



Experiential Learning of Using Digital Tools in Construction Management Education

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Abstract: The Fourth Industrial Revolution (IR4.0) is gradually reshaping the entire construction industry. It is not an option that skills and abilities in a wide range of digital technologies should be part of the construction management curriculum. The sheer lack of skills and expertise in the shift to digital construction is related to the insufficiency of hands-on activities using various digital tools. This study outlines the experience learning of utilising digital tools in construction management education. The purpose of this article is to investigate the extent to which Experiential Learning Theory (ELT) influences students' perceptions of digital tools. The student association in the construction management programme offered at Universiti Teknologi MARA (UiTM) designed and organised a hands-on workshop activity approach to address the issue of lack of proficiency in using digital tools such as Autodesk Revit (BIM system), Microsoft Excel (Quantity Take-Off). The method begins with a basic grasp of digital tools for construction-related applications. Then, step by step, explores the computer interface ribbons, shortcuts, and associated tabs. The proposed method is examined in faculty computer laboratories by employing practical learning for both digital tools (i.e. Revit and Excel) in either creating a three-dimensional (3D) BIM Model or the capacity to calculate material amounts. Based on the assessment results, the strategy helps students master the digital tools and implement such activities in their official course module.

Keywords: Experiential Learning Theory, digital tools, construction management

1. Introduction

The digital transformation has begun to enhance the productivity in the construction sector tremendously. The academic curriculum for construction management education should be improved to focus on how to utilise IT skills in construction practise. The lack of exposure to and implementation of numerous digital technologies throughout their university courses is a barrier for many graduates. In their official evaluation, the majority of the course content relies largely on the theoretical part of the lesson and just a few hours on hands-on training utilising digital technologies. Intensive training of digital technologies outside of their class contact hours can improve student experiential learning. The student association at Universiti Teknologi MARA (UiTM) Shah Alam's Centre of Studies for Construction organised a one-day event on tutoring digital tools such as Autodesk Revit and Microsoft Excel. Both trainings were held in separate computer laboratories, with first-year students attending the Microsoft Excel training and final-year students participating in the Autodesk Revit training. Both trainings have experienced instructors and peer-to-peer mentors who will lead participants through sample assignments for producing 3D models in Autodesk Revit as well as

a basic way for quantity take-off in Microsoft Excel. This type of experience teaches students how to toggle and become familiar with the computer interface, which is the actual objective to complete at the end of the trainings.

2. Literature Review

2.1 Digital Tools in Construction Industry

Since the advent of the information era, a plethora of advanced digital technologies have been introduced to the construction sector. The potential of reducing construction completion time, increasing cost effectiveness has contributed to improving overall construction delivery performance. Moving from conventional pen and paper to two-dimensional drawings and now three-dimensional objects, building practise has gradually improved integration and collaboration among interdisciplinary construction specialists (Liu and Killingsworth, 2012; Hu, 2019). The most prominent digital construction method employing Building Information Modelling (BIM) provides wider coverage in embedding information in 3D models for sharing with construction participants involved in a specific project (Hu, 2019). Autodesk Revit, the platform for designing and creating 3D models and information exchanges, is the most popular digital tool for BIM. However, the usefulness of employing Autodesk Revit in construction management research remains restricted. This is due to the absence of use of Autodesk Revit to conduct a take-off in material amounts. As a result, in the construction industry, the usage of Microsoft Excel is still prevalent and feasible for quantity take-off.

2.2 BIM Platform Using Autodesk Revit

The advent of BIM has significantly changed the procedure of building design and documentation, making the construction process much easier for all construction practitioners. BIM allows all graphical and non-graphical building information for a construction project available in a single database system (Hu, 2019; Woo, 2006). This will improve AEC/FM (Architecture, Engineering, and Facilities Management) professionals' efficiency and effectiveness in general construction practices (Woo, 2006). The underlying notion of BIM is well-known in AEC/FM practise, and the approach for allowing BIM deployment is gradually gaining acceptance. However, the shift in practise may not be rapid and would need a comprehensive approach that includes reskilling and training of future employees in both the construction sector and higher education.

Construction studies in higher education have incorporated BIM topics into the academic curriculum, however there is no acknowledge instruction technique that can equip students with enough knowledge and expertise in using BIM because it is not discipline-specific (Hu, 2019; Olatunji, 2019; Woo 2006). This may perplex or even distort the concept of BIM, which is confined to constructing a BIM model. The Center of Studies for Construction at Universiti Teknologi MARA (UiTM) organised an intensive programme to educate final-year undergraduate students to Autodesk Revit, BIM-based digital technologies. A teacher briefed a lecture on BIM and designed a basic residential house throughout the three-hour course. However, due to time restrictions, only a part of the digital tool's capabilities was investigated. The capabilities of Autodesk Revit extend beyond the creation of a BIM model to include construction planning and management, schedule visualization, and quantity take-off (Abbasnejad & Moud, 2013; Heigermoser et al, 2019).

