FIELD EXCURSION AS ALTERNATIVE TEACHING APPROACH FOR CIVIL ENGINEERING QUANTITIES AND ESTIMATION COURSE

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ABSTRACT

This study explores the effectiveness of integrating experiential learning, specifically site visit, as part of a teaching method in the Civil Engineering Quantities and Estimation course. The course is crucial for developing the skills necessary for accurate project management and successful implementation of infrastructure projects. The research focuses on a group of year three of Diploma of Civil Engineering students at UiTM Johor Branch Pasir Gudang Campus in semester 20232 year of academic. The aim of this study is to compare students' performance in formative and summative assessments before and after participating in a site visit activity. The findings reveal that, while male students show modest (43.8%) improvement, female students demonstrate a significant (100.0%) improvement in their understanding of the course after the site visit. The results suggest that experiential learning, particularly site visits, can positively impact students' comprehension and performance in the Civil Engineering Quantities and Estimation course. The study recommends the incorporation of experiential learning methods into the curriculum, acknowledging the potential benefits for students' understanding and application of theoretical knowledge in real-world contexts

Keywords: Experienced-based learning, Site visit, Taking off, Quantities and Estimation, Education, Higher learning, Engineering education.

1.0 INTRODUCTION

In completing a project, a comprehensive skill sets are needed in ensuring the success of a project. Besides, learning on the structural and infrastructure's design calculation aspect, a fresh engineering graduate should equip themselves with others technical knowledge. This is because, the nature of civil engineering works may involve multidisciplinary field and technical person including quantity surveyor. Therefore, knowledge on the quantities and estimation in construction plays a pivotal role in the field of Civil Engineering. This is because quantities and estimation serving as the foundation for effective project management and successful implementation of infrastructure projects (Ramabodu, 2014). Accurate quantification of materials, labour, and associated costs is fundamental in developing realistic project budgets, ensuring financial viability, and aiding in

the meticulous allocation of resources (Saka et al., 2024). Generally, building measurement, estimating and cost planning is part of main activities which required to be conducted during the pre-construction phase of a project development (Ernest et al., 2017). The estimation skills are important which may guide civil engineers in predicting project timelines and identifying potential challenges before any construction started (Ernest et al., 2017). A precise understanding of quantities and estimation not only contributes to the financial health of projects but also promotes efficiency in resource allocation, minimizing waste and maximizing productivity (Habibi et al., 2018). Thus, these skills empower civil engineers to make informed decisions, navigate uncertainties, and ultimately deliver projects that meet both functional and economic objectives. Therefore, the estimation knowledge and skills required to be integrated in the civil engineering programme for shaping potential future young proficient professionals for the construction industry. The development of engineering education is shifting from disciplinary to interdisciplinary thinking maintaining competitiveness and producing better engineers (Alabadan Babatope et al., 2020). Previous research conducted in the United Kingdom (UK), Malaysia and Nigeria also pointed out some difficulties involved in and learning processes of building measurement units (Tunji-Olayeni et al., 2016). Therefore, it is essential to explore and introduce the variety of teaching approaches which can help to enhance the understanding of the measurement practices and principles amongst students. The aim of this research is to determine the effectiveness on the experience-based learning approach may be integrated into the process of learning method in Engineering Quantities and Estimation course for Diploma of Civil Engineering Programme (CEEC110) in UiTM Cawangan Johor Branch Campus Pasir Gudang.

1.1 Quantities and Estimation in the Civil Engineering Course

Engineering Quantities and Estimation course constitutes as a fundamental subject mandatory for students enrolled in the Diploma of Civil Engineering Program in UiTM. According to the CEEC110 program curriculum, this course is anticipated to be taken by students in semester five (third year). In general, the course provides students with knowledge of quantity taking off, bill of quantities preparation, work estimation, and comprehensive cost estimations for construction projects.

