INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN SOCIAL SCIENCE (IJRISS)
ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI July 2026 | Special Issue on Education

Interactive Teaching Intervention For Civil Engineering Education: An Action Research Study

Faisal Amsyar[1*]

[1]Department of Civil Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

DOI: https://doi.org/10.47772/IJRISS.2026.1026EDU0440

Received: 04 July 2026; Accepted: 09 July 2026; Published: 18 July 2026

ABSTRACT

The increasing demand for outcome-based education in civil engineering has promoted a shift from the lecture-centred instruction toward an interactive and student-centred learning approaches. KNS2133 Structural Analysis with specifically the Moment Distribution Method (MDM) for statically indeterminate structures, remains a challenging topic for the undergraduate students due to its fundamental concepts, multi-step procedures and displacement-based reasoning requirements. This study presents an action research investigation into the implementation of an interactive, technology-enhanced teaching intervention for MDM within a Structural Analysis course. The primary aim of this study is to evaluate the students' learning experiences, perceived learning outcomes and motivation responses following the intervention. The specific objectives are to: (i) examine the students' conceptual understanding and procedural confidence in applying MDM, (ii) evaluate the effectiveness of interactive teaching strategies and digital tools and (iii) assess students' motivation, engagement and overall evaluation of the learning experience. A descriptive action research design was adopted in this study by involving the undergraduate civil engineering students enrolled in KNS2133 Structural Analysis at Universi Malaysia Sarawak. About 80% of the enrolled students voluntarily take part in this statistic survey. The intervention incorporated step-by-step worked examples, QR-based diagnostic activities and integration of live digital tools such as Whiteboard.fi and eLEAP to facilitate real-time interaction and formative feedback. Data were collected using a post-lesson Google Form survey and analyzed using descriptive statistics. The findings indicate that strong positive student perceptions across conceptual understanding, teaching effectiveness, technology integration and perceived learning outcomes. Students reported with high confidence in stiffness computation, MDM tabulation and internal force determination, while comparative lower confidence was being observed in constructing shear force and bending moment diagrams. These substantial findings highlight areas for further instructional reinforcement. The novelty of this study lies in its context-specific application of technology-supported interactive teaching to a traditional structural analysis method, providing empirical classroom-level evidence to support the pedagogical integration of active learning strategies in civil engineering education.

Keywords: interactive teaching, action research, structural analysis, moment distribution method

INTRODUCTION

The necessity of shifting from a focus on knowledge transmission to instructional approaches has been highlighted by recent advancements in engineering education nowadays [1-2]. This transition to instructional approaches has include students in meaning-making, problem-solving and reflective learning [1]. The need for the civil engineering programs to meet outcome-based education (OBE) standards is accelerating the process of transformation in teaching and learning methods, as is the widespread recognition that students cannot acquire an adequate basis in complex analytical procedures through the more conventional lecture-centred approach [2]. Active, collaborative and interactive learning techniques have seemed to enhance student engagement, conceptual gains and retention in engineering and scientific courses, in accordance with empirical research [1-3]. However, the effectiveness of these approaches is extremely context dependent, especially in analytically heavy disciplines that demand structured procedural reasoning.

Structural analysis is a foundational course of civil engineering education, serving as a critical bridge between mechanics theory and professional structural design practice. A topic where most of the civil engineering undergraduates have difficulties in understand the analysis of statically indeterminate structures, especially when using displacement-based methods like the Moment Distribution Method (MDM). Unlike statically determinate analysis, MDM requires students to integrate multiple interdependent concepts, including member stiffness, joint equilibrium, distribution factors, carry-over moments and iterative convergence. Previous research has shown that most of students have a hard time to understand the basic concepts behind MDM's tabular workflow [1, 4]. Instead of they see it as a representation of structural behaviour, student forecast it as an automated technique [1, 4]. As there is no scope for diagnostic feedback or active cognitive engagement in the form of worked examples or class tutorials, these problems become more even severe. Johnson et al. [5] and Prince & Vigeant [6] found out that students when learn complex analytical abilities better when they work in pairs or groups as they were easily engaging in guided problem-solving activities and receive immediate formative feedback. Such pedagogical affordances can be particularly important in the context of MDM for clearing up common misunderstandings about the calculation of stiffness, the mathematical framework of moment distribution and the conversion of mathematical findings into shear force diagram (SFD) and bending moment diagram (BMD). By facilitating iterative adjustment, real-time visualization and instructor-led scaffolding of student conceptualization, technology-enhanced instructional tools may strengthen such procedures when they correspond with defined learning activities [5-6]. But there has been lack of research into the effectiveness of digital tools for interactive instruction in conventional structural analysis techniques particularly in setting with small batches of civil engineering students.

To address this need, this study uses a Structural Analysis course (KNS2133) for undergraduates in civil engineering in the Faculty of Engineering UNIMAS. This is to demonstrate and evaluate a technology-enhanced, interactive learning intervention for the topic of Moment Distribution Method (MDM). The intervention is designed to assist students comprehend the full MDM workflow by incorporating diagnostic class activities based on QR tags, live digital tool whiteboard exercises along with the partially finished worked examples. This study is a valuable contribution to the field of engineering education research due to the employs of an action research framework to systematically examine the impact of interactive teaching strategies on students' conceptual understanding, procedural confidence as well as perceived learning effectiveness in MDM lessons. Although the active learning and technology-enhanced teaching have been extensively investigated within engineering education, limited classroom-based action research has specifically examined their application to the MDM, particularly in supporting students throughout the complete analytical workflow form stiffness calculation to graphical interpretation using shear force and bending moment diagrams. Furthermore, existing studies rarely evaluate how interactive digital tools can facilitate real-time formative feedback during highly procedural structural analysis lessons. Therefore, this study attempts to address this instructional gap by providing classroom-level evidence regarding students' perceptions of an interactive teaching intervention within the context of undergraduate Structural Analysis.

LITERATURE REVIEW

Teaching Challenges in Structural Analysis

Due to its dependence on symbolic reasoning, complex problem-solving processes and abstract representations, structural analysis course is considered as one of the most mentally difficult courses offered by civil engineering programme [7-8]. In analytically complex engineering courses, the passive acquisition of working solutions emphasized through the conventional lecture-based education is insufficient for generating enduring conceptual knowledge [1-2, 6]. Because the student fails to fully comprehend the theory behind the analytical procedures, they often ended up with information that is not adaptable to numerous kinds of problems. Challenges with information retention and engagement are made worse by the fact that individual attention spans are getting shortened during lengthy lectures [2, 9-11]. As compared to the conventional lecture methods, engineering and STEM education research shows that active learning approaches that combine organized interaction, formative feedback and student engagement substantially enhance the learning outcomes [2, 9-11]. Johnson et al. [5] and Prince & Vigeant [6] are the only two of many meta-analyses that illustrate how cooperative and collaborative learning environments maximize the academic achievement of students, conceptual clarity and persistence in difficult technical programs. Despite this data, teacher-centred approach is still prominent in many structural analysis courses. This is due to the students sometimes concern about not receiving enough material and because analytical syllabi are seen to be much complicated. One of the ongoing challenges in structural engineering education is the gap between what is known to be effective pedagogy and what is being taught in the classroom. **Table 1** illustrate the summary of key teaching challenges and pedagogical implication in Strucutral Analysis course.

