Students' Engagement in Virtual Learning of Heritage Building During the Pandemic

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Abstract The COVID-19 outbreak has caused a significant impact on the higher education system unprecedented in modern history. Learning institutions were closed, tight regulations enforced to encourage social and physical distancing and switched classes from face-to-face to online delivery (ODL). As a result, e-learning tools and platforms were explored to keep students engaged in learning during this pandemic. Although this virtual teaching–learning adaptation is not by choice and challenging for both educators and students, modern technology has encouraged us to explore a new interactive way of delivering knowledge and continue students' learning engagement. This paper focuses on the alternative teaching methods that have been conducted in Architecture Measured Drawing, which traditionally relies on physical interactions and interaction in the form of collaborative work in-studio learning and field trips. A case study of one (1) private university conducted the Architecture Measured course online in response to the pandemic has been investigated. This paper aims to identify the teaching and learning methods of this course during the pandemic and to analyze the level of students' engagement throughout the course. A survey was distributed to students enrolled in the module to gain feedback on their experience. Findings proved that the alternative method adopted has shown that students have experienced different types of engagement with each stage in the course. Students' engagement was maintained at a high level despite the shift and completed the course successfully.

Keywords Student engagement · Virtual learning · Architecture drawing · Heritage building

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1 Introduction

With the rapid changes in the built environment, preserving buildings becomes necessary to safeguard each nation's character and identity. Heritage buildings should be documented as a reference for future generations. In architecture studies, buildings are like vessels containing the stories of who we are, where we have come from, and where we will be going. Therefore, to gain this information, the building's forms, purpose, and evolution are studied and recorded. With the study of existing buildings, implement innovations are necessary to evolve with the current need. These recorded building studies, in turn, help the modern-day architects as well as students of architecture to learn about ancient buildings and compare the architecture of the past with contemporary architecture to have a fundamental and culturally inclusive approach when designing. The study of architecture history bridges the gap between the past and the present. It is essential to understand the chronology of events in the current age as every story has a storyline, and if one of the puzzle pieces is missing, the storyline would be incomplete. History of architecture is a part of learning architecture as it is essential to understand the philosophies that were common in the past to reflect the relation to social needs. Through the different eras of the past architecture, from Egypt to the Industrial Revolution, the history of architecture teaches us how spaces evolved along with human needs and vice versa. By studying the history of architecture, we understand that buildings do not just reflect our society; they shape our culture down to the smallest spaces. Therefore, to make better buildings, cities, and a better world, studying the architecture of the past is essential in architecture institutions because architects are the "reality builders." To better learn the history of architecture, measured drawing was introduced as a subject that records buildings' physical and historical properties. With the current pandemic situation, online learning was introduced in learning measured drawing. However, there are a few concerns regarding online learning in measured drawing, mainly because the measured drawing course requires a lot of physical activities and engagement with students. The online learning process becomes monotonous due to the limitation of learning engagement between learners and learners. Koonin agrees that students are less likely to grasp and understand new and complex ideas when they are not fully engaged during online learning. Therefore, it proves to be a challenge in shifting the methods in teaching and learning in the course and maintaining the level of students' engagement.

2 Literature Review Students' Engagement in Learning

Student engagement is defined as "the time and energy students devote to educationally sound activities inside and outside of the classroom, and the policies and practices

those institutions use to induce students to take part in these activities" [1]. Concentrating on student engagement will offer beneficial information concerning the effectiveness of course instruction. A significant number of studies were conducted emphasizing student engagement in tertiary education [2–5]. Therefore, it becomes essential that educators should be able to observe and assess student engagement as a part of the students' overall learning experience [6–9].

