Perceptions of Civil Engineering Undergraduates on Using Learning Management System (LMS) and Zoom Platform for Online Design Studio Teaching

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Abstract— As the COVID-19 pandemic continues, 'online teaching and learning' became the only possible solution to continue the education programmes at universities. Though there are multiple solutions presented in the educational literature, many of the universities were not prepared to carry out complete online-based educational models in their degree programmes. Therefore, converting the teaching process; mainly studio base design teaching from physical to online was a whole new experience to most of the academia in developing countries. Further, it is a challenge to run these virtual teaching processes with limited technological resources for a long time. This study was conducted to investigate the perceptions of online based education using the Learning Management System (LMS) and Zoom platform for a studio base module. Thus, the methods were adopted to evaluate influencing factors of the online learning experience of the subject. Quantitative analysis was used where unstructured and structured questionnaires were conducted among students. Finally, the students' perceptions of online learning experience for a studio base module were presented.

Keywords: o*nline teaching/learning, Moodle, Learning Management Systems (LMS), Zoom, studio teaching, project-based learning, student perceptions, civil engineering curriculum*

I. INTRODUCTION

Studio teaching and project based learning are the traditional disciplines of teaching programs associated with architecture and design. Architectural design education highlights on achieving technical, technological, cultural and social aspects together with studio teaching (Afacan, 2016). It is emphasized on creative methods where it basically deal with the arrangement of physical form and space for fulfilling criteria related to the avenues of use, construction and aesthetics. Consecutive involvement of making, seeing, reflecting and forming habits via practice has been identified as the fundamental of designing process (Daalhuizen *et al.*, 2019). Therefore, these subjects are basically communicated through visual representations such as artefacts in the form of drawings, prototypes and scale models. Traditional artefacts included graphite and ink on paper, objects made of plaster, cardboard and wood which were tangible. However, with the arrival of computer-aided design (CAD), immaterial artefacts such as digital images, movies and models are been used (Steinø and Khalid, 2017). Therefore, these design subjects typically involves learning and working on "architectural space and form, using of appropriate materials and construction techniques and presenting of drawings and 3D models"(Afacan, 2016). Similarly, in architecture and design studies, predominant approach of instructing students is one on one studio supervision, where design ideas are shared by supervisors with students through individual or group discussions. Furthermore, academics or invited guest practitioners provide their opinions or comments to the students, by observing their work in progress which is technically known as 'Critique/ critic'. This is also another major path of traditional studio learning format in architectural design study (Ruangvanich, Nilsook and Wannapiroon, 2019).

As an alternative to education at traditional university model, online design education has emerged as a method of perusing education which provides flexible, high quality learning experiences to location independent audiences at

a relatively low-cost (Cavanaugh and Jacquemin, 2015). Similarly, experimental learning through online platforms has become an important pedagogical approach in higher education because of the integration of Learning Management Systems (LMS) and other web platforms such as Google, Zoom, Scopus, You tube and etc. It has been identified that online learning has enabled the interaction of students with online learning assets such as video and text references, unlike traveling physically and also it has allowed the communication among peers and instructors without physically being at the same location at the same time. Similarly, it has allowed the collaborative learning and evaluation by sharing work in progress across space and time. Therefore, these three aspects of online education has enabled to practice architectural design education in online platform (Steinø and Khalid, 2017). Moodle is one of the prominent platforms of learning management system adopted by many higher educational institutes in the world to fulfil the requirement of online education. It has centralized the academic information services, online contents and learning applications and simplified the management and administration of teaching and learning through e-learning (Cabero-almenara, Arancibia and Prete, 2019). One of the main advantages of using Moodle is its open source or having open source facility allowing the users to program their knowledge to modify and adapting the environment according to their own needs. Similarly, it assures the distant learning process by having reachable interface for students, academics and administrators which allow them to plan their learning and teaching processes and it enhances the ability of working together (Kerimbayev, Kultan and Abdykarimova, 2017). In the functional perspective, it has configured features which allow the formation of student assessment processes, and the management of their learning activities. Similarly, it has enabled the enriching of learning process by allowing to insert open source learning materials and also it has the features of providing automated adaptive educational assessments (Lopes, 2011). However, teaching of studio design subjects entirely through e-learning platforms have been limited and remained understudied. In design education, theory lectures are important to explain the underlying theories and methods. In terms of experiential learning, these lectures guide to abstract the concepts and generalizations of underlying theories. In the e-learning platform this can be applied in the form of an online lecture or recorded video of the lecture which typically includes background theory and a specific method the students were to use for the design exercise (Scagnoli, Choo and Tian, 2019). The presence of references or benchmarks of the designs of other students and the examples and feedbacks of a teacher are key features of design education in a studio environment. Providing a benchmark video through open sources in online platforms allow the students to compare their design work with qualified professional works of the same design exercises. Similarly, providing expert videos as supplementary reference materials via open sources allow students to gain advanced visions into the specific step they used and to identify methods they applied in that step. Furthermore, these references allow to trigger the reflection of the course content and the experiences of the experts in a wider sense (Daalhuizen and Schoormans, 2019).