Research in problem-based and cooperative learning has demonstrated that new students have struggle to apply what they already learned in the past when their conceptual schemas are still underdeveloped [11-12]. This shows up is due to the lack of relationship among the numerical results and structural response diagrams, errors in applying distribution or carry-over factors and uncertainty in establishing stiffness parameters in statically indeterminate analysis. Student with short-term academic performance could be negatively impacted by self-directed problem solving without explicit guidance from instructors. This is particularly pertinent when students have never been exposed to displacement-based reasoning prior to their study [10-12]. Nevertheless, research has consistently show that students' understanding of concepts and procedural accuracy are improved when specific instruction, small-group interaction and explicit problem-solving frameworks are used to support complicated analytical tasks [5, 8].

Table 1 Summary of key teaching challenges and pedagogical implication in Structural Analysis.

Author(s)	Identified Challenges	Pedagogical Implications
Prince (2004); Felder & Brent (2016)	Passive learning in analytical subjects	Need for active and interactive engagement
Hartley & Davies (1978); Wankat (2002)	Limited attention span in lectures	Break lectures with structures activities
Norman & Schmidt (2000); Albanese & Mitchell (1993)	Conceptual difficulty in indeterminate analysis	Scaffolding displacement-based reasoning
Colliver (2000); Albanese (2000)	Procedural errors in multi-step methods	Guided, step-by-step analytical workflows
Johnson et al. (2013); Woods et al. (2000)	Weak transfer from computation to diagrams	Visualization and iterative feedback

Active Learning and Technology in Engineering Education

Numerous research studies were conducted on active learning as a method of learning that places the responsibility of learning on the student through a meaningful participation, self-reflection and group work. Worked examples, group problem solving and student-centred classroom activities are types of active learning strategies that being used in engineering learning education [1-2, 12]. These methods encourage students to critically think and solve problems on their own, instead of just receiving the knowledge in class. When compared to the traditional lecturing, active learning approaches significantly improve students' engagement and conceptual understanding, in according to the thorough review by Prince [1]. This is particularly relevant in technically challenging disciplines. Likewise, Felder & Brent [2] highlighted that the need of student-centred instructional approaches in engineering curricula, particularly when teaching sophisticated concepts and requiring students to follow a series of steps to solve problems.

By facilitating instant feedback, digital technologies have strengthened the effectiveness of active learning even further. Previous research studies have shown that when teachers or facilitators are able to quickly detect whether their students are confused and make the necessary adjustments to their teaching lessons, the results of their students' learning might improve substantially [13]. Interactive-engagement environments, including live digital whiteboards and response systems, have been shown to produce substantial higher conceptual gains than conventional methods, particularly in mechanics-based subjects [14-15]. These results provide legitimacy to the idea that engineering schools can benefit from formative assessment that makes use of technology. Instead of being implemented as independent components, digital technologies operate the best within student-centred learning frameworks when they are integrated into a cohesive instructional design. Johnson et al. [5] and Prince

& Vigeant [6] noted that cooperative and collaborative learning that shows how structured interaction, along with clear task design and instructor guidance, improves engineering students' academic achievement and retention rates.

Pedagogical Basis of The Teaching Intervention

The teaching intervention implemented in this study was developed by integrating several evidence-based instructional strategies that have been widely recommended in engineering education research. Rather than relying on a single teaching approach, the intervention combined worked examples, scaffolded problem-solving activities, formative assessment, collaborative learning and technology-supported interaction to facilitate students' conceptual understanding and procedural competence in the MDM. Worked examples formed the core instructional strategy throughout the lesson because they provide structured guidance for solving the complex analytical problems that involve multiple sequential calculations. Previous studies have demonstrated that carefully designed worked examples improve the students' procedural understanding by reducing unnecessary problem-solving complexity during the early stages of learning while allowing students to gradually internalize analytical reasoning processes [2, 6]. To further support formative learning, QR-code-based diagnostic activities were incorporated at the beginning of the lesson to active students' prior knowledge and identify misconceptions before introducing the complete MDM procedure. This approach aligns with the principles of active learning, where continuous interactive between instructors and students promote meaningful learning through the timely feedback and guided reflection rather than delayed evaluation [1, 13]. Interactive digital platforms, including Whiteboard.fi and eLEAP, were employed to facilitate real-time participation and collaborative learning throughout the lesson. Previous studies have consistently reported that technology-supported interactive learning environments improve student engagement, encourage active classroom participation and promote conceptual understanding in engineering education when integrated with appropriate pedagogical strategies [5, 13-15].

Collaborative discussion was also incorporated throughout the instructional activities to encourage students to explain analytical procedures, compare alternative solutions and reflect upon their own understanding. Engineering education research has consistently shown that collaborative learning enhances conceptual understanding, problem-solving ability and long-term knowledge retention, particularly for analytically demanding subjects that require sequential reasoning and structured decision-making [5-6]. **Table 2** simplifies the pedagogical basis of the teaching intervention adopted from previous studies.

Table 2 Summary of pedagogical basis of the teaching intervention adopted from previous studies.

Teaching Strategy	Educational Purpose	Supporting References
Worked examples	Reduce procedural complexity and develop analytical reasoning through scaffolded learning.	[2], [6]
QR-code diagnostic activities	Active prior knowledge and identify misconceptions through formative assessment.	[1], [13]
Whiteboard.fi	Provide immediate feedback and monitor students' conceptual understanding in real time.	[5], [13-15]
eLEAP platform	Facilitate continuous interaction, participation and learning support.	[13-15]
Collaborative discussion	Promote peer learning, conceptual clarification and problem-solving confidence.	[5], [6]