Students' engagement assessment is divided into two categories, institutional level and course level. For this paper, the focus will be on the course level. Measuring student engagement at the course level provides valuable feedback to assess and enhance students' investment in the learning process as a reflection of a course's structure, pedagogy, and design. Course level data determines the effect of learner-centered pedagogical methods on student success [6]. Student engagement is a complex experience that comprises a mixture of behavioral, cognitive, and affective dimensions of learning involvement [10]. As outlined by Chapman [11], the range of descriptions for student engagement is as follows:

(1) Cognitive criteria, which index the extent to which students are attending to and expanding mental effort in the learning tasks encountered.
(2) Behavioral standards, which index the area to which students are making active responses to the learning tasks presented.
(3) Affective measures index the level of students' investment in and their emotional reactions to the learning tasks.

Students' engagement is a progressively researched matter at the tertiary education level, notably in online education. Dickinson [12] recommended research to be conducted in examining the effectiveness of online courses. Hence, Nasir et al. [13] attempt to refine the version of the Student Course Engagement Questionnaire (SCEQ) created by Handelsman et al. [10] to evaluate the students' engagement in online learning. Four (4) factors of student engagement were suggested in the questionnaire modification, which significantly reflects the online learning method:

(1) Factor 1: Applied Engagement—The student gaining learning experience that applied to the student's life. It reflects the effective criteria.
(2) Factor 2: Goal-Oriented Engagement—The student putting effort to complete tasks and achieve good grades. It reflects the cognitive criteria.
(3) Factor 3: Self-disciplined Engagement—The students make sure tasks are conducted in assigned manners without other forces. It reflects the cognitive, behavioral, and affective criteria.
(4) Factor 4: Interactive Engagement—The student actively involved in group work, tutorial and willing to help others complete tasks. It reflects the behavioral criteria.

These four (4) factors listed will be the fundamentals of this study questionnaire survey.

2.1 Architecture Measured Drawing

To learn the history of architecture more extensively, measured drawing is introduced to engage the students in historical recording buildings for historical understanding through site drawings and by measuring the building by hand. This process of documenting existing environmental contexts has been a valued part of architectural education for centuries, including Architecture Measured Drawing [14]. While the method used can be applied in making records of buildings of all types and ages, this method is beneficial for vernacular buildings and architectural details that are crucial to recording the history of a building or site. Measured drawing involves collecting data on the building through extensive research via site visitations, interviews, and observations. The act of measuring is to be conducted on-site to assist with orientation and help ensure the building is recorded fully. The complete drawings and documentation then would assist the future generation in understanding the structure.

The conventional practice in Architecture Measured Drawings involves a lot of activities involving off-site and on-site. With the shift to online learning, adapted alternative methods to ensure that students' engagement and the outcome of the course would not be affected by this shift. The following paragraphs will be discussing the ways of conventional practice and online technologies relating to the measured drawing.

Physical Learning in Architecture Measured Drawing

To understand the measured drawing course, it is essential to look at the steps in the course. According to Johar et al. [15], two courses require fieldwork study. As shown in Fig. 1, the two courses are land survey and building and measured drawing. Architecture Measured Drawing is a part of documenting buildings and is divided into four (4) different phases: site selection, theoretical, fieldwork, and report preparation [15]. Among the four (4) stages, theoretical and fieldwork require fundamental activities in the measured drawing course, data collection that involves a physical site visit, on-site measurement, and on-site drawing [16]. While the division of phases shown in Fig. 2 is more related to the Land Survey and Measured Drawing course, it is similar to learning Architecture Measured Drawing.

Data collected through hand-measuring methods using simple tools such as a measuring tape or laser measuring device are still the most common for recording existing buildings. The projection of architectural surfaces in the plan, section, and elevation drawings allows architects to understand the 3D qualities of artifacts in 2D and conceptualize historic structures about their dimensions, proportions, and scales [14, 17]. Nowadays, the documentation outcome is digitally drafted. Documenters use digital surveying technologies such as photogrammetric tools and three-dimensional laser scanners to mass capture measurements from the architectural surface [14]. The main advantage of digital measures is the ability to accurately

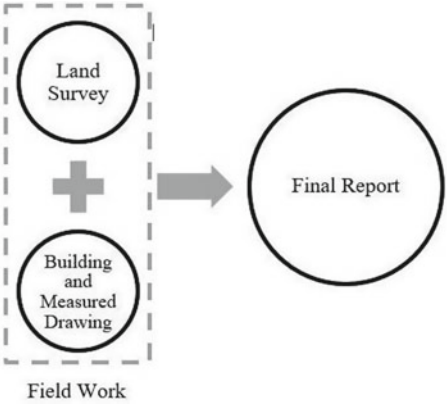

Fig. 1 Approach learning for measure drawing course [15] (adapted from Johar et al.)