This course is a 3-credit hours course, necessitating students to engage in weekly lectures for a duration of 3 hours over a 14-week semester. Therefore, students are to dedicate 42 hours in attending lecture classes. The knowledge imparted in this course holds significant importance for students, particularly in developing proficiency in construction measurement and cost estimation. This expertise becomes particularly crucial during the quantification and estimation phases of construction projects in the pre-construction stage. Table 1 delineates the course outcomes and program outcomes specifically designed for this subject.

Table 1. CO-PO Matrix.

Course Outcomes (CO)		Program Outcomes (PO)	
CO1	Evaluate bill of quantity for major elements of building and civil engineering works in accordance with Malaysian Civil Engineering Standard Methods of Measurement (myCESMM).	**PO2**	Identify and analyse well-defined engineering problems reaching substantiated conclusions using codified methods of analysis specific to their field of activity.
CO2	Manage cost estimation using appropriate technique and	**PO5**	Apply appropriate techniques, resources, and modern engineering

	Course Outcomes (CO)		Program Outcomes (PO)
	engineering tools with an awareness of the limitation.		and IT tools to well-defined engineering problems, with an awareness of the limitations.
CO3	Justify knowledge and understanding on cost estimate for a selected set of structure elements and type of contract as a member and leader in a team in multidisciplinary environments.	**PO12**	Recognize the need for and have the ability to engage in independent updating in the context of specialized technical knowledge.

1.2 Teaching and Learning Method

Compared to traditional teaching and learning methods, 21st-century teaching and learning is more focused on communication between the lecturers and students (Ishkov & Leontiev, 2015). Academia is challenged to think of ways to deliver the knowledge that students need to gain without only focusing on the delivery but also on how to attract their attention to keep them engaged.

Conventional Method

Advancement of technology nowadays known in most area, however for basic understanding Quantity surveying (QS) measurement is still primarily a manual operation (Gurmu, 2023). Reading the construction drawings, estimating, and quantifying the work, and documenting the amount of work were all part of the teaching strategy for this course's quantity-taking-off process. According to Standard Methods of Measurement (SMM) or the New Rules of Measurement (NRM) published by the Royal Institution of Chartered Surveyors (RICS), an essential skill of quantity surveyors involved in the measurement of ability to read and interpret drawings, knowledge of building construction and standard acquaintance (Ilmi et al., 2021).Nevertheless, based on previous research, stated that graduates are unable to perform or comprehend construction components which are to visualize 2D to 3D in the quantification work(Yusop et al., 2018). Supported by (Lee, 2013), the author agreed it is challenging to teach students to understand 2D and 3D in the quantification work. In the education structure program, one of the course learning outcomes is to develop skills in sketching components and building elements were included in this course. However, based on comments by the industry sector, some new approach needs to be used to improve the learning and teaching methods for a more efficient and better understanding of the Quantity surveying (QS) measurement course.

Experienced based Learning Method

Experienced-based learning methods, as illuminated in the educational literature, represent a pedagogical approach that centres on first-hand experiences as a primary tool for knowledge acquisition (Asad et al., 2021). This approach diverges from traditional didactic methods, emphasizing active engagement and application of knowledge in real-world contexts. Scholars underscore the transformative impact of experiential learning in fostering a deeper understanding of concepts and enhancing retention rates among students. Through activities such as internships, fieldwork, simulations, and case studies, experiential learning immerses students in practical situations, encouraging them to develop connections between theoretical comprehension and practical practice (Foo & Foo, 2022). The educational discourse surrounding experiential-based learning underlines its potential to develop a comprehensive grasp of the subject content, problem-solving techniques, and critical thinking skills(Razbani et al., 2023).This method aligns with constructivist principles,

emphasizing that learners construct their own knowledge through active participation. As a result, the literature advocates for the integration of experiential-based learning methods into educational curricula to cultivate well-rounded, adaptable, and resourceful individuals prepared to meet the challenges of a dynamic world.

Quantities and Estimation Courses Site Visit

Students required to attend a technical on-site visit arranged by the Civil Engineering Centre of Studies. The site visit was conducted on week 13 of the academic calendar which was after the formative assessment completed and before the summative assessment took place. This site visit was arranged by the lecturer in charge as an alternative of teaching and learning approach to enhance student's understanding on the topic of Taking Off Quantities for Building Works that has been taught theoretically during in-class lecture.