This study was conducted to investigate the perceptions of students on online base education using Learning Management System (LMS) and Zoom platform for the 'Building Design Process and Applications' (BDPA) module which was conducted to year one undergraduates who are following bachelor of civil engineering degree in University of Moratuwa, Sri Lanka. The objectives of this module are mainly achieved through studio based teaching, project based learning and end semester exams. BDPA is a three (03) credit elective subject which covers 150 notional learning hours per semester (06 calendar months). Thus the lesson plans were prepared to achieve the four (04) learning outcomes (LO's) such as LO 1: Articulate an appreciation of the roles of different professions in the design team, LO 2: Apply building regulations to residential, commercial and public buildings, LO 3: Apply basic building planning concepts for activity spaces and means of circulation, LO 4: Produce building drawing using computer tools, for 14 weeks on LMS platform. Table 1 shows the particular delivering and assessment methods prepared for weekly lesson plans given under the subject.

Table 1: Particular delivering methods (DM) and assessment methods (AM) prepared for 14 weeks of lesson plans given under the subject.

Week	Topics covered in lesson plans of BDPA
W-01	Introduction Lecture
DM	Lecture notes, Open source video references, Zoom session for face to face discussion
AM	Forum discussion#01
W-02	Practicing Pictorial Drawing Types
DM	Lecture notes, Open source video references
AM	Assignment #01- Drawing of perspective, orthographic, isometric and oblique views
W-03	▪ What is "creativity" and why "creativity" is important? ▪ Architectural "concept" and space-making
DM	Lecture notes, Open source video references
AM	Forum discussion#02, Assignment #02 – Building review
W-04	▪ Pre-design services ▪ RIBA Plan of Work 2007 ▪ RIBA Plan of work 2013 ▪ Responsibilities as a matrix of design team members as accordance with the RIBA Plan of Work
DM	Lecture notes, Open source video references, Zoom session for face to face discussion
AM	Quiz, Assignment #03
W-05	▪ Introduction to planning and building regulations ▪ Importance of anthropometrics and ergonomics in building design
DM	Lecture notes, URL#01 – external references, Zoom session for face to face discussion
AM	Forum discussion#03, Assignment#04
W-06	Elements of a Building - Introductions of different types of foundations in buildings
DM	Lecture notes, URL#02 – external references
AM	Assignment#05- Group 01 – Zoom session for face to face discussion (Student presentations)
W-07	Elements of a Building - Introductions of different types of walls and floors in buildings
DM	Lecture notes, URL#03 – external references
AM	Assignment#05- Group 02 – Zoom session for face to face discussion (Student presentations)
W-08	Elements of a Building -Introductions of different types of Roof structures, Introductions of different types of doors and windows in buildings
DM	Lecture notes, URL#04 – external references
AM	Assignment#05- Group 03 – Zoom session for face to face discussion (Student presentations)
W-09	Elements of a Building - Steps, Stairs and Elevators/ Lifts, Building Services, Finishes of buildings
DM	Lecture notes, URL#05 – external references
AM	Assignment#05- Group 04 – Zoom session for face to face discussion (Student presentations)
W-10	Introductions of construction site management
DM	Lecture notes, URL#06 – external references
AM	Assignment#05- Group 05 – Zoom session for face to face discussion (Student presentations)
W-11	Green concepts and sustainable building design strategies
DM	Lecture notes, Open source video references, Zoom session for face to face discussion
AM	Forum discussion#04, Assignment#06
W-12	Developing a basic building plan –Stage-I
DM	Open source video references for manual and AUTOCAD/Revit lessons, Zoom session for face to face tutoring session
AM	Forum discussion#05, Scheme Design
W-13	Developing a basic building plan –Stage-II
DM	Zoom session for face to face tutoring session
AM	Forum discussion#06, Design Development
W-14	Developing a basic building plan –Stage-III
DM	Zoom session for face to face tutoring session, URL-external reference for arrange portfolio
AM	Forum discussion#07, Detail Design submission
****For all the continues assessment (Assignment 01,02,03,04,05 and 06) : 30% of total marks	
****End Semester Examination (Open book paper based exam) : 70% of total marks	