METHODOLOGY

Research Design

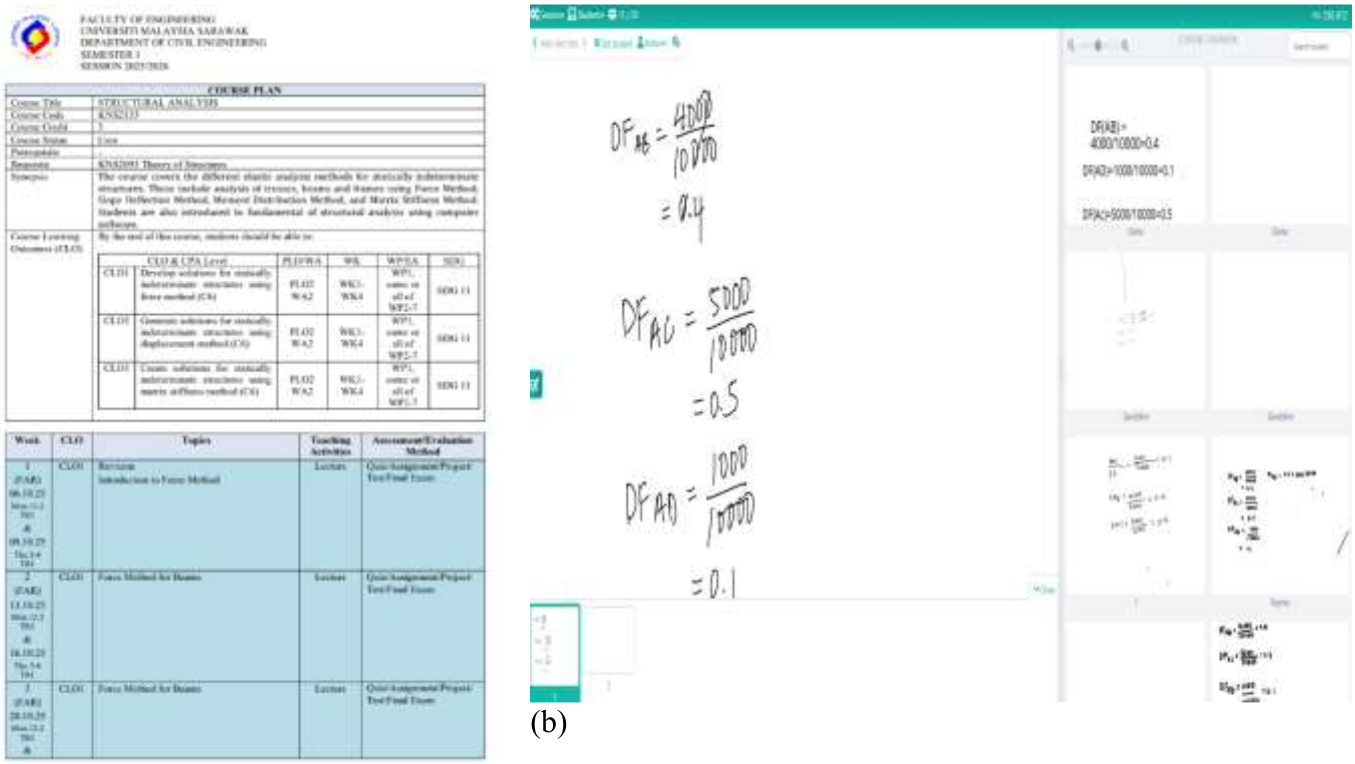
To evaluate how the students in a course of KNS2133 Structural Analysis thought regarding on the interactive, technology-enhanced teaching intervention, this research study employed a descriptive action research approach. In order to reflect on effectiveness of instructional techniques carried out to this study, interactive resources and

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI July 2026 | Special Issue on Education

teaching planning, this research revolved around post-lesson student feedback through Google Form. Since it is ideal for collecting data on students' perceptions of their own learning results and their experiences shortly after a targeted instructional intervention, a survey-based methodology was selected. The purpose of the investigation was not to demonstrate a cause-and-effect relationship, but to rather cast some insight into how effective instructors are in dealing their teaching lesson in real classroom. **Figure 1** illustrates the sample of course plan adopted from KNS2133 Structural Analysis and employment of live interactive tool (Whiteboard.fi) during the learning lesson. This study followed the classroom action research cycle consisting of planning, action, observation and reflection. During the planning stage, common learning difficulties associated with the MDM were identified based on previous teaching experience. The intervention was then implemented during the scheduled lecture session (action), followed by post-lesson observation through students' survey responses. Finally, the findings were reflected upon to identify instructional strengths and aspects requiring further improvement for future teaching cycles.

Research Context and Participants

The study was carried out during a teaching practicum by scheduling lecture session for the course of KNS2133 Structural Analysis which being offered under the Bachelor of Civil Engineering programme in Semester 1 Session 2025/2026 at Universiti Malaysia Sarawak (UNIMAS). The participants comprised 10 undergraduate civil engineering students which all of whom were enrolled in the course during this semester. The teaching intervention has been taken place in Week 9 (in UNIMAS academic calendar), during a two-hour face-to-face lecture session at 2:00 PM till 4:00 PM. The teaching lesson was held at TR1, Level 1, Faculty of Engineering. The instructional focus of the session was the Moment Distribution Method (MDM) for statically indeterminate beams. This instructional topic is a displacement-based analysis technique aligned with Course Learning Outcome 2 (CLO2). Prior to the teaching session, students have been exposed to the fundamental of statistically determinate beam analysis which has been taught during their last semester in a course of KNS2093 Theory of Structures. Students were familiar with the equilibrium principle, shear force diagrams and bending moment diagrams. The study involved a single cohort of undergraduate civil engineering students enrolled in KNS2133 Structural Analysis. As this classroom action research was intended to improve instructional practice within a specific teaching context, no attempt was made to obtain a statistically representative sample.



(b)

(a)

Figure 1 Sample of teaching method by preparing the: (a) Course plan generated manually for KNS2133 Structural Analysis course and (b) Employment of live interactive tool (Whiteboard.fi) during the learning session.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI July 2026 | Special Issue on Education

Teaching Intervention

An instructional design with worked examples and digital engagement tools that students may use in real-time classroom was carried out for the intervention in this teaching lesson. To help students with warm up session, Whiteboard.fi presented brief diagnostic activities based on QR codes that they could use to calculate distribution moments and basic distribution factors, as illustrated in **Figure 1(b)**. Establishing prior knowledge and identifying early misunderstandings were the main objectives of this approach. The main lecture segment employed step-by-step worked examples of continuous beams analyzed using the Moment Distribution Method (MDM). Students were provided with partially completed lecture slides which then require them to actively fill in missing steps during the stiffness calculation, moment distribution and diagram construction (SFD and BMD). Through the session, live digital tools such as Whiteboard.fi and eLEAP platform were employed to facilitate the student responses in classroom, peer discussion and immediate lecture feedback. The intervention concluded with a structured recap of the full MDM workflow, reinforcing conceptual coherence and procedural understandings. The details of the proposed teaching plan for leaning intervention are depicted in **Table 3**.

Table 3 Details of the proposed teaching plan for KNS2133 Structural Analysis.

Date:	4th December 2025 (Thursday) – Week 9
Time:	2:00 P.M. – 4:00 P.M. (2 hours lecture)
Venue:	TR1, Level 1, Faculty of Engineering, UNIMAS
Number of Students:	10 students (Civil)
Topic:	Moment Distribution Method for Beams (CLO2) – Learning Unit 9 • Using MDM tabular form/table to analyze continuous beam
General Objective:	To enable students to understand and apply the Moment Distribution Method (MDM) as a displacement-based analysis technique for solving statically indeterminate beams. Through this learning unit, students will develop the ability to use a systematic “moment distribution” table or tabular form to determine internal moments, support reactions and to construct the corresponding shear force diagram (SFD) and bending moment diagram (BMD) for continuous beams.
Specific Objectives:	By the end of this lesson, students should be able to: • CLO & PLO: CLO2, PLO2 [C6] • CLO & CPA Level: Generate solutions for statically indeterminate structures using displacement method. • WK: WK1 – WK4 • WP/EA: WP1, some or all of WP2 – WP7

Research Instrument, Data Collection & Analysis

A Google Form survey was distributed out immediately right after the class session. The survey is as the primary instrument for data collection. This survey was created with a specific goal of gathering student opinions regarding to the MDM session’s teaching techniques, their understandings of key concepts and their general evaluation of the learning experience. Results were quantitative in form and were determined by the students’ self-reported opinions articulated on a five-point Likert scale from Strongly Disagree (1) to Strongly Agree (5). The Google Form was structured into four main sections:

- **Section A:** This section is for acquiring student background information and prior exposure to statically indeterminate analysis.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI July 2026 | Special Issue on Education

- **Section B:** This section related to the learning experience with the teaching intervention, including conceptual understanding, effectiveness of teaching strategy, interactivity and technology integration.
- **Section C:** Perceived learning outcomes related to MDM skills and confidence.
- **Section D:** Motivation, engagement and overall evaluation of the lesson.