In this case, the criteria during approaching the key person in charge of potential construction site to be visited were as follows:

1. The area of construction site is in range of Johor Bahru District
2. The construction site had ongoing construction activity which involved the excavation works, installation of formwork, reinforcement works and concrete works.
3. The selected project/ construction site was decided by the project's stakeholder.

The primary motivation for selecting a close-by building location was to reduce commuting expenses and time. Moreover, students were able to spend more time at the building sites as a result. Students were expected to explore the nature of construction activities specifically the excavation work, formwork, reinforcement work, and concrete work of the main structural elements including the pad footing, slab, beam, and column. In this context of study, the parties that were willing to accept this site visit were a project that involved construction works of a residential building.

A briefing was held by the site supervisor on the management and background of project construction. The students were briefed on the safety and health aspects of the respective sites. Personal Protective Equipment (PPE) such as safety helmets and safety were compulsory for the students to wear before entering the construction site. **Fig.1** shows a Safety and Health Officer giving the briefing session to the lecturer and students.

Fig.1 *Briefing by the on-site Safety and Health Officer*

During the site visit, the contractor gave the students the opportunity to explore every aspect of the ongoing construction area under the supervision and guidance of designated technical personnel. In this approach, students gained a more in-depth understanding of what had been taught theoretically in class. The visiting activity was allocated four hours during the construction site visit. Students had the opportunity to spend their time in exploring, observing, asking, and communicating with the technical person face to face. **Fig. 2** and **Fig. 3** show the experience-based learning approach on site during the visit.

Fig.2 *Students observing the process of reinforcement steel on site.*

Fig. 3*Students observing the Excavation work.*

Teaching and Learning Assessment

Assessing students' progress towards the learning objectives is critical for educators in the context of the teaching and learning process. This is to determine the effectiveness of instructional strategies in facilitating the progressive acquisition of conceptual knowledge by the students. Hence, the utilization of formative and summative assessment is a viable approach.

Formative assessments are used for identifying strengths and weaknesses for better learning by focusing on areas to improve. Meanwhile, summative assessments are used for

evaluating students based on prescribed criteria and are primarily targeted for identifying strengths and weaknesses for better learning(Rawlusyk, 2018). These approaches have been adopted and practiced in this course. The formative assessment has been conducted in the format of the test while the summative assessment is in the format of the final examination. In contrast to summative assessments, which serve to classify students or provide information for certification, formative assessments are intended as feedback to help students monitor, improve, and accelerate their learning (Harlen & James, 1997). **Fig. 4** shows the timeline of assessments that have been conducted throughout the semester which are on 15 May 2023- Week 7 (Test) and on 26 July 2023- After week 14 (Final Exam).

Fig. 4 *Timeline of assessment and the site visit activity throughout semester.*

2.0 MATERIALS AND METHODS

This study employed a two-stage of methods which are the data collection, while the subsequent phase encompassed the analysis of the collected data. Method on data collection encompassed the organization of a construction visit and the development of specific questions to serve as instruments for assessing the comprehension and knowledge of the students involved. These questions were designed to gauge student's understanding on the material taking off aspects of the common building's structural components including pad footings, beams, columns, and slabs. Subsequently, the students' scoring marks were documented and subjected to analysis through the utilization of appropriate statistical tools. The results were organized in a structured manner and analysed in accordance with the specific statistical methodology that was compatible with the research objective

2.1. Sampling and Data Collection Method

Study participants were year three Diploma of Civil Engineering students at the School of Civil Engineering at UiTM Johor Branch Pasir Gudang Campus for the March-July 2023 semester. Twenty-one (21) students were enrolled in the Civil Engineering Quantities and Estimation course and only one lecturer in charge of this course for the respective semester. The lecturer in charge of this course has more than 5 years of experience in teaching this course.