2.3 Quantity Take-Off Using Microsoft Excel

The process of producing an estimate of material quantities associated with the development of a facility based on construction documents and the scope of work is known as quantity take-off (QTO) (Srivastava, 2022; Chitkara, 2019). QTO is critical in terms of measurement accuracy and consistency in practise for any particular building project (Wijayakumar & Jayasena, 2013). It is often done manually or with the use of digital technologies such as a spreadsheet in Microsoft Excel or 2D/3D Computer Aided Design-Autodesk Quantity Take-Off or Autodesk Revit. With the evolution of digital tools for calculating QTO, teaching estimate in construction studies must begin with the fundamental manual take-off in a paper-based document. This is to ensure that students understand the overall project knowledge in a paper-based format before demonstrating estimating mechanics in a digital tool (Wijayakumar & Jayasena, 2013). The purpose of this approach is to ease students the pressure of learning the digital tool in the mechanics of QTO, as well as to improve comprehension and make it simpler and faster when they apply it in the digital tool.

Microsoft Excel was presented to first-year undergraduate students during the previously described simultaneous intense training programme. The three-hours course comprised basic aspects of taking-off and estimating, and shortcut features in Microsoft Excel with the direction of an instructor. The training unable to cover all the functionalities in Microsoft Excel as anticipated since the students were lacking of the fundamental understanding of taking-off and estimating. The instructor demonstrated and students learned firsthand with the assistance of mentors who were able to create valuable experience for the students.

2.4 Experiential Learning Using Digital Tools

The best approach for students to master the digital tools (i.e. Revit and Excel) is through experience utilising them. Experience learning is one of the most effective student learning approaches. Kolb's (1976, 1984, 1999) term Experiential Learning Theory (ELT) refers to the experience component of learning and active participation. There is a wealth of literature applying Kolb's ELT in the context of higher education that demonstrates the solid justification of the learning models used in many aspects of education, including the use of digital tools (Olatunji, 2019; Rodriguez, 2018; Asad et al, 2021).

ELT examines four major components: Concrete Experience (CE), Reflexive Observation (RO), Abstract Conceptualisation (AC), and Active Experimenting (AE). Firstly, concrete experience is the active engagement of students in using the digital tools. This includes having proper access to the computer and being able to access the relevant applications (i.e. Revit and Excel). The learner then consciously and reflexively observes the instructor's advice on toggling the programme. Once the learner is prepared to proceed on their own, they will attempt to conceptualise the job of what is expected of them at the end of the training programme. Lastly, throughout the learning process, student will actively explore depending on their knowledge of the assignment and will try-and-error on toggling the digital tools. The ELT cycle occurs through collaborative work and support from peers, as well as assistance from the instructor, to retain their desire to learn more on the digital tools. This would enhance to discover solution collaboratively rather than individually (Buchanan et al., 2005).

Several advantages of Kolb's ELT theory have been discovered to be effective in bridging the gap between theory and practise for instructors seeking advice on how to improve their practise, integrated with other learning styles to enhance the theory, can be applied in a wide range of subject areas, emphasises student ability to reflect and the importance of providing feedback in order to encourage their studying skill, and can be applied from the individual level to the entire organisation regardless of particular course, training or lesson.

3. Research Design

Students from the Faculty of Architecture, Planning, and Surveying at Universiti Teknologi MARA in their first and final years were chosen to participate in this study. At the end of the workshop, they were encouraged to submit an online questionnaire using a Google Form link sent via the social media platform (i.e. Whatapps). In all, 42 students freely participated in this survey, which yielded 100% usable data. For this study, the Experiential Learning Theory (Kolb, 1984) was applied. The ELT assesses 12 items linked to concrete experience, reflexive observation, abstract conceptualisation, and active experimentation, including comments about doing, thinking, observing, and experimenting. The online questionnaire items employed a five-point Likert scale which spans from 1= "Strongly Disagree" to 5= "Strongly Agree". Several constraints hampered data collecting for this investigation. The online questionnaire, which was self-administered, might lead to distribution problems. Moreover, because the sample size is small and confined to construction management students, the findings are discipline-specific and do not represent a larger population.

4. Findings & Discussion

Section A: Background Profile

In the first part of the questionnaire included questions regarding the background profile of respondents. The results of background profile information is shown in **Table 1** below.