All responses were collected anonymously, and it was used solely for teaching reflection and academic analysis purposes. Data were then collected immediately right after the completion of the lecture session. Eight of the ten students voluntarily completed the questionnaire, representing an overall response rate of 80%. Participation was voluntary, anonymous and had no influence on students' course grades. The questionnaire was administered immediately after the instructional session to capture students' immediate learning perceptions while minimizing recall bias to the data analysis. Data analysis was carried out using descriptive statistical methods, focussing on the calculation of response percentages for each Likert-scale item. This approach enabled a clear representation of students' perceptions regarding conceptual understanding, effectiveness of worked examples, usefulness of interactive tools and overall engagement. The findings were synthesized using tables and bar-chart figures to visualize the trends across the survey sections. No inferential statistical analysis was performed in this study as the aim of this research action is to provide reflective, classroom-level insights rather than generalized conclusions.

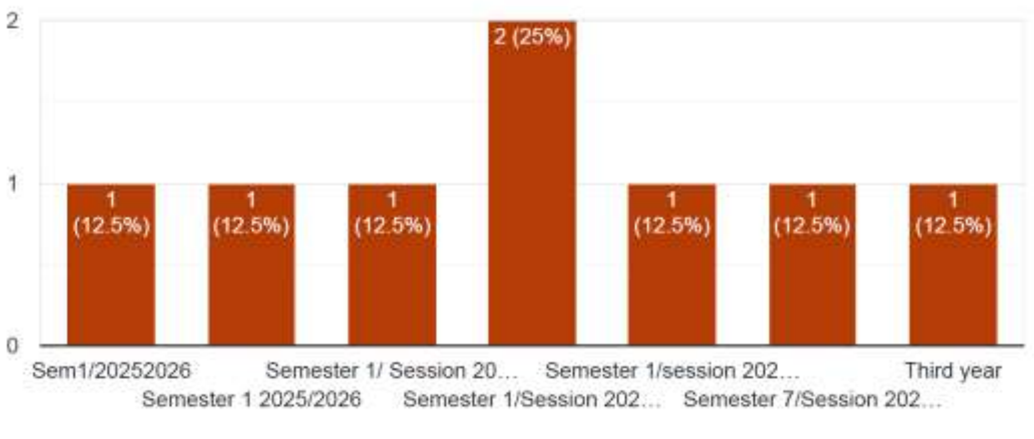
RESULTS AND DISCUSSION

Analysis of Student Information

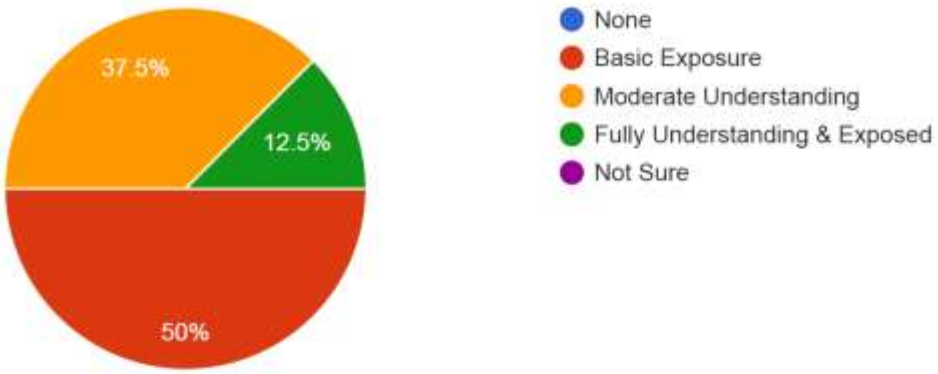
This subsection presents an analysis of the background characteristics of the students taking part in the statistical survey. An eight out of ten (8/10) were reported to answer the survey form by declaring for an honest and to the best of their knowledge and own learning experience during lesson. It is prior exposure of the student to the structural analysis concepts and their initial conceptual understanding of the Moment Distribution Method (MDM).

Table 4 Summary of student background and prior understanding of MDM.

Item	Response Category	Percentage (%)
Prior study of indeterminate beams	No	87.5
Prior study on determinate beams	Yes	87.5
Familiarity with MDM before the lesson starts	None	0.0
	Basic exposure	50.0
	Moderate understanding	37.5
	Fully understanding	12.5
	Not sure	0.0



(a)



(b)

Figure 2 Student academic background and prior familiarity with the MDM: (a) Current semester/year of study at UNIMAS and (b) Self-reported familiarity with MDM prior to the instructional intervention.

A total of eight out of ten undergraduate civil engineering students enrolled in KNS2133 Structural Analysis have voluntary participated in the post-lesson survey, representing an 80% response rate for the cohort. All respondents were from the Bachelor of Civil Engineering programme and were undertaking this course during their Semester 1, Session 2025/2026. The students were within the typical undergraduate age range of 20 – 25 years old which indicates that a relatively homogeneous group in terms of academic progression and maturity. Analysis of section A of the Google Form survey has revealed that a clear distinction between the students' prior exposure to statically determinate and statically indeterminate structural analysis. While 87.5% of the students have reported that for having previous studied of statically determinate beam analysis, primarily through the earlier KNS2093 Theory of Structures course. An equivalent of 87.5% indicated that most of the students had not studied statically indeterminate beam analysis before attending the MDM lecture. Furthermore, when asked about their familiarity with the MDM prior to this lecture lesson, 50% of the students reported for having a basic exposure to MDM, about 37.5% indicated for a moderate level of their understanding and only 12.5% of overall stated that they were fully familiar and exposed to the method before attending the class session. Notably, none of them are selecting the categories of "none" or "not sure", suggesting that the cohort possessed some degree of preliminary awareness of MDM, likely through self-study, prior coursework references or informal exposure in their previous course of Theory of Structures. These findings were summarized in **Table 4** and illustrated in **Figure 2** by confirming that the cohort entered the session with strong prerequisite knowledge in equilibrium-based analysis but limited conceptual grounding in displacement-based methods, particularly those involving stiffness formulation and iterative moment balancing. These findings indicate that most students entered the lesson with adequate pre-requisite knowledge of statically determinate structures but had limited prior exposure to the displacement-based analysis. Consequently, improvements observed throughout the intervention should be interpreted within the context of introducing a new analytical procedure rather than reinforcing previously mastered knowledge.