Assessment Development

In both formative and summative types of assessments, a set of subjective questions was designed to gauge student's understanding of the topic as comprised in the course information. Based on the Examination Specific Table (EST), which was endorsed by the Centre of Studies, questions were developed to test the students experience in this visit. However, for the purpose of this study, only questions which covered under topic of; taking off the quantities of material for a common building's structural elements and construct based on the same level of difficulties according to Bloom's Taxonomy were selected as an instrument to indicate student's understanding and performance. The questions' specifics are displayed in Table 2.

Table 2. Details of instrument's question.

Element	Formative Assessment	Summative Assessment
Form of Assessment	Test	Final Exam
Schedule of Assessment	Week 7	Week 16
Topic	Topic 3: Taking Off Quantities for Building Works	Topic 3: Taking Off Quantities for Building Works
Type of Structural Element asked in the assessment	Beam	Slab
Allocation of Marks	30	15
Demand of Question	● Illustration of structure based on given detailing ● Conduct Taking off ● Prepare Bill of Quantities	● Explain the suitability use of mild steel bar and high tensile steel bar ● Prepare taking off ● Prepare Bill of Quantities
Time allocation to answer question	2 hours	30-40 minutes
Contribution to total course marks	10%	6%

Assessment Execution

Every student who took part in the study had to respond in writing to the assigned questions within the allotted time frame. Students use the time allotted to them to respond to the questions according to their comprehension and knowledge. The assessment has been conducted in a class with an examination setting. An invigilator is responsible for invigilating the respective assessment session. Students must turn in their written answer scripts for the questions they were asked during the session for them to be evaluate.

Assessment Evaluation

An evaluator was appointed to assess the student's written answer scripts. The evaluator was in charge of evaluating and marking the answers submitted by the student. It is important to ensure consistency in the evaluation process. In addition, assigned evaluator is required to refer to a standard answer scheme which has been checked and endorsed by the panel during the Examination Question Paper Workshop which has been arranged by the Civil Engineering Centre of Studies.

Scoring Marks Distribution

Each student's score can be used to ascertain how well they grasp the Taking Off Quantities for Building Works. According to (Abushandi, 2021), experience needs to be followed by reflection and internal processing that links the experience with previous learning and transforms an individual's prior understanding. In this study, the scoring marks is adopted from study conducted by (Ismail et al., 2021)which were categorised into four namely (1) good understanding; (2) better understanding; (3) moderate understanding and (4) poor understanding as shown in Table 3. Each student's graded grades were recorded for data analysis**.**

Table 3. Category of marks

Category	Marks
Good	16-20
Better	11-15
Moderate	6-10
Poor	<5

2.4 Data Analysis Method

A statistical analysis of the data was conducted with the recorded grades that each student received. In this study, descriptive statistics such as mean analysis has been conducted. This is due to the limitation of data which is less than 30 participants. Therefore, a frequency analysis was adopted to compare the difference of student's understanding between attended site visit and after attended site visit.

3.0 RESULTS AND DISCUSSION

3.1 Students' Demographic

The demographic aspect for the group of students who participate in this study is shown in Table 4. All students participated in the site visit activities arranged by the Centre of Civil Engineering Studies.

Table 4: Number of students according to the gender.

Demographic aspect	Items	Freq	(%)
Gender	Female	5	23.8
	Male	16	76.2

Comparison of Scoring Marks Before and After Attended Site Visit

Table 5 shows the number of students, and the mark categories based on the type of assessment.

Table 5. Student's scoring marks based on type of assessment.

Category	Marks	Number of Students	
		Summative Assessment	Formative Assessment
Good	16-20	3	1
Better	11-15	5	8
Moderate	6-10	8	9
Poor	<5	5	3

From the analysis, the mark's frequency score by the student for summative assessment which has been conducted before the student went to a site visit shows that 3 students acquired good understanding, 5 students acquired better understanding, 8 students acquired moderate understanding and 5 students has poor understanding on the topic of Taking Off Quantities for Building Works. However, after students went and participated in

one site visit, the mark's frequency score by the student for formative assessment shows that one student acquired good understanding, eight students acquired better understanding, nine students acquired moderate understanding, and three students had poor understanding on the similar topic.