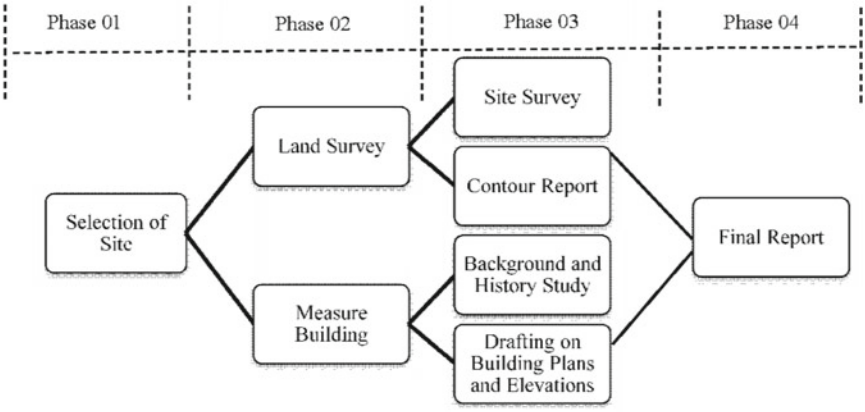

Fig.2 Approach learning for land survey and measured drawing course [15] (adapted from Johar et al.)

measuring on challenging spaces. It helps solve complex cases where architectural manual measurements are not feasible, challenging to execute, or financially controlled [18].

Compared to the survey methods, manual survey methods can be the least costly but less accurate and speed for more complex buildings. Photogrammetry can be less expensive than laser scanning but requires a high computational effort for post-processing and is less practical for indoor environments. Despite having the advantage as the most accurate survey method, laser scanning is very costly, and the data preprocessing can be very time-consuming to achieve a high-quality point cloud [19].

In the industry, the recent development in digital documentation displays the transition from 2D CAD representation to 3D Building Information Modeling (BIM)

and Heritage Building Information Modeling (HBIM) as tools that can help preserve heritage buildings. It also produces the creation of a centralized digital model that can merge data from different areas. The method is further supported by the concept of the "digital twin," which is connected with Building Information Modeling (BIM), building simulation, cross reality (XR), and Internet of Things (IoT) concepts. The aim is to build a digital replica of the building that can help in optimizing the decision-making process [19]. In learning Architecture Measured Drawing, a mixture of manual and digital methods has been adapted before the pandemic in line with the industry. However, the level of outcome heavily depends on the tools and knowledge provided by the university.

Online Learning in Architecture Measured Drawing

According to Pattacini [20], field trips and on-site research are significant and essential in architectural education. However, due to the current COVID-19 crisis, fieldwork was replaced by virtual field trips by visiting and exploring the spatial characteristics of sites virtually using 3D functions or street view functions on the web map services resources such as OpenStreetMap or Google Maps [21]. Many existing studies have attempted to use street view images to measure neighborhood attributes. These studies demonstrate that street view imagery can be used as a reliable data source for observing the built environment [22]. In the case of learning Architecture Measured Drawing, online technologies play an essential aspect in teaching and learning, particularly in Phase 2 and Phase 3, which require on-site research.

A few methods have been adapted to include data collection through pictorial documentation. Germen [23] agrees that data collection from visual documentation and images from online resources were used to reinterpret a significant physical existence in architecture. This method was applied in Phase 2, which required students to be on-site to measure the building in the past.

Whereas in Phase 3, conventionally, students are to gather data through online research or information and conduct interviews with the owner or any recipients that would be able to assist the students in understanding the background and history study of the building. However, due to the limitation of the pandemic, this phase has been replaced entirely online, whereby students conduct online interviews through online platforms such as Zoom and Microsoft Teams.