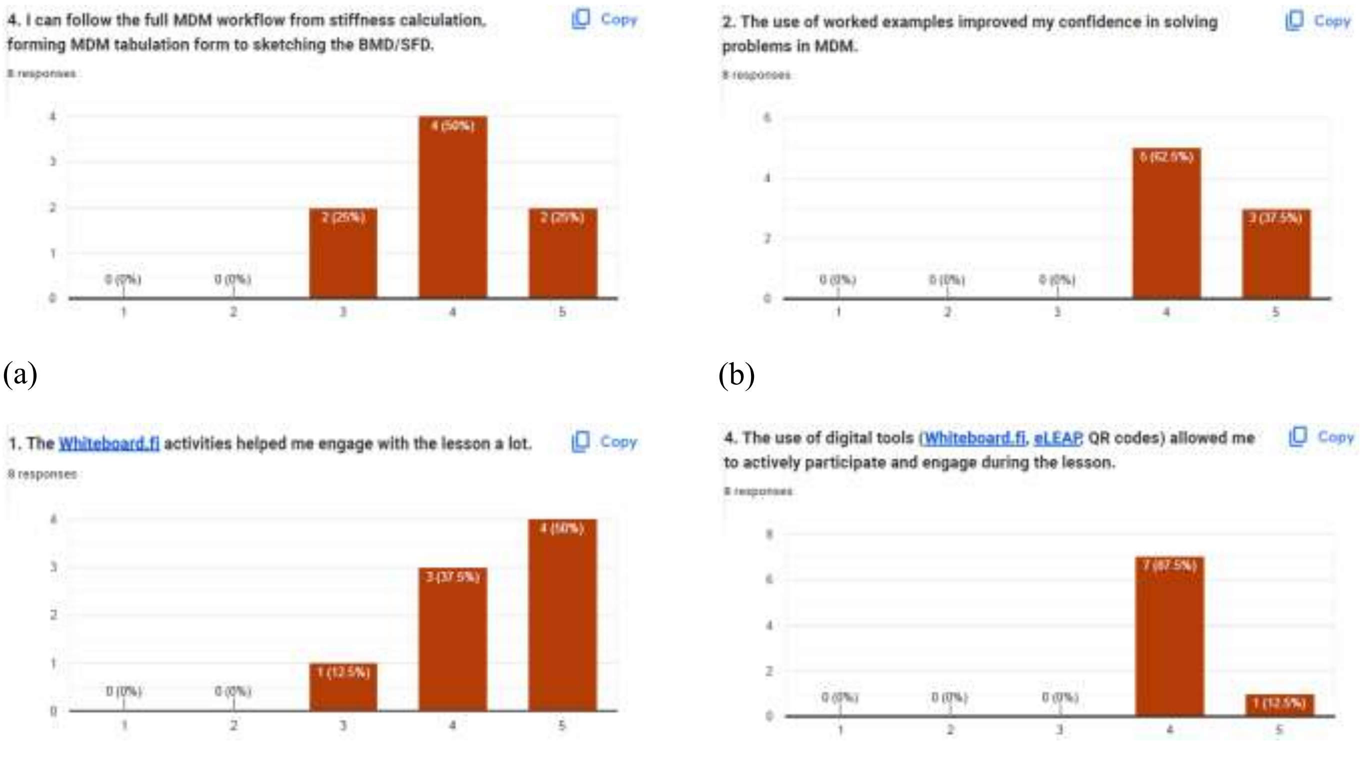
Learning Experience with The Teaching Intervention

Conceptual Understanding

Students' conceptual understanding of MDM was examined in this study through four (4) items in Google Form Section B1 which focussing on the member stiffness, distribution factors, fixed-end moments and the overall MDM workflow. The responses directly indicate a positive conceptual outcome after the lecture session, though with some variation across concepts. For the understanding of member stiffness (K), 75.0% of students selected "agree", while the remaining 25.0% selected "strongly agree", indicating for universal positive agreement. Similarly, understanding of fixed-end moments (FEMs) showed strong results by 75.0% agreeing and 12.5% strongly agreeing even though 12.5% remained neutral. This shows that partial conceptual uncertainty for a small subset of students. Understanding of distribution factors (DF) exhibited slightly more variation. While 62.5% of the students were agreed and 25.0% strongly agreed, the rest of 12.5% selected for a neutral response. This indicates that DF formulation may still be present conceptual challenges for some learners. When asked whether

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI July 2026 | Special Issue on Education

the students could follow the full MDM workflow – from stiffness calculation through tabulation of SFD/BMD construction – the responses were similarly distributed, with 50.0% agreeing, 25.0% strongly agreeing and 25.0% selecting a neutral position. These findings suggest that while the intervention significantly supported conceptual understanding, the complete integration of all MDM steps may require further reinforcement through additional practice or extended exposure. **Figure 3(a)** illustrates the statistically data on student's ability to follow the complete MDM workflow from stiffness calculation to BMD/SFD construction. An interesting observation is that students demonstrated greater confidence when understanding individual analytical concepts such as member stiffness and fixed-end moments that when integrating the complete MDM workflow. This suggests that conceptual understanding may develop earlier than procedural integration, highlighting the importance of providing additional scaffolded practice that links individual computational stages into a coherent analytical sequence.



(a) (b)

(c) (d)

Figure 3 Students' perceptions of learning engagement and instructional support during the MDM lesson: (a) Ability to follow the complete MDM workflow from stiffness calculation to BMD/SFD construction; (b) Perceived impact of worked examples on problem-solving confidence; (c) Effectiveness of Whiteboard.fi activities in enhancing lesson engagement; (d) Role of digital tools in supporting active participation during the lesson.

Effectiveness of Teaching Strategy

The effectiveness of the teaching strategy in this study was evaluated using Google Form Section B2 which examined the step-by-step explanation, worked examples, teaching pace and lesson structure. Overall, students responded positively to the instructional design (teaching plan). Notably, 75.0% of students agreed and 25.0% strongly agreed that the step-by-step explanation of MDM significantly supported their deep understanding. The use of worked examples in the lecture class was particularly well received with statistic of 62.5% agreeing and 37.5% strongly agreeing that these examples improved their confidence in solving MDM problems. **Figure 3(b)** demonstrates the statistically data on perceived impact of integrating worked examples on problem-solving confidence. With respect to the teaching pace, 75.0% of the students agreed that it was appropriate for the complexity of MDM, while 25.0% strongly agreed. This indicates that the lesson progression was well aligned with the student's learning capacity. Similarly, the lesson structure was perceived as effective in bridging prior knowledge and new MDM concept with 87.5% agreeing and 12.5% strongly agreeing. These findings support the pedagogical effectiveness of combining structured explanation with worked examples, particularly for analytical intensive topics that required careful sequencing of concepts. The effectiveness of worked examples observed in this study is consistent with cognitive scaffolding principles, whereby students progressively internalize analytical procedures through guided practice before attempting independent problem solving. However, the present findings are based on students' perceptions and should not be interpreted as direct evidence of improved academic achievement.