Table 1 - Background profile of respondents (N=42)

Demographic Characteristic	Items	Number of respondents	Percentage (%)
Age	18-24	41	97.6
	25-30	1	2.4
	31-40	-	-
	>41	-	-
Gender	Male	14	33.3
	Female	28	63.1
Year	1	10	23.8
	2	9	21.4
	3	22	52.4
	None	1	2.4

Almost of all students were age 18-24 with majority (63.1%) of female gender. The distribution of year of studies mainly comes from the third-year students (52.4%), followed by second-year (21.4%) and first-year (23.8%)

Section B: Experiential Learning in using the Digital Tools

In the second part of the questionnaire is about experiential learning in using the digital tools. There were 16-items represents each of the components of ELT model including statements on (1) Concrete Experience, (2) Reflexive Observation, (3) Abstract Conceptualising, and (4) Active Experimenting. The data were analysed a discussed in the form of stack bar charts below.

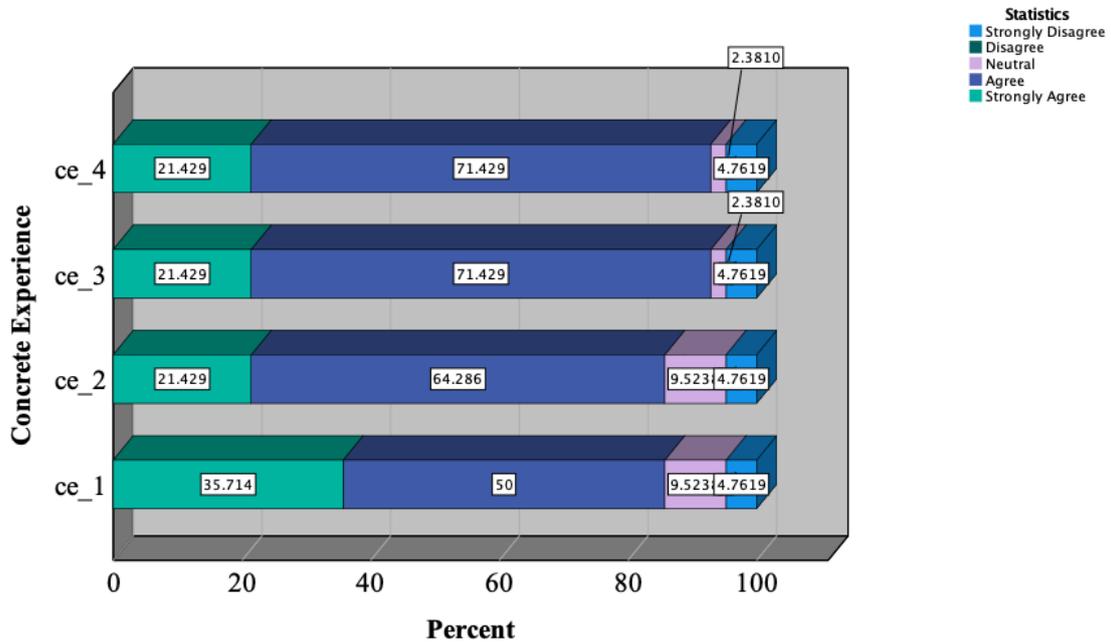


Fig. 1 - Concrete experience items

Figure 1 above shows the items that assess the concrete experience of students in using the digital tools. It was found that all statements that had been rated tend to agree that concrete experience prove to facilitate their learning experience in using digital tools. The statement in ce_3 ('After using Revit/Excel, I gained better understanding in Revit and Excel') and ce_4 ('After taking this class, I can create; BIM model in Revit/ Calculation Spreadsheet in Excel') scored the highest in percentage of the tendency in agreement. This indicate the most students had better experience and feedback in using their respective digital tool after the workshop is over. According to Irwin et al. (2013), student can benefit from the digital tools and guidance which allow them to engage with the feedback and learn from it. Other studies also support that feedback enhance student learning (Adamu and Thorpe, 2015; Gibbs and Simpson, 2004).