Source: Author

In order to conduct the evaluation of the learning activities, formative quizzes, automated assessments and peer and self-assessments can be incorporated with the Moodle LMS. Similarly, the grading for such assessments can be used as a strategy to motivate the participation of the students in online education. Online discussion forums is one of the pedagogical technique often used in e-learning platforms (Seethamraju, 2014). Student's abilities such as critical thinking, problem solving, and decision making, written communication skills, organizing and analysing information are often enhanced through forum discussions. Similarly, combining online forums with case studies have been widely adopted by the academics and this technique encourage students to relate theory to practice. Furthermore, these combined activities enable the independent learning and knowledge construction and enhancing critical thinking skills of the students (Wong *et al.*, 2015). In the other hand, peer reviewing is a common pedagogical approach which can be more significantly blended with online learning platforms as well as in design studies. Peer reviewing enables students to receive evaluations of their work by their peers. This allow students to discuss the steps taken in developing the design work, assess the ideas and insights, exploring the various paths of the same design and finally the quality of the individual work with true reviews (Ruangvanich, Nilsook and Wannapiroon, 2019). In order to identify the success of delivering design subjects through e-learning platforms, various evaluation techniques can be utilized. Course evaluation feedbacks, demographics of the LMS with the number of student enrolments and their consistency, work performance metrics, information posted by students on course forum discussions and by assessing the students' experience through pre and post course surveys are some of these techniques which can be used to emphasize the success of the delivering and learning processes (Berga et al., 2021).

II. METHODOLOGY

A comprehensive literature review was done, and an unstructured and structured preliminary questionnaire was designed to evaluate the perception of the students who followed the module for entire semester. An informal/ casual discussion was organized with the students and the students were tutored before setting the final questionnaire. Pre-validity testing was carried out with 10 respondents and the feedbacks was taken into further consideration. Data were collected by considering the students' demographic features, perceptions, preferences, drawbacks, and suggestions. The statements were presented on a five-point Likert scale (05 being strongly agreed and 01 being strongly disagreed). The data and the statements were categorized in to five (05) sections as follows;

Demographic features (Gender, Region, Status of the internet connection)

Perception of the online learning experience of the subject

Perception of the online learning experience in terms of the designing aspect

Perception of the online assignments and exams

Feedbacks for future development of the module

III. ANLYSIS AND DISCUSSION

A. Selected sample profile

Civil Engineering undergraduates were chosen as the sample for this study. "Building Design Process and Application" (BDPA) subject was offered them through the university Learning Management System (LMS) in their second semester of the first year. There were 131 students registered and 126 of them have submitted valid responses. SPSS (version 23) was used to analyse the collected data. The selected sample consisted of 96 male students and 30 female students. Figure 1 shows the demographic information according to the region.