The results indicate that the comprehension and academic achievement of the students after participating in a site visit activity were enhanced in comparison with before attending with any visit activity, however the number of students who attained better and moderate understanding is increasing. This is in line with study by (Eiris Pereira & Gheisari, 2019), which indicates that students believe the benefits of seeing and interacting with the experts and surroundings of the construction site to be extremely important.

Comparison of Scoring Marks Before and After Attended Site Visit According to Gender

Table 6 shows the student's Scoring marks for summative assessment (with zero site visit). As seen from the frequency analysis, a higher percentage of male students gained a good grasp of the topic compared to female students. More male students also acquired moderate understanding compared to female students. Female students only show moderate and poor understanding of the topic. Female students lack the ability to visualize the structural element with the dimensions on the blueprint thus contributing to the low performance in the formative assessment of the topic. (Razbani et al., 2023) study results showed that male students exhibit higher levels of conceptual understanding than female students in STEM (Science, Technology, Engineering, and Mathematics) learning.

Table 6: Student's scoring marks for formative assessment (with zero site visit).

Category	Marks	Formative Assessment			
		Male	Female	Total	%
Good	16-20	3	0	3	14.3
Better	11-15	5	0	5	23.8
Moderate	6-10	6	2	8	38.1
Poor	<5	2	3	5	23.8

In addition, Table 7 shows the Student's Scoring marks for summative Assessment (with one site visit). As a result of the frequency analysis, a higher number of male students were able to acquire a good and better understanding of the topic. The rate of male students acquiring moderate understanding was also higher than that of female students.

Table 7: Student's scoring marks for summative assessment (with one site visit).

Category	Marks	Summative Assessment			
		Male	Female	Total	%
Good	16-20	1	0	1	4.8
Better	11-15	8	0	8	38.1
Moderate	6-10	4	5	9	42.9
Poor	<5	3	0	3	14.3

Comparison of Scoring Marks Before and After attending site Visit for Each Male and Female Student

To further in depth the findings, a comparison of marks for each student has been conducted by tabulating the histogram as shown in **Fig. 5 and Fig. 6**. In this case, sixteen male students are participating in this study. **Fig. 5** shows the scoring marks for each student for their formative and summative assessment. It shows that, seven out of sixteen students show an improvement after attending one site visit. M1, M6, M8, M9, M11 and M12 represented 43.8% improvement of scoring marks among male students before and after attending one site visit.