In addition to the two phases mentioned above, despite being a phase that is not involved with the fieldwork, the final stage of Architecture Measured Drawing, report preparation involves efficient communication between peers and lecturers. Therefore, this communication is also conducted through the online platform. As opposed to pre-pandemic, the report preparation usually took place physically in the studio, where there was also a group of discussion [15].

This method has assisted the students in maintaining a similar workflow, keep students engaged, and continually expand their digital problem-solving capacities; accessible consultations via sharing screens need to be provided. In addition to the online platforms, Zoom and MS Teams, a digital whiteboard, MIRO, is introduced to the students. Komarzy et al. [24] support this. They suggested that the new communication platforms, such as the whiteboard software Miro, online telecommunication

software, and sharing digital media such as Google Drive, MS Teams, would benefit the pandemic.

3 Methodology and the Approach

This paper looks at the methods of teaching and learning Architecture Measured Drawing course concerning the students' engagement in Diploma of Architecture, UCSI University, Kuala Lumpur. Following the chart Johar et al. [15] proposed, the phases in learning the Architecture Measured Drawing course applied in the pandemic are shown in Fig. 3. The approach of teaching and learning is divided into two parts, the theoretical and practical. The theory provides a basis and introduction of the relevant subject and practically provides knowledge by exposing students to the production of measured drawing. The practicality involves conventional and utilizing digital methods such as pictorial documentation, Google Maps, virtual tours, and street view images.

In this course, students are grouped into a group consisting of 8–10 students. They must complete the research virtually and measure drawing by producing a final report and video of proposed site studies. The planning and timeframe were designed to meet the learning sessions within 14 weeks. There are four phases (individual and group work) that are identified in completing the course.

A questionnaire survey was adopted as the primary data collection. Ninety-six (96) respondents, comprised of students from three semesters, intake October 2020, Jan 2021, and May 2021, were involved in the survey.

For this research, an adaptation of the Student Course Engagement Questionnaire-Modified (SCEQ-M) by Nasir et al. [13] was applied to determine the level

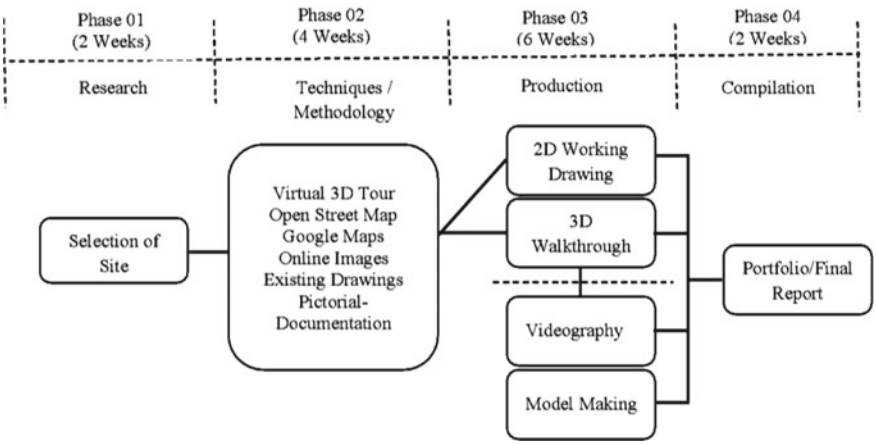

Fig. 3 Approach learning for measured drawing course in diploma in architecture, UCSI University

of students' engagement for the Architecture Measured Drawing course. The questionnaire was outlined to cover four engagement factors: Applied Engagement, Goal-Oriented Engagement, Self-discipline Engagement, and Interactive Engagement, which directly refer to the cognitive, behavioral, and affective criteria assessment. The posed questions are modified to tailor the online Architecture Measured course in addressing all phases involved, as shown in Fig. 3.