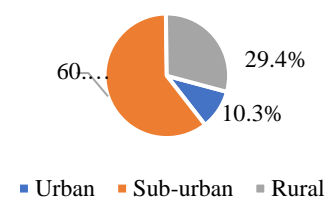Demographic information of the respondents according to the region

Figure 10: Demographic information of the respondents (N=127)
Source: Author

The majority of the sample were males (76.2%) and the percentage of the female respondents was 23.8% of the sample population. The students have connected to the online sessions from their homes because of the country was lockdown due to the COVID-19 pandemic. The majority of the respondent students were from sub-urban areas (60.3%). 29.4% of the respondents were connected from the rural areas and 10.3% of the respondents were living in the urban areas.

B. Reliability Test

Table 3: Reliability of the variables

Variable	Cronbach's alpha	Number of questions
Perception of the online learning experience of the subject	0.760	07
Perception of the online learning experience in terms of the designing aspect	0.714	06

The reliability test interprets the internal consistency and measured the properties of the scale (Hair et al., 2005). The reliability of the data set was measured by Cronbach's alpha, which is commonly applied in Likert scale-based surveys. Table 3 shows Cronbach's alpha values for each of the categorized variables separately.

The Cronbach's alpha value between ±0.41 and ±0.70 represents moderate reliability of the measuring scale and values greater than ±0.70 represent higher internal consistency (Sekaran and Bougie, 2009). As shown in Table 3, Cronbach's alpha value is 0.760 and 0.714 which interprets that the internal consistency of the collected data is good and can be used for further analysis. The question statements were ranked according to the mean rank derived by Friedman's test using SPSS software. The formula used for Friedman's testing is as follows:

$$\text{Mean Rank} = \frac{12}{n_r k(k+1)} \sum R_i^2 - 3n_r(k+1)$$

Here, n_r = number of rows; k = number of columns; R_i =Sum of the ranks.
This students' perception study has mainly depended on the given questionnaire. Insights can only be stated on the statements in which

answers been recorded. This issue is overcome by using content analysis. Content analysis was done to analyze the conventional open-ended questions. Content analysis stands for a statistical generic name that analyzes a set of textual data that usually involves contrasting, comparing, and categorizing (Schwandt, 1997). The objective of performing a content analysis is to identify the students' perspective of online learning for building design and applications related subjects. Two authors were investigating the open-ended questions' responses. The categories and subcategories were created after testing the interrater reliability by using Kappa Co-efficient. The Kappa coefficient was estimated and resulted as 0.74 which interprets significant agreement between the investigators.

The questions were presented in a five-point Likert Scale which was ranging from 1: "Strongly Disagree" to 5: "Strongly Agree". "Strongly Agree":5 and "Agree":4 was combined to create one positive response which denotes "Agree". "Strongly Disagree":1 and "Disagree":2 clubbed to create one negative response which denotes "Disagree". "Neutral" was kept as it is.

C. Perception of the online learning experience of the subject

The variables of perception of the online learning experience (OLE) of the subject shown in the Table 4.
The analysis of the percentages of the perception of the online learning experience of the students is shown in Table 5. 69% of the students agreed that learning the subject online, provided the platform to access more Open Educational Resources (OER) that leads to high-quality education (OLE_3). 66% of the students agreed that active learning strategies such as group projects, discussions, case studies, debates are more advantageous during online lessons than in classroom sessions (OLE_1).

Table 4: Variables of the perception of online learning experience of the subject

Code	Variable
OLE_1	Active learning strategies are more advantageous in online learning
OLE_2	Learner-centered approach was encouraged than in traditional class room sessions
OLE_3	Provided the platform to access more Open Educational Resources (OER)
OLE_4	More convenient to participate in lessons online
OLE_5	Same subject guidance as in traditional class room sessions
OLE_6	Perfect alternative to education in the traditional university mode
OLE_7	Quality of the distance-education course is higher

Source: Author

Table 5: Percentages of perception of the online learning experience of the subject (N=126)

Code	SD% (1)	D% (2)	Total% 1+2	N% (3)	A% (4)	SA% (5)	Total% 4+5
OLE_1	0	6	6	29	60	6	66
OLE_2	0	2	2	39	59	0	59
OLE_3	0	2	2	29	61	8	69
OLE_4	0	2	2	42	48	7	55
OLE_5	0	6	6	37	56	1	57
OLE_6	0	4	4	37	53	6	59
OLE_7	0	11	11	40	46	3	49