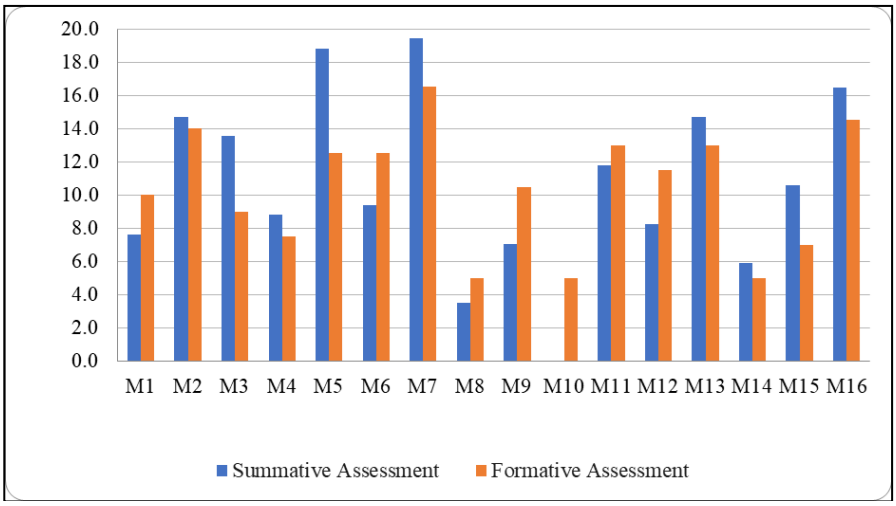

***Fig. 5**. Scoring marks before and after attended one site visit for male student.*

In this case, five female students are participating in this study. **Fig. 6** shows the scoring marks for each student for their formative and summative assessment. Even though the scoring marks is low for all female students which is less than 10 marks, however, the findings show that all five students had increments in the scoring marks after attending one site visit for their summative assessment. This indicates a 100% of improvement among female students. A few male students missed the site visit because of various situations, which could have contributed to this situation. Therefore, the respective student did not have the opportunity to observe the real construction activity and did not acquire any technical experience which may be gained from the site visit session. In addition, this may contribute to the lack of performance in scoring marks for the summative assessment. Meanwhile, all female students attended the site visit and spent more than two hours exploring and observing the construction works which covered the topic of Taking Off Quantities for Building Works. This exposure enhances student's understanding and improves the visualization ability when conducting the taking off building structural main elements such as pad footing, beam, column, and slab. This is because, in doing this task, it will be an advantage for the student with one site visit experience because they can visualize and imagine the shape, placement and condition of the reinforcement work, formwork work and concrete work of each structural element.

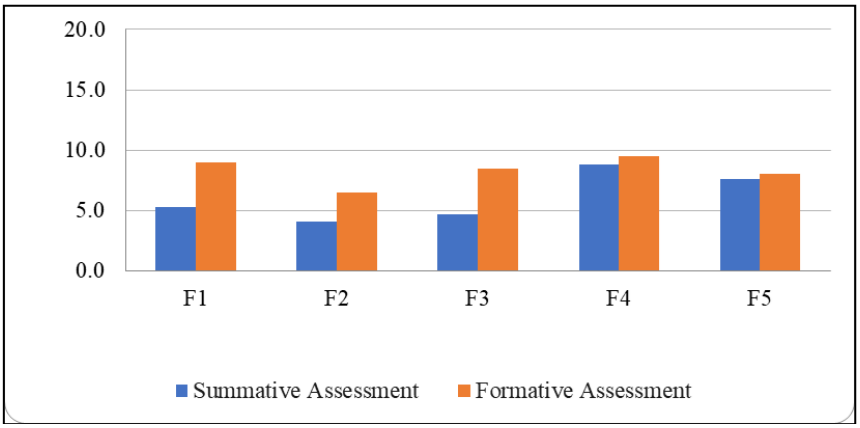

Fig. 6. *Scoring marks before and after attended site visit for female student.*

Mean Analysis

Mean analysis, in a statistical context, refers to the process of calculating and interpreting the arithmetic mean of a dataset. It is used to quantify the central location of a dataset and facilitate comparisons between different groups or samples. This statistical measure serves as a central indicator of the dataset's average or central tendency. The mean value of a dataset is calculated by adding up all individual values and dividing the result by the number of observations in the dataset. Mean analysis is fundamental in providing a concise and representative summary of the data, offering insights into the typical or average value within the distribution. Moreover, the standard deviation (SD) measures how dispersed the data are compared with the mean. High standard deviations indicate that values are far from the mean, whereas low standard deviations indicate that values are clustered around the mean.

The number of students (n), mean (M) and standard deviation (SD) for the summative and formative assessment of the student for semester 20232 is shown in Table 8.

Table 8. Mean value based on type of assessment.

Type of Assessment	Gender	N	Mean (M)	Std. Deviation (SD)
Formative Assessment	Female	5	6.10	2.02
	Male		10.70	
	Total			
Summative Assessment		16	10.10	5.41
	Female	21		5.16
	Male			
	Total	5	8.30	1.15
		16	10.40	3.65
		21		3.33
			10.40	

In this study, the mean (M) scoring marks for female students for the formative assessment is 6.10 with a SD of 2.02 and 8.30 for summative assessment with a SD of 1.15. It shows the female scoring marks in each assessment was close to the mean value. Therefore, the marks distribution for female students indicates low variability. Meanwhile, for

the male student, the mean scoring marks for formative assessment is 10.7 (SD = 5.41) and 10.4 for the summative assessment (SD =3.65). It shows the male scoring marks in each assessment was not very close to the mean value. Therefore, the marks distribution for male students indicates higher variability.