Student-Centred and Interactive Learning

Students' experiences with student-centred and interactive learning were completely analyzed using Google Form Section B3. The responses suggest that interactive elements contributed positively to the engagement and participation, though with moderate variation. For the employment of Whiteboard.fi, about 50.0% of the students were strongly agreed and 37.5% agreed that it enhanced their engagement in interactive class, while only 12.5% selected a neutral response. **Figure 3(c)** demonstrates the statistically data on the effectiveness of using Whiteboard.fi activities in enhancing lesson engagement. In contrast, QR-code-based activities received uniformly positive feedback from students. With 50.0% of them agreed and 50.0% strongly agreed that these activities encouraged active participation. Regarding to the student's comfort in contributing their answer or take part during the live session, 50.0% were agreed and 37.5% were strongly agreed, while 12.5% of respondents had remained neutral. This suggests that although most students felt comfortable in participating, a small proportion may be still experienced hesitation in live interactive settings. Similarly, for the identification of misconceptions, 50.0% strongly agreed and 37.5% agreed that interactive activities helped them recognize misunderstandings early, with 12.5% neutral. These results indicated that student-centred learning strategies were largely effective, while also highlighting opportunities to further support less confident students. Although students responded positively towards the interactive learning activities, the present study could not determine whether the observed engagement resulted primarily from Whiteboard.fi, QR-code activities, peer discussion or the combined instructional design. Future investigations should isolate these instructional components to determine their individual contributions towards student learning.

Technology Integration

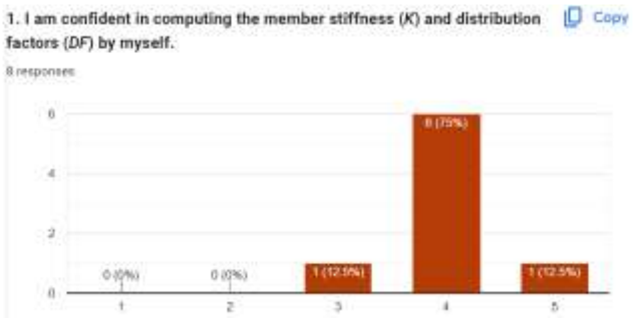
Technology integration was evaluated through the Google Form Section B4 where it is focussing on the usability, learning enhancement and real-time feedback. The results show for strong overall acceptance feedback of digital tools from respondents. For the statement that digital tools enhanced learning, 62.5% of the respondents agreed and 25.0% strongly agreed and only 12.5% selected for a neutral response. Importantly, a 100% of the students either agreed (75.0%) or strongly agreed (25.0%) that concluded the technology was easy to use and did not distract them from learning during the teaching lesson. The role of real-time feedback was also positively perceived with an equal split between Agree (50.0%) and Strongly Agree (50.0%) responses. Similarly, 100% of the students agreed or strongly agreed that the use of digital tools enabled for their active participation during the lesson. These findings suggest that technology was effectively integrated into the pedagogical design, supporting interaction and feedback without imposing additional cognitive or technical burden on students. **Figure 3(d)** demonstrates the statistically data on the role of digital tools in supporting active participation during the lesson. The positive responses also suggest that digital technologies functioned as instructional support tools rather than sources of cognitive distraction. Nevertheless, it remains uncertain whether similar responses would be observed following repeated implementation once the novelty of the digital platforms diminishes.

Perceived Learning Outcomes

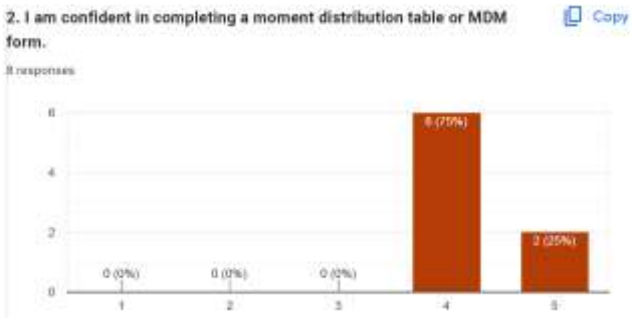
This subsection reports students perceived learning outcomes after completing the lesson on the Moment Distribution Method (MDM) which is based on Google Form Section C of the post-lesson survey. Five (5) items were directly used in this survey's section to evaluate the students self-reported confidence in performing key analytical tasks and their overall improvement in structural analysis understanding. All results are derived from all eight valid responses, analyzed using descriptive percentages. For the first learning outcome which examined the confidence in computing member stiffness (K) and distribution factors (DF) independently, the responses from students show for a very strong outcome. About 75.0% of the students selected "Agree" while 12.5% students selected "Strongly Agree" and only about 12.5% of them chose for neutral response. **Figure 4(a)** illustrates the statistically data on student's confidence in computing member stiffness (K) and distribution

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI July 2026 | Special Issue on Education

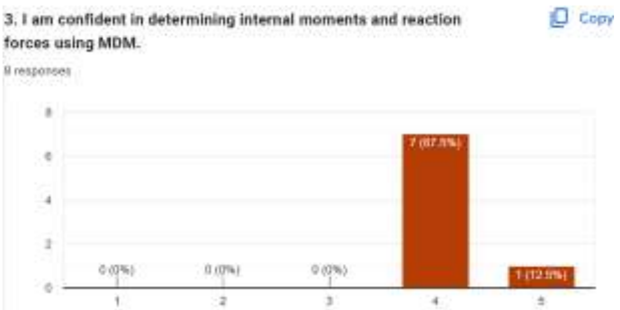
factors (DF). A similar trend was being observed for assessing confidence in completing a moment distribution table (MDM form). Here, 75.0% of students selected “Agree” and 25.0% of students selected “Strongly Agree”, indicating that all students felt confident in performing the tabulation stage of MDM after the lesson. This data analysis has been supported as indicated in **Figure 4(b)** by assessing the confidence of students in completing full MDM form tabulation. These results suggest that the instructional emphasis on stiffness formulation and structured tabulation, as outlined in the teaching plan. This effectively supported students’ procedural confidence in the core computational stages of the method.



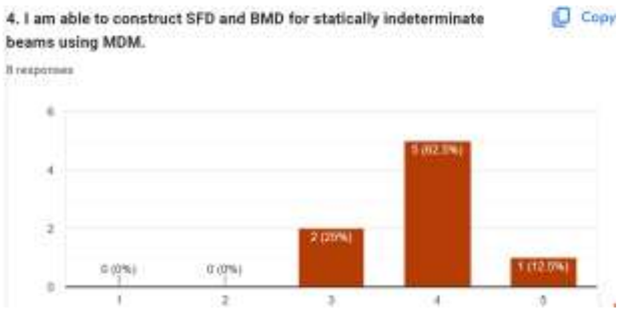
(a)



(b)



(c)



(d)

Figure 4 Students’ perceived learning outcomes following the MDM lesson: (a) Confidence in computing member stiffness (K) and distribution factors (DF); (b) Confidence in completing the moment distribution table (MDM form); (c) Confidence in determining internal moments and reaction forces using MDM; (d) Ability to construct shear force and bending moment diagrams (SFD/BMD) for statically indeterminate beams.