The online survey was divided into Sections A and B to measure the level of involvement and engagement factors. These two sections are to measure the level of engagement against the phases stated in Fig. 3. Section A is focused on the level of involvement due to the nature of the grouping in the course, while Section B focuses on the level of engagement in each phase of the course. There were four factors of students' engagement stated in the questionnaire survey: (1) Applied Engagement, (2) Goal-Oriented Engagement, (3) Self-discipline Engagement, and (4) Interactive Engagement.

It is worth noting that this study has some limitations. This study took place at a single institution and only in one particular subject, which might not represent any other similar courses in other tertiary institutions. The course requires students to be in a group and conduct the work phases collectively. However, some groups might have appointed 1 or 2 students to accomplish specific tasks, for example, Phase 2 only. Therefore, these students might not engage very well in Phase 3 of measurement as reflected in the students' engagement survey.

Additionally, some of the building measurement methodologies mentioned in digital documentation, namely 3D Building Information Modeling (BIM) and Heritage Building Information Modeling (HBIM), cannot be carried out due to time, tools, and technology limitations students' capability. Based on the feedback, students face challenges due to the usage of different approaches compared to the physical measure drawing, particularly in getting accurate measurements. Even though various techniques have been applied, some existing pictures and drawings can be blurry at times. Furthermore, virtual applications such as Google Maps, virtual tours, and online measures have their limits and constraints in getting accuracy in the measurement.

4 Finding and Discussion

Measuring student engagement at the course level provides valuable feedback to assess and enhance students' involvement as a reflection in the learning process. Handelsman et al. [10] mentioned that dimensions of learning involvement include student engagement in a complex experience that comprises a mixture of behavioral, cognitive, and affective. Table 1 shows the results of the level of engagement for each phase in learning Architectural Measured Drawing.

The survey showed that forty-four percent (44%) of the students showed engagement in Stage 1: Research (cognitive) is related to Applied Engagement. The students

Table 1 Level and factor of students' engagement in architecture measured drawing course, UCSI University

			Level of Engagement (Scale 1 : Least Experience and 5 : Most Experience)				
Section A			1	2	3	4	5
	Level of Involvement						
Stages		Research	1%	3%	27%	33%	36%
		Method and Technique	3%	3%	19%	38%	37%
		Production	5%	2%	27%	32%	34%
		Compilation	2%	6%	23%	35%	34%
Section B							
	Factor of Engagement						
Stage of Works	Stage 01 : Research	Applied Engagement	0%	4%	29%	44%	23%
		Goal Oriented Engagement	0%	4%	23%	38%	35%
		Self Disciplined Engagement	0%	3%	23%	38%	36%
		Interactive Engagement	0%	3%	21%	39%	38%
	Stage 02 : Method and Technique	Applied Engagement	0%	4%	26%	39%	31%
		Goal Oriented Engagement	0%	2%	24%	42%	32%
		Self Disciplined Engagement	0%	2%	23%	45%	30%
		Interactive Engagement	0%	2%	27%	39%	32%
	Stage 03 : Production	Applied Engagement	0%	4%	24%	38%	34%
		Goal Oriented Engagement	0%	2%	28%	32%	38%
		Self Disciplined Engagement	0%	3%	21%	34%	42%
		Interactive Engagement	0%	4%	19%	44%	33%
	Stage 04 : Compilation	Applied Engagement	1%	4%	27%	36%	31%
		Goal Oriented Engagement	0%	3%	19%	52%	26%
		Self Disciplined Engagement	0%	4%	23%	39%	34%
		Interactive Engagement	2%	7%	19%	39%	33%

show their involvement is mainly to gain knowledge and learning valuable experiences in their lives. It can be related to the ability of the students to utilize technology in finding sufficient online information on the selected building and site. In Phase 1, data collection from physical documentation and images from online resources is essential to reinterpret a particular physical existence in architecture. Next, forty-three percent (43%) of students involved in Stage 2 (method and techniques) showed that the phase of work related to Self-disciplined Engagement. The factor has required the students to be self-disciplined in completing all the tasks in assigned manners. Those involved in this stage admitted that they have to be organized, responsible, and self-independent in making progress regularly with little encouragement from the lecturers or teammates.