Source: Author

59% of the students agreed that the learner-centered approach allows one to grab more knowledge than in traditional classroom lessons and learning the subject online is a perfect alternative to education in the traditional university model (OLE_2, OLE_6). 57% and 55% of the students agreed that the subject guidance given to them in the online lessons was the same as the classroom session and students feel more convenient to participate in lessons online than in traditional on-campus lessons because they are location independent and low cost accordingly. 49% of the students agreed that the quality of their distance-education courses in comparison with traditional classroom education is higher. Also, 30%-40% of students shown neutral perception on the variables which is a specific percentage. According to Friedman's testing, the average mean rank of the perception of the online learning experience of the subject is 4, which denotes "agree" in the Likert's scale (Table 6).

According to the analysis, students had a better online learning experience of the "Building Design Process and Application" subject.

Table 6: Mean Rank Value of OLE according to the Friedman's testing

Code	OLE _1	OLE _2	OLE _3	OLE _4	OLE _5	OLE _6	OLE _7
Mean Rank	4.00	3.95	4.60	3.96	3.73	4.15	3.63

Source: Author

D. Perception of the online learning experience in terms of the designing aspect

The variables of perception of the online learning experience in terms of the designing aspect (DA) are shown in Table 7.

Table 7: Variables of the perception of the online learning experience in terms of the designing aspect

Code	Variable
DA_1	Allowed them to learn and perform different design activities
DA_2	Had more opportunity to reflect their own experiences through design
DA_3	Had the opportunity to experience all of the basic activities and the main phases of the design process
DA_4	Allowed to apply design theories in different areas
DA_5	Boosted the confidence and allowed for innovative activities towards designing
DA_6	Had more supervisory guidance for designing activities

Source: Author

Table 8: Percentage of the perception of the online learning experience in terms of the designing aspect (N=126)

Code	SD% (1)	D% (2)	Total% 1+2	N% (3)	A% (4)	SA% (5)	Total% 4+5
DA_1	0	86	86	13	2	0	2
DA_2	0	54	54	44	2	0	2
DA_3	0	60	60	38	2	0	2
DA_4	0	10	10	89	2	0	2
DA_5	0	64	64	34	2	0	2
DA_6	0	33	33	63	4	0	4

Source: Author

The analysis of the percentages of the perception of online learning experience in terms of the

designing aspect shown in Table 8. 86% of the students disagreed that the students are not limited to the tutor's ideas and it allows them to learn and perform different design activities (DA_1). 64% and 60% of the students disagreed with the statement that online learning boosts the confidence of the student (DA_5) and allows for innovative activities towards designing and the students have the opportunity to experience all of the basic activities along with the main phases of the design process (DA_3) accordingly. 54% of the students disagreed that the students had more opportunity to reflect their own experiences through design when doing the subject online (DA_2). 89% and 63% of students stayed neutral on the statements of the online subject allowed them to apply design theories in different areas rather than focusing on one specific problem (DA_4) and the students could take more supervisory guidance for designing activities during online lessons than in on-class sessions (DA_6).

Table 9: Mean Rank Value of DA according to the Friedman's testing

Code	DA_1	DA_2	DA_3	DA_4	DA_5	DA_6
Mean Rank	2.14	2.47	2.33	3.10	2.31	3.24

Source: Author

According to Friedman's testing, the mean rank of the perception of the online learning experience in terms of the designing aspect mostly denotes "disagree" in the Likert's scale. According to the analysis, students haven't had a better online learning experience in terms of the designing aspect of the "Building Design Process and Application" subject (Table 9).

E. Perception of the assignments and exams

The variables of perception of the assignments and exams (PA) are shown in Table 10.

