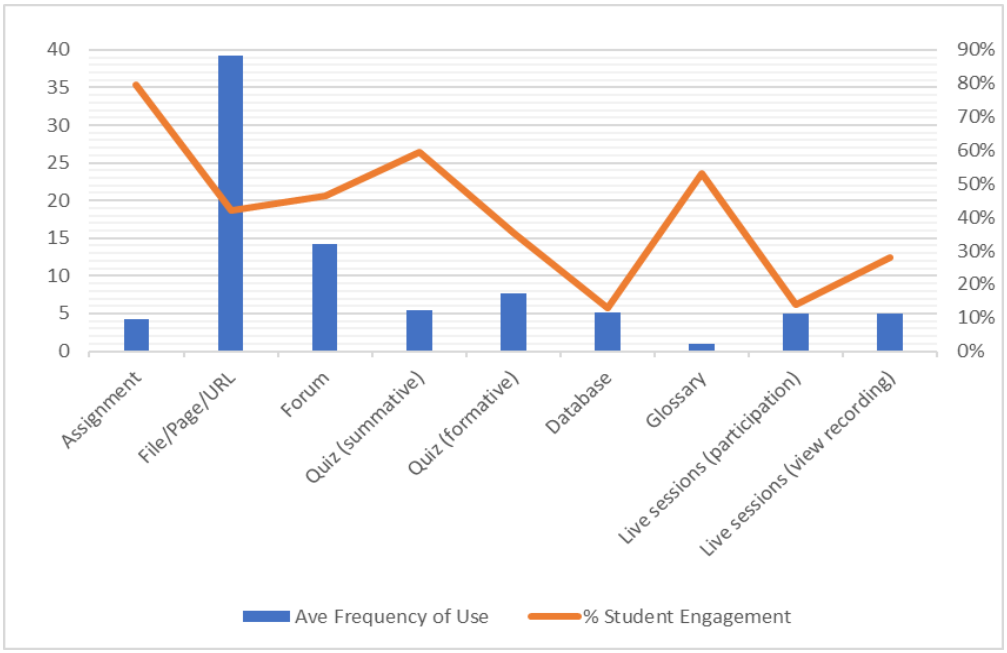

Figure 1: Implementation of Moodle Techniques and Student Engagement

Results show file/page/URL resources as the mostly implemented technique in courses. This can be attributed with the fact that most course materials are shared in these forms apart from intext content and concept videos. Student engagement is also considerable as some of these resources provide useful course content and assessment details.

Among different Moodle activities, forum is the mostly implemented activity and showing a considerable student engagement. Findings reported by Deng and Tavares (2013) suggest that social relationships and owning by peers as the motivational factors for students to engage in online discussions. Their study indicates the requirement of designing and facilitating forums to address the needs of students from informal chatting to discussion of academic issues. This can be considered by the academic team in the construction management courses to further improve student engagement because, communication is important for construction management students whereby construction industry is multi-disciplinary in nature and require vast communication and negotiation among stakeholders.

Despite the less implementation, assignment activity has the highest student engagement given it is the major mode of submitting summative assessments. This activity contributes to several digital competencies and involve outputs produced by a variety of computer packages thus, an effective Moodle activity for construction management courses.

Quizzes are fairly implemented in courses for both summative and formative activities, and summative activities are compulsory for students. However, all Online Course Coordinators agreed that quizzes are popular among students even if used as formative activities as reflected in Figure 1. Meurant (2010) also identified that if the quizzes are set accordingly, the student can find out their score immediately on completion which is a significant advantage. This can be the reason for high engagement in quizzes despite the activities are being summative or formative. More quizzes with automated marking can be implemented in courses as an effective technique with popularity among students and involve a range of skills with a variety of question types and thus, contributing to several digital literacy competencies.

Databases activity has fair implementation but, lack of student engagement reflecting the view of Online Course Coordinators regarding lack of user-friendliness. Glossary activity has lack of implementation but, higher student engagement and more contributions towards digital literacy competencies. Therefore, this study suggests implementing Moodle glossary in more activities to gain its benefits but, to limit activities with databases or to explore more effective tasks to implement with.

Results show lack of engagement in live sessions (participation) but, comparatively higher engagement in viewing recorded sessions. This is somehow in contrast with the view of Abdous and Yen (2010) stating live class meetings as an increasingly important delivery method in online learning given the less effectiveness among these online students. Anyhow, the effectiveness of live sessions cannot be undermined as this an online student group studying part time and engage in asynchronous learning from interstate. Personal commitments and different time zones attribute to the less active engagement but, more views of the recording. It is worth to explore strategies to increase the active participation with this activity as it contributes to several competencies including the use of software and hardware and, more importantly contributing to improve communication skills of construction management students learning online.

5. Conclusion

This paper reviewed the 'Digital Literacy Global Framework' proposed by UNESCO and construction professional bodies (AIQS, RICS) to identify the digital literacy competencies required by construction management graduates. It also reviewed online activities and resources offered by Moodle Learning Management Systems with the implementation in seven first year courses in a construction management degree program operating in an online educational environment in Australia. Identified digital literacy competencies were mapped with Moodle techniques implemented in selected courses as a result of a focus group discussion with Online Course Coordinators. This mapping identified that information and data literacy competency is addressed with all implemented Moodle techniques. Findings suggest 'Assignment', 'Forum' and 'Quiz' as relevant and therefore, recommended to implement for the potential enrichment of digital literacy of students. 'Glossary' activity found with less implementation but, as a relevant technique to be used due to higher engagement and higher contributions to general and career-related competencies. Supported with literature findings, the study suggests activities such as forums and live sessions should be implemented carefully to retain student engagement as these are very important for construction managers given the nature of industry with communication and collaboration with multi-disciplinary stakeholders. The current study recommends the relevant online activities and resources with high relevance to address digital literacy competencies

based on the level of implementation and student engagement and this study can be extended to find the effectiveness in enriching digital literacy of construction management students in the online learning environment.

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