Under the production stage, the result has shown that forty-four percent (44%) of the students engage with the learning is due to the Interactive Engagement factor. This factor requires high involvement, participation, and willingness to help others in completing tasks. This stage also requires the students to engage or get help from the lecturer as part of their learning curve. As part of the factor, Komarzy et al. [24]

suggested that the students can engage virtually by adaptation to new communication platforms and digital platforms such as Miro, Zoom, Meet, and Google Drive. Lastly, fifty-five percent (55%) of students completed the Portfolio due to the Goal-Oriented Engagement factor. The production usually took place in the studio where their students submitted work such as reports and models physically to the lecturer. The students have adapted to sharing digital platforms such as Google Drive and learning management system (LMS) to reflect a similar workflow. In conclusion, the student's engagement in completing all tasks in the final stage (report preparation) is affected to achieve good grades.

The survey in Section A also required the students to rate their level of involvement in each phase as they were grouped from the beginning of the course. This process is to acknowledge that the students might have allocated tasks in their group. From the survey in Table 1, result shown that thirty-six percent (36%) of the students participating in Phase 1: Research, (2) thirty-eight percent (38%) for Phase 2 (techniques and methodology), (3) thirty-four percent (34%) from Phase 3 (production), and lastly (4) thirty-five percent 35% in Phase 4, a compilation of the Portfolio. The survey has shown that, among all four stages, thirty-eight percent (38%) of the students have highly anticipated the involvement level in Phase 2: application of method and techniques in measure drawing like this is the phase whereby students have explored various methods and techniques such as using Google Maps (refer to Fig. 4), virtual tour (Fig. 5), pictorial documentation (Fig. 6), and referring to existing drawings (Fig. 7) in conducting research and getting data to virtually measure the selected building.

Remarkably, the other stages have a lesser level of involvement in different phases due to the division of individual work in Phase 3, which involves producing 2D, 3D drawings, videography, and model making. The compilation of the final report also does not require many students to be engaged as the students have to utilize

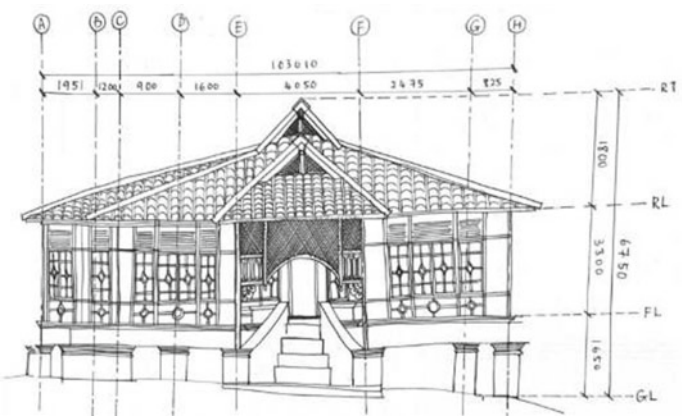

Fig. 4 Data collected from google image and transferred to the manual drawing

Fig. 5 Data collected from virtual tour (*Source* https://www.elcm.org.my/ZionCathedral ELCM)

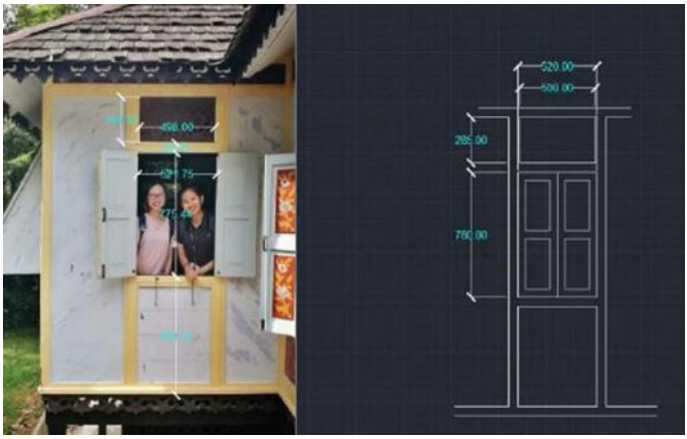

Fig. 6 Pictorial documentation. Dimension based on scale and proportion

digital platforms such as Google Drive and learning management system (LMS) in submitting the works.