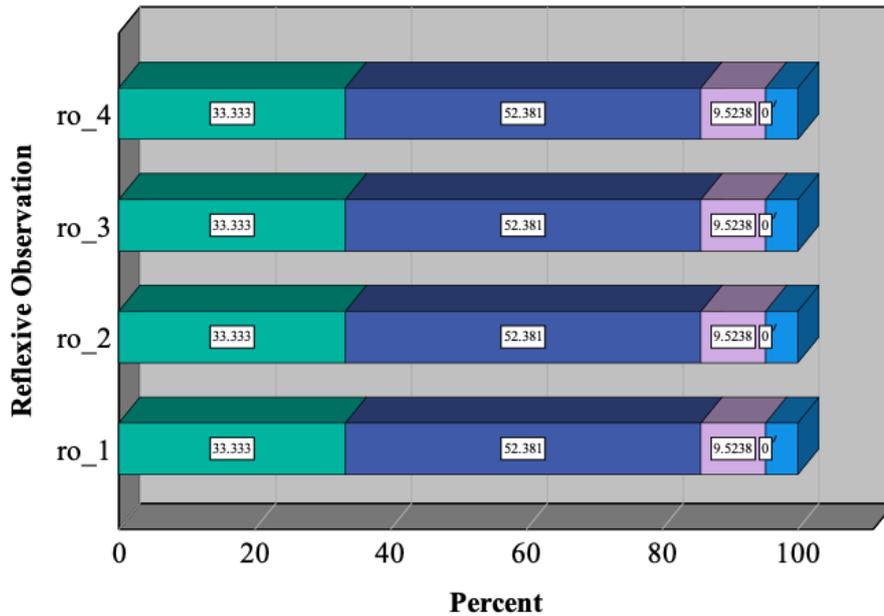


Fig. 2 - Reflexive observation items

Meanwhile, **Figure 2** highlights the findings on reflexive observation statements that indicate student consciousness on the activity they observed during the workshop. Most students in agreement in all of the four of statements (ro_1 to ro_4) provided that include they could have open dialogue with other trainee, the instructor’s teaching, inquiring other trainee about the task and comparing hand-on learning with self-learning. This suggest that the physical workshop provide an mental stimuli for ‘trial and error’, interaction and problem-solving to enhance their experience and observation along with other students so that they could keep up with the task given. Intervention of instructors, peers and students could enrich an active participation and enhance problem-solving competence in using the digital tools more confidently as students are able to apply their knowledge and navigate their ability to complete their task (Sotiriou et al, 2020).

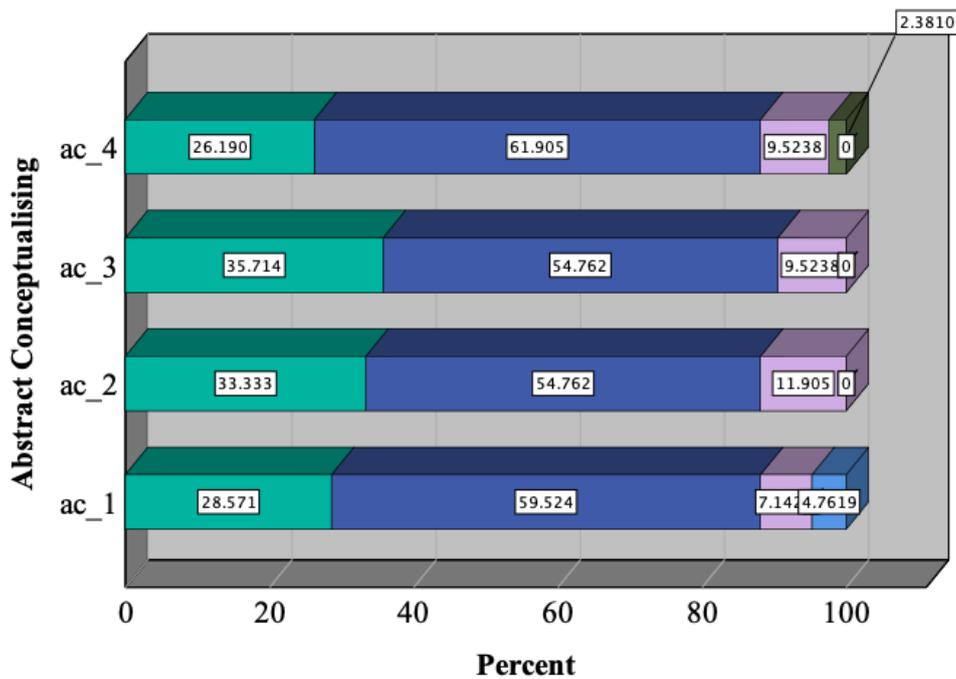


Fig. 3 - Abstract conceptualising items

Furthermore, the statements on ‘Abstract Conceptualising’ as illustrated in **Figure 3** indicate students tends to agree more on conceptualizing the importance of the workshop in team- building, integrate the digital tools in the

curriculum, demand of job market, and sufficiency to apply for an entry-level position. The statement ac_4 'I believe Revit/Excel content given in this class is enough for an entry level position in construction' scored the highest in tendency to agree. The significance of this findings suggest that students can anticipate the extent to which the digital tools can be at their advantage and applicable in their future prospect. This supported by Deniz (2018) that demonstrated students' feedback on digital tools (Revit and CAD) which both have significance influence in their future professional career and meeting the demand of industry for graduates in proficiency and skill using digital tools.