The summative assessment results reveal distinctive patterns between female and male students within a total number of twenty-one students. Among the female group comprising five students, the mean summative assessment score is 6.10, with a moderate standard deviation of 2.02, indicating a consistent performance around the mean. In contrast, the male group, consisting of sixteen students, exhibits a higher mean score of 10.70, accompanied by a larger standard deviation of 5.41, suggesting a more varied distribution of scores among male students. When considering the entire cohort, the combined mean summative assessment score for all twenty-one students is 10.00, with a standard deviation of 5.16, providing an overview of the overall average performance and variability in scores across both female and male students. These statistics offer valuable insights into the comparative performance and spread of scores within the assessed groups.

The data pertaining to formative assessments provides a detailed insight into the performance of both female and male students, as well as the overall cohort of twenty-one students. In the female group, consisting of five students, the mean formative assessment score is 8.30, demonstrating a relatively strong performance, as supported by a low standard deviation of 1.15, indicative of minimal variability around the mean. On the male front, comprising sixteen students, the mean formative assessment score is slightly higher at 10.4, accompanied by a standard deviation of 3.65, suggesting a moderate level of variability in scores within this group. For the entire cohort of twenty-one students, the overall mean formative assessment score matches that of the male group at 10.4, with a standard deviation of 3.33, reflecting a reasonable consistency in performance across the collective student body. These statistics not only provide an overview of the average scores but also shed light on the degree of variability, helping to gauge the overall effectiveness of formative assessment strategies of this subject.

4.0 CONCLUSION

The primary objective of this study is to assess the effectiveness of incorporating site visits as a method of instruction for students enrolled in the Civil Engineering Quantities and Estimation course in School of Civil Engineering program at UiTM Johor Branch Pasir Gudang Campus.

The focus on experiential-based learning, particularly through academic site visits, shows promise in improving students' comprehension of Civil Engineering Quantities and Estimation. This study assesses how well a particular course integrates experienced-based learning and offers information on how site visits affect students' performance and comprehension.

The analysis of students' demographic data and assessment results before and after site visits reveals interesting patterns. Although there is no substantial overall enhancement in academic performance, the study highlights variations between male and female students. Male students show higher scoring marks, but the improvement among female students after site visits is notable, indicating the potential benefits of experiential learning for certain groups.

The conclusions drawn from this study provide valuable insights and additional information for stakeholders, potentially influencing the decision-making process regarding the inclusion of site visits as a requisite educational method alongside traditional lectures and e-learning. Moreover, the Academic Affairs Department and administration of the

university may consider earmarking funds for the implementation of this pedagogical approach. This allocation of resources is warranted due to the anticipated positive impact on students, as it is expected to deepen their comprehension of theoretical concepts and bolster their proficiency in tasks such as quantity surveying and project cost estimation.

Amid the dynamic landscape of engineering education, characterized by the increasing relevance of multidisciplinary approaches, this study underscores the imperative for adaptable teaching methodologies. Site visits demonstrate how experiential learning fosters critical thinking and a thorough understanding of the subject matter in accordance with constructivist principles. According to the findings, engineering education must be continuously assessed and improved to meet the changing demands.

5.0 SUGGESTION FOR FUTURE RESEARCH

The study can be replicated to a group of students for different semesters and level of studies like degree level. Future research is advised to adopt a different statistical approach by comparing the numbers of site visit implemented in the academic semester. In addition, by having large numbers of participants, advanced statistical analysis may be conducted to explore more on the different perspectives between male and female students.

This research constituted an initial exploration employing a limited student sample size and was conducted solely at the UiTM Pasir Gudang branch. Thus, future research can be conducted at a larger scale by having engineering students nationwide. Moreover, future research endeavours should consider delving into diverse subjects, disciplines, and domains to achieve a more comprehensive and insightful comprehension of this pedagogical approach.

6.0 CO-AUTHOR CONTRIBUTION

The authors affirmed that there is no conflict of interest in this article. Author[1], wrote the research methodology, did the data entry, and conducted the statistical analysis and interpretation of the results. Author[2] prepared the literature review. Author[3] overlook the write up of the entire article.

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