5 Conclusions

This study has shown how the shift to online learning in Architecture Measured Drawing has offered opportunities in digital learning that might not explore if it was not due to the pandemic. While the course itself required a substantial portion working on-site, students were still able to adapt to the new method successfully

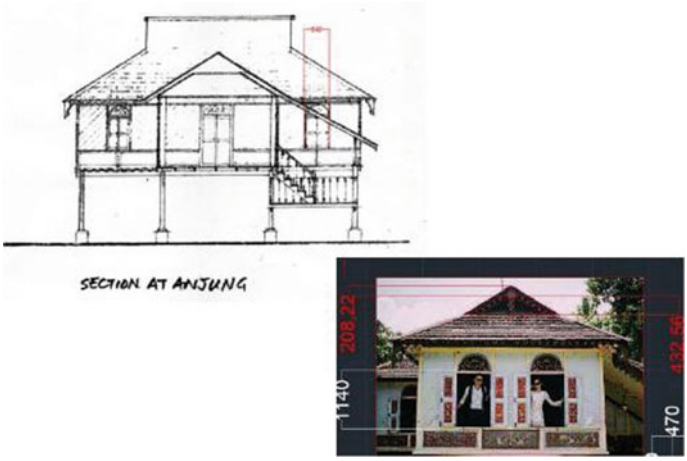

Fig. 7 Measure the dimension based on an existing drawing (*Source* https://rimbundahan.org/)

and have shown that the level of engagement is still high based on the distributed survey. Each phase shows that the level of engagement is at least 4, which is toward highly engaged. Therefore, the shift to online learning in this course did not bring down the level of students' engagement despite the limitations of not carrying out the tasks allocated on-site. Students also appreciated the skills learned in the course and acknowledged the importance of engagement in teams based on the students' feedbacks:

> Excellent experience for a site visit and learn about measure drawing and history even though the course is conducted online and did not experience using laser cut machine but still learn about other skills such as making walkthrough video. Having an online measure drawing class is a pretty challenging thing, and it requires a good team.

The study has proven that students' engagement plays an essential role in determining a good quality of learning outcome. It is also crucial to find different and effective teaching methods in delivering information, especially in architecture drawing courses. There are a few shortcomings in the course's online learning based on the students' feedback as such:

> Difficult to get the most accurate measurements online or virtually.

> Challenging because unable to conduct a physical site visit and unable to communicate with teammates face to face.

Despite the shortcomings, the outcome of the course successfully shows that the alternative method adopted has demonstrated positive results concerning student engagement through the production of drawings and digital re-creation of heritage buildings. The implementation of various techniques has proven to assist students' performance and involvement in every task. The students are required to plan their works and be creative in problem-solving, increase the ability to investigate, improve

soft and interpersonal skills to produce quality works. Undoubtedly, positive and negative feedback gained here will help the students and the lecturer to understand, implement, and improve current online learning disputes.