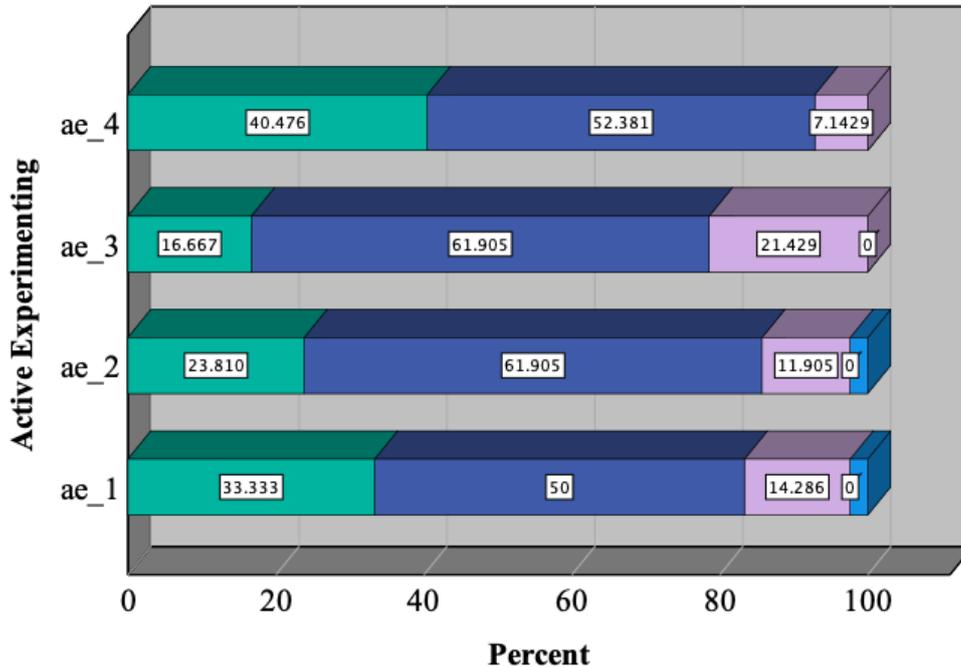


Fig. 4 - Active experimenting items

Finally, above **Figure 4.0** present the last component of ELT model–Active Experimenting. The statements that related to active engagement in the workshop, further self-exploration, more challenging task and further training have scored highest in agreement than disagreement. The statement in ae_4 ('I would attend further training on Revit/Excel in the future to improve my skill' has the highest in percentage of the tendency in agreement than disagreement. Active experimenting allows students to explore further on the given task at their own understanding. The results suggest that students can confidently use the digital tools to simulate 3D model or calculate numerical formula in spreadsheet to enhance their learning. The findings of Woo (2006) suggest that students are skilled at learning new digital tools if they know the value it will bring into their future career. The motivation and desire shared by the faculty, industrial players and academia play a significance role to enhance the experience of learning the digital tools (Woo, 2006).

5. Conclusion

This study investigates experiential learning in construction management education utilising digital tools (e.g., Revit/Excel). The purpose of this study is to investigate how Experiential Learning Theory (ELT) influences students' perceptions of digital tools. The construction sector currently demands experienced and competent graduates who can work on a multitude of construction-related digital tools. Because of current career requirements and coursework assignment requirements, Autodesk Revit and Microsoft Excel appear to be the most important digital tools for UiTM undergraduates studying construction management. Two workshops were held tandem in the computer laboratories at UiTM by the student association of construction management studies (BUILDERS). An online questionnaire was prepared and given to a total of 42 participants that engaged throughout the course using Autodesk Revit or Microsoft Excel. The results showed a positive tendency to agreement in all of the ELT model's claims. The students had a positive experience throughout the session using digital tools that they could study in an interactive physical environment. The majority of them can participate, query, simulate, and interpret the instructor's lesson on the given task. Furthermore, students can expect the relevance of mastering digital tools for their advantage in terms of their education and future. Also, the workshop helps to enhance students' self-esteem in utilising digital tools more confidently since they can resolve the issue immediately. The findings of this study underline the importance of experience learning in the construction management curriculum as opposed to purely theoretical and lecture-based

learning. Because the sample size is limited and confined to a single higher education institution in Malaysia, new research with a bigger sample size and similar courses at inter-universities can be conducted in the future.

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