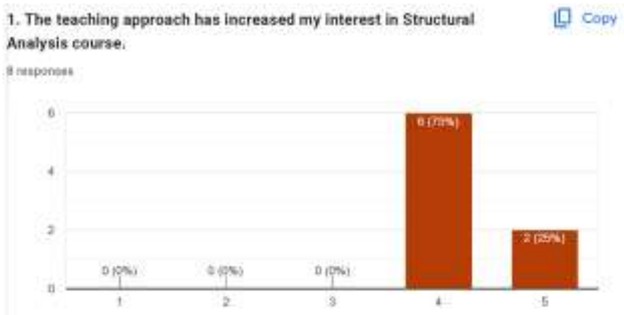
As shown in **Figure 4(c)**, students’ confidence in determining internal moments and reaction forces using MDM also showed a uniformly positive response with 87.5% of respondents selecting “Agree” and 12.5% selecting “Strongly Agree”. However, slightly more variation emerged for the ability of the students to construct shear force diagrams (SFD) and bending moment diagrams (BMD) for statically indeterminate beams using MDM, as shown in **Figure 4(d)**. While most of the students reported for positive outcomes (62.5% selected “Agree” and 12.5% of them chosen “Strongly Agree” and the rest of 25.0% selected “Moderate”), in which indicate that a quarter of the cohort remained only partially confident at this final graphical interpretation stage. This pattern is pedagogically meaningful as SFD/BMD construction requires careful integration of numerical results, sign conventions and diagrammatic reasoning in which typically demands repeated practice beyond a single instructional session. The final analysis of Section C has captured students’ overall perception of improvement in Structural Analysis understanding to follow the lecture session. The responses were strongly positive, with 87.5% of the respondents selecting “Agree” and 12.5% selecting “Strongly Agree” with no neutral or negative responses recorded. Collectively, the results indicate that the teaching intervention was the most effective in strengthening student’s confidence in computational and tabulation-based tasks, while diagram construction of SFD/BMD remained the area with the greatest scope for further reinforcement. These findings provide clear direction for future instructional refinement, particularly through the additional of guided practice or targeted activities focussed on translating MDM results into consistent SFD and BMD representations. The comparatively lower confidence reported in constructing shear force and bending moment diagrams provides an important pedagogical insight. While students appeared confident in completing numerical computations, translating these

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI July 2026 | Special Issue on Education

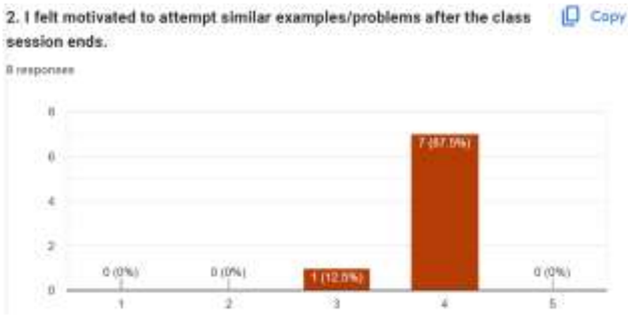
results into graphical structural representations remained comparatively challenging. This finding suggests that future teaching cycles should allocate additional instructional time specifically for diagram construction through scaffolded exercises and repeated guided practice.

Motivation, Engaggement & Overall Evaluation

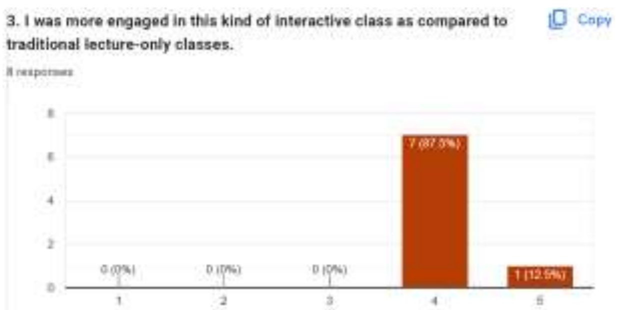
This subsection reports students' motivation, engagement and overall evaluation of the interactive MDM lesson in which it based on Google Form Section D of the post-lesson survey. Overall, students' ratings were strongly positive across all five (5) items with responses concentrated in the upper end of the Likert scale (Agree/Strongly Agree) and minimal neutrality. In terms of motivation impact, students indicated that the teaching approach increased their interest in KNS2133 Structural Analysis, with 75.0% selecting for "Agree" and 25.0% selecting "Strongly Agree", as depicted in **Figure 5(a)**. This suggests that the intervention did not merely support topic comprehension but contributed to the affective outcomes that are important for sustaining effort in analytically demanding subjects. Students also have been reported for strong intentions to continue practicing beyond the lesson. This can be depicted from **Figure 5(b)** in measuring the motivation to attempt similar examples after the class session where 87.5% selected for "Agree" while 12.5% selected for "Moderate" and no students selected for "Strongly Agree". This pattern is meaningful due to it indicated for broad readiness to engage in follow-up practice yet also signals that a small proportion of students may still require additional reinforcement or structured practice opportunities before they feel fully driven to the similar problems independently. In this context, students may still be unfamiliar with the full procedural of MDM mechanics (e.g., carry-over effects and iterative balancing), this moderate response can be interpreted as a realistic reflection of the cognitive demands associated with consolidating a new displacement-based workflow.



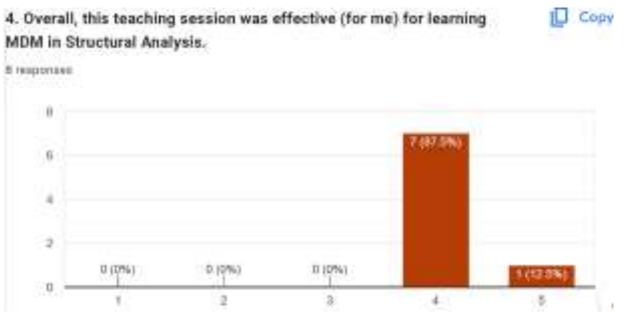
(a)



(b)



(c)



(d)

Figure 5 Affective and evaluative outcomes of the interactive MDM lesson: (a) Increased course interest; (b) Motivation to practise; (c) Engagement in interactive learning; (d) Overall learning effectiveness.

Engagement and overall evaluation items further reinforce the perceived value of interactive delivery. When comparing this interactive lesson with the conventional lecture-only classes, about 87.5% of the respondents agreed and 12.5% of them strongly agreed that they were more engaged in class using interactive tools such as Whiteboard.fi, eLEAP and LMS platform. This result was illustrated in **Figure 5(c)**. Consistently, students judged the session to be effective for learning MDM, again with statistically data of 87.5% chosen for "Agree" and another 12.5% chosen for "Strongly Agree" as depicted in **Figure 5(d)**. Finally, willingness of the students to recommend this interactive approach for other topics was high, with 75.0% agreeing and 25.0% strongly agreeing. Taken together, Section D from Google Form indicates that the intervention achieved not only positive learning perceptions but also strong affective and evaluative outcomes, supporting the feasibility of extending similar interactive designs to other Structural Analysis topics that probably require sequential reasoning and iterative problem solving. Although students expressed strong intentions to continue practising similar problems independently, the present study did not evaluate whether these intentions subsequently translated into actual learning behaviours or improved assessment performance. Longitudinal investigation would therefore provide a more comprehensive understanding of sustained learning motivation.