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References

1. Kuh GD (2003) What we're learning about student engagement from NSSE: benchmarks for effective educational practices. Change 35(2)
2. Barkley EF (2010) Student engagement techniques: a handbook for college faculty. Jossey-Bass, San Francisco, CA
3. Bowen S (2005) Engaged learning: are we all on the same page? Peer Rev 4–7 (2005)
4. Günüç S, Kuzu A (2014) Factors influencing student engagement and the role of technology in student engagement in higher education: campus-class—technology theory. Turkish Online J Qual Inq 5(4):86–113
5. Korobova N, Starobin SS (2015) A comparative study of student engagement, satisfaction, and academic success among international and American students. J Int Stud 5(1):72–85
6. Butler JM (2011) Using standardized tests to assess institution-wide student engagement. In: Miller RL, Amsel E, Kowalewski B, Beins B, Keith K, Peden B (Eds) Promoting student engagement, volume 1: programs, techniques, and opportunities. Society for the Teaching of Psychology, Syracuse, NY
7. Fredricks JA (2013) The measurement of student engagement: a comparative analysis of various methods and student self-report instruments. In: Christenson SL (ed) Handbook of research on student engagement, pp 763–782. Springer, New York, NY
8. Garrett C (2011) Defining, detecting, and promoting student engagement in college learning environments. Transform Dialog Teach Learn J 5(2):1–12
9. Mandernach BJ, Donnelli-Sallee E, Dailey-Hebert A (2011) Assessing course student engagement. In Miller RL, Amsel E, Kowalewski B, Beins B, Keith K, Peden B (eds) Promoting student engagement, volume 1: programs, techniques, and opportunities. Society for the Teaching of Psychology, Syracuse, NY
10. Handelsman MM, Briggs WL, Sullivan N, Towler A (2005) A measure of college student course engagement. J Educ Res 98:184–191
11. Chapman E (2003) Alternative approaches to assessing student engagement rates. Prac Assess Res Eval 8(13)
12. Dickson A (2017) Communicating with the online student: the impact of e-mail tone on student performance and teacher evaluations. J Educ Online 14(2)
13. Nasir MAM, Janikowski T, Guyker W, Wang CC (2020) Modifying the student course engagement questionnaire for use with online courses. J Educ Online 17(1)
14. Akbby-Ilk S (2016) The nature of drawing in the changing culture of architectural documentation. J Arch Plan Res 33(1):29–44
15. Johar S, Surat M, Che-Ani AI, Mohd T, Nik INL (2013) Problem-based learning for measured drawing in bachelor of science architecture program. In: UKM 4th international research symposium on problem-based learning (IRSPBL) 2013
16. Akbby-Ilk S (2017) Drawing to read architectural heritage. Draw Res Theor Prac 2(1):97–116 (20)

17. Devilat B (2016) Recording of heritage buildings: from measured drawing to 3D laser scanning. Drawing Futures: Speculations in Contemporary Drawing for Art and Architecture. UCL Press. https://doi.org/10.2307/j.ctt1ht4ws4
18. Pavlovskis M, Migilinskas D, Antuchevičienė J, Kutut V (2019) Implementing BIM for industrial and heritage building conversion. In: 17th International conference on colloquium sustainable decisions in built environment, Vilnius Gediminas Technical University. https://doi.org/10.3846/colloquium.2019.003
19. Khalil A, Stravoravdis S, Backes D (2021) Categorisation of building data in the digital documentation of heritage buildings. Appl Geomat 13:29–54 (2021). https://doi.org/10.1007/s12518-020-00322-7
20. Pattacini L (2018) Experiential Learning: the field study trip, a student-centered curriculum. Compass J Learn Teach 11(2)
21. Kristianova K, Joklova V (2020) On-site research, excursions, and field trips in architectural education—constraints in the time of Covid-19. In: 13th Annual international conference of education, research and innovation. https://doi.org/10.21125/iceri.2020/12/19
22. Kang Y, Zhang F, Gao S, Lin H, Liu Y (2020) A review of urban physical environment sensing using street view imagery in public health studies. Annals GIS. https://doi.org/10.1080/19475683.2020.1791954
23. Germen M (2008) Redesigning architecture through photography publication date (Print): July 2008. In: Conference on electronic visualisation and the arts (EVA 2008) (EVA)
24. Komarzy'nska-Swie'sciak' E, Adams B, Thomas L (2021) Transition from physical design studio to emergency virtual design studio. Teaching and learning methods and tools—a case study. Buildings 11:312. https://doi.org/10.3390/buildings11070312
25. Allan T (2016) Adams. Drawing for Understanding Creating Interpretive Drawings of Historic Buildings. Historic England
26. Baik A, Alitany A (2018) From architectural photogrammetry toward digital architectural heritage education. https://www.researchgate.net/publication/325471555, last accessed 18 Sept 2021