Table 10: The variables of perception of the assignments and exams

Code	Variable
PA_1	Satisfied with the time taken to post back the grades and scores
PA_2	Activities and assignments increased the motivation towards the subject
PA_3	Evaluating the work-in-progress of the students has not been limited during the online learning period

Source: Author

Table 14: Percentages of the perception of the assignments exams

Code	SD % (1)	D% (2)	Total % 1+2	N% (3)	A% (4)	SA % (5)	Total % 4+5
PA_1	2	4	6	32	58	5	63
PA_2	4	11	15	8	66	11	77
PA_3	0	0	0	40	50	10	60

Source: Author

The analysis of the percentages of the perception of assignments and exams shown in Table 11. 66 % of students agree that the activities and assignments increased the motivation towards the subject. 58% and 50% of the students agree that they are satisfied with the time taken to post back the grades and scores of the student Assignment/exams and evaluating the work-in-progress of the students has not been limited during the online learning period accordingly. An average of 58% of students has shown positive perception about the assignments and exams given and an average of 7% of students shown negative perception about it. An average of 26.6% of students stays neutral of the perception on assignments.

F. Feedbacks for future development of the module.

One of the main issues the instructors faced during the online classes were responding to students' questions when they having technical difficulties such as audio echo, webcam or audio not working, zoom lags or freezes, zoom crashes, or unavoidable background noises. A rank answer question was designed to get feedback for finding the most convenient responding other medias (Table 12).

Table 15: Mode of most convenient media for response to the questions specially when students face a technical difficulty during face to face Zoom sessions (post-session responses)

		Rank_1	Rank_2	Rank_3	Rank_4
N	Valid	126	126	126	126
	Missing	0	0	0	0
Mode		3	1	2	4

Source: Author

Question: When having a technical difficulty with a component of your online course, how would you like your instructor to respond your question after the session?

1: Through e-mail

2: Through Moodle forum

3: Through social media chat room

4: Through phone call

A frequency analysis test has done to find the most convenient media. According to the analysis, the most preferable communication media when in a technical difficulty is through the social media chat room and the second most preferable media is sending an email. The least preferred communication method is through a phone call. The feedbacks were collected in terms of pacing the online course, how often should new content be available. According to the analysis, 67% of students prefer to receive the new content weekly and 26% of students prefer to receive the new content every two weeks. Only 2% of students preferred to receive the new learning materials more than once per week.

IV. CONCLUSION

This study identifies the perceptions of year one - BSc civil engineering undergatuate students who followed the design studio module, 'Buidling Design Process and Application' (BDPA) which was delivered through Moodle (LMS) and Zoom platform. Every year, 95%-100% of students per a batch are following this module though this an optional subject in curriculum. In 2020, the module was totally offered through online due to COVID-19 pandemic situation. Thus, the majority of the students were joined from urban and sub-urban areas (70.6%) and 29.4% of the respondents were connected from the rural areas. According to the analysed data, 59% of the students agreed that the learner-centered approach allows one to grab more knowledge than in traditional classroom lessons and learning the subject online is a perfect alternative to education in the traditional university model. Further, 51% of the students agreed that the quality of traditional active class room teaching is effective than online distance-education. However, 60%-65% of students not confident enough to handle online design projects because they lost the opportunity of experiencing basic physical design development activities. In addition, 66 % of students agree that the

activities and assignments were given in online module was increased the motivation towards the subject. An average of 58% of students has shown positive perception about the assignments and exams given and 07% of students shown negative perception about it. According to overall student perceptions, coupling Moodle (LMS) with Zoom platform is efficient enough to deliver a subject module though it is not fully effective to handle design based assignments in a studio base module of a BSc civil engineering degree. However, a few positive aspects were identified such as students do more self-learning within the online delivering system than in a physical class room teaching. Most of the students are familiar with the virtual technologies/communications and most preferable communication media for answering their questions in post-sessions is through social media chat room or sending an email. Although the workload involved in setting up, monitoring and assessing the online learning materials, forum discussions and tutoring sessions are significant, it is possible to reduce the work load by preparing the weekly plan, because 67% of students prefer to receive the new content weekly. One senior lecture and four (04) assistant lectures were continually monitored online tutoring sessions and the forum discussions to solve the design related matters of students. The critiques were handled via face to face zoom sessions. That strategy was effectively captured by most of the students and it confirmed the human experience/input is an essential component for studio based teaching. Thus the study should improve to make effective connections between human interaction and online education platforms in studio teaching and project based learning in a civil engineering curriculum.

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