LIMITATIONS OF THE STUDY

This study should be interpreted within several limitations. First, the intervention was conducted in a single undergraduate Structural Analysis course involving one cohort of students from one institution, limiting the transferability of the findings. Second, only eight (8) students voluntarily completed the post-lesson questionnaire, introducing the possibility of response bias. Third, the study relied exclusively on students' self-reported perceptions without incorporating objective measures such as pre-test and post-test assessments. Consequently, the findings represent perceived learning outcomes rather than verified improvements in academic performance. Finally, multiple instructional components were implemented simultaneously in preventing the individual contribution of each digital tool from being isolated.

CONCLUSIONS

This study was conducted to examine the effectiveness of an interactive, technology-enhanced teaching intervention for the Moment Distribution Method (MDM) in a Structural Analysis course. Specifically, the study aimed to evaluate students' learning experiences, perceived learning outcomes and levels of motivation and engagement following the intervention. The findings indicate that the teaching approach has successfully supported students' conceptual understanding and procedural confidence in key stages of MDM, particularly in stiffness computation, distribution factor calculations and moment distribution tabulation and internal force determination. While students have reported for a strong confidence in analytical procedures, comparatively lower confidence was being observed in constructing shear force and bending moment diagrams in which highlighting the cognitively demanding nature of graphical interpretation in statically indeterminate analysis. As an overall, the findings demonstrate that interactive lectures supported by worked examples and integration of intuitive digital live tools such as Whiteboard.fi and eLEAP may enhance students' engagement and perceived learning effectiveness in analytically intensive civil engineering topics. This study contributes to the engineering education research by providing empirical, classroom-level evidence on the pedagogical value of integrating interactive strategies and digital tools into the teaching of a traditional structural analysis method. The novelty of this work lies in the context-specific application of technology-supported active learning to MDM, an area of which often taught using conventional lecture-based approaches. The findings also reveal practical challenges, particularly the need for an additional instructional support when translating numerical MDM results into structural diagrams. The findings should nevertheless be interpreted cautiously due to they are derived from a small classroom-based action research involving self-reported survey responses. Therefore, the study provides evidence of students' perceived learning experiences rather than definitive evidence of improvements in academic achievement. Future teaching implementation may be benefited from the extended practice sessions, scaffolded diagram-construction activities or follow-up tutorials to reinforce students' skills. From a research perspective, future studies could expand the sample size, incorporate pre- and post- performance assessments or examine the long-term retention of MDM concepts. Despite these limitations, the study demonstrates that thoughtfully designed interactive teaching interventions can foster meaningful learning experiences, enhance student engagement and support deeper understanding in civil engineering education, offering a positive and forward-looking pathway for instructional innovation in structural analysis courses.

Conflicts of Interest

The authors affirm that there are no conflicts of interest related to the publication of this paper. All research activities, data analyses and interpretations were conducted independently and objectively, without any personal

or institutional influences that could affect the outcomes or conclusions of this study.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the institutional support provided by the Ministry of Higher Education Malaysia and Universiti Malaysia Sarawak (UNIMAS).

REFERENCES

1. Prince, M. (2004). Does active learning work? A review of the research. Journal of Engineering Education, 93(3), 223–231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x
2. Felder, R. M. & Brent, R. (2016). Teaching and Learning STEM: A practical guide. Jossey-Bass (Wiley). https://ipa-pasca.unpak.ac.id/pdf/Teaching-and-Learning-STEM-A-Practical-Guide.pdf
3. Borrego, M., Froyd, J. E. & Hall, T. S. (2010). Diffusion of engineering education innovations: A survey of awareness and adoption rates in U.S. engineering departments. Journal of Engineering Education, 99(3), 185–207. https://doi.org/10.1002/j.2168-9830.2010.tb01056.x
4. Mills, J. E. & Treagust, D. F. (2003). Engineering education—Is problem-based or project-based learning the answer? Australasian Journal of Engineering Education, 3, 2–16. http://pandora.nla.gov.au/pan/10589/20050128-0000/www.aaee.com.au/journal/2003/mills_treagust03.pdf
5. Johnson, A. M., Ozogul, G., Moreno, R. & Reisslein, M. (2013). Pedagogical agent signaling of multiple visual engineering representations: The case of the young female agent. Journal of Engineering Education, 102(2), 319–337. https://doi.org/10.1002/jee.20009
6. Prince, M. & Vigeant, M. (2006). Using inquiry-based activities to promote understanding of critical engineering concepts. Proceedings of the American Society for Engineering Education Annual Conference & Exposition. https://peer.asee.org/using-inquiry-based-activities-to-promote-understanding-of-critical-engineering-concepts
7. De Campos, L. C., Dirani, E. A. T., Manrique, A. L. & van Hattum-Janssen, N. (Eds.). (2012). Project approaches to learning in engineering education: The practice of teamwork. Sense Publishers. https://doi.org/10.1007/978-94-6091-958-9
8. Guerra, A. O. & Holgaard, J. E. (2013). Students' perspectives on education for sustainable development in a problem-based learning environment. In Re-Thinking the Engineer: Proceedings of EESD 2013. University of Cambridge. https://www-csd.eng.cam.ac.uk/system/files/documents/guerra-a.pdf
9. Begum, M. (2010). Book review: Research on PBL practice in engineering education. Interdisciplinary Journal of Problem-Based Learning, 4(2), Article 7. https://doi.org/10.7771/1541-5015.1180
10. Case, J. M. & Light, G. (2011). Emerging methodologies in engineering education research. Journal of Engineering Education, 100(1), 186–210. https://doi.org/10.1002/j.2168-9830.2011.tb00008.x
11. Dym, C. L., Agogino, A. M., Eris, O., Frey, D. D. & Leifer, L. J. (2005). Engineering design thinking, teaching, and learning. Journal of Engineering Education, 94(1), 103–120.https://doi.org/10.1002/j.2168-9830.2005.tb00832.x
12. Johri, A. & Olds, B. M. (2011). Situated engineering learning: Bridging engineering education research and the learning sciences. Journal of Engineering Education, 100(1), 151–185. https://doi.org/10.1002/j.2168-9830.2011.tb00007.x
13. Tembrevilla, G., Phillion, A. & Zeadin, M. (2024). Experiential learning in engineering education: A systematic literature review. Journal of Engineering Education, 113(1), 195–218. https://doi.org/10.1002/jee.20575
14. Streveler, R. A. & Smith, K. A. (2013). Conducting rigorous research in engineering education. Journal of Engineering Education, 95(2), 103–105. https://doi.org/10.1002/j.2168-9830.2006.tb00882.x
15. Litzinger, T. A., Lattuca, L. R., Hadgraft, R. G. & Newstetter, W. C. (2011). Engineering education and the development of expertise. Journal of Engineering Education, 100(1), 123–150. https://doi.org/10.1002/j.2168-9830.2011.tb00006.x