Indonesian Journal of Science & Technology 11(1) (2026) 149-166

Indonesian Journal of Science & Technology

Journal homepage: http://ejournal.upi.edu/index.php/ijost/

Reducing Early Failure through a Six-Week Integrated Approach in Foundational Engineering Mathematics

*Abdulkareem Sh. Mahdi Al-Obaidi**

Taylor's University, Selangor, Malaysia

*Correspondence: E-mail: abdulkareem.Mahdi@taylors.edu.my

ABSTRACT

Foundational Engineering Mathematics often shows uneven engagement and high early failure in diverse cohorts. This study evaluated a six-week integrated framework combining a placement diagnostic, weekly pre- and post-lecture online quizzes, peer-learning tutorials, and one invigilated written quiz. Data from eight online quizzes, one written quiz, and the placement test were analysed for participation, performance, and progression. Results showed sustained engagement (mean participation 89%) and average quiz performance of 6.9/10; failure peaked at 33% in an early pre-quiz but declined to 15-18% in later weeks. Placement was predictive: 79% who passed the diagnostic later passed quizzes, whereas failing or absent groups were less consistent. The approach worked because frequent low-stakes assessments provided retrieval practice and timely feedback, heterogeneous peer groups offered scaffolding, and the early diagnostic identified at-risk students who needed support. This framework offers a scalable path to enhance engagement, reduce early failure, and strengthen accountability in foundational engineering mathematics.

ARTICLE INFO

Article History:
Submitted/Received 03 May 2025
First Revised 20 Jun 2025
Accepted 26 Aug 2025
First Available Online 27 Aug 2025
Publication Date 01 Apr 2026

Keyword:
Active learning,
Engineering mathematics,
Formative assessment,
Peer learning,
Placement diagnostic,
Student success.

1. INTRODUCTION

Engineering education continues to face persistent challenges, particularly in managing the wide diversity of student backgrounds and reducing high failure rates in foundational courses. Numerous reports have documented these challenges across institutions (**Table 1**). Among the most demanding subjects is Engineering Mathematics, which is both a branch of mathematics and a branch of engineering, situated at the intersection of theoretical foundations and practical applications. It equips students with essential tools for modelling, analysis, and problem-solving, bridging abstract mathematical concepts with real engineering systems. Consequently, Engineering Mathematics is not only fundamental for mastering advanced engineering courses but also critical for preparing students to meet complex professional challenges.

Table 1. Previous studies on science and engineering education.

No	Title	Ref.
1	Bibliometric analysis using VOSviewer with Publish or Perish of computational thinking and mathematical thinking in elementary school	[1]
2	Chatbot artificial intelligence as educational tools in science and engineering education: A literature review and bibliometric mapping analysis with its advantages and disadvantages	[2]
3	Industrial engineering students' readiness towards industrial revolution 4.0 at technical and vocational university: Literature review	[3]
4	Problem based learning (PBL) learning model for increasing learning motivation in chemistry subject: Literature review with bibliometric analysis	[4]
5	Identifying and dispelling students' misconceptions about electricity and magnetism using inquiry-based learning in selected junior high schools	[5]
6	Perceptions of senior high school science, technology, engineering, and mathematics (STEM) students toward STEM and non-STEM courses: A comparative qualitative study	[6]
7	How to make a cognitive assessment instrument in the merdeka curriculum for vocational high school students: A case study of generating device materials about the stirling engine	[7]
8	Advancing sustainability and green engineering in mechanical engineering education: Concepts, research trends, challenges, and implementation strategies	[8]
9	Utilization of visual basic software and its effect on students' computer programming performances	[9]
10	The paradigm of curriculum differentiation in higher IT education	[10]
11	Adaptive strategies for technical and vocational education and training (TVET) science educators: Navigating online home-based learning	[11]
12	Accessibility and utilization of artificial intelligence (AI)-based intelligent tutoring systems (ITS) and information and communication technology (ICT) in enhancing biology education	[12]
13	Examining climate change issues for improving cross-generation awareness in 21st century agenda: A bibliometric approach	[13]
14	The ethical and educational implications of greenwashing in corporate sustainability practices	[14]
15	Impact of single parenting on academic performance of junior secondary school students in mathematics	[15]
16	Towards designing technology for classroom role-play	[16]
17	Can the inquiry learning model improve students' system thinking skills?	[17]
18	Correlation between process engineering and special needs from bibliometric analysis perspectives	[18]
19	The emergence of new technologies in metalwork/automobile industries: Issues, challenges and opportunities in emanating from for delivery of technical education on a pandemic era	[19]
20	Exploring effective differentiated instruction in the teaching and learning of mathematics	[20]
21	The impact of project-based learning (PjBL) on students' motivation and learning outcomes: A literature review	[21]

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

Table 1 (continue). Previous studies on science and engineering education.

No	Title	Ref.
22	Bibliometric analysis on artificial intelligence research in Indonesia vocational education	[22]
23	Retaining female students in school: Intervention for improving menstrual hygiene	[23]
24	Preparing future geography teachers through problem-based learning technology: A short review	[24]
25	Perception of early childhood education lecturers on the use of virtual learning	[25]
26	Integrating TPACK for soft skills and communication in engineering education: Definition, concept, strategies, challenges, and opportunities	[26]
27	Effect of preparatory homework on pupils' academic performance in basic science	[27]
28	A bibliometric analysis of global trends in engineering education research	[28]
29	How to do research methodology: From literature review, bibliometric, step-by-step research stages, to practical examples in science and engineering education	[29]
30	Development and validation of CalTech (calculator techniques) exercises manual	[30]
31	Utilization of dynamic visualization tools: Enhancing students' motivation and engagement in biology education	[31]
32	Technology-supported project-based learning: Trends, review and future research in science, technology and engineering education	[32]
33	Low-cost Arduino to foster the engineering design process in STEM education	[33]
34	Experimental demonstration for teaching the concept of steam engine power plant to vocational students to support the sustainability development goals (SDGs) and its comparison to Indonesian Merdeka curriculum	[34]

These courses are often regarded as barriers to progression, with weaker students struggling to keep pace. Traditional lecture-based delivery, although efficient in covering content, often fails to ensure meaningful engagement and tends to leave less-prepared students behind. Consequently, many institutions are seeking innovative teaching and assessment approaches that can sustain motivation and provide timely support for at-risk students.

A growing body of research has highlighted the benefits of active learning and formative assessment in improving student understanding and long-term retention. Active learning strategies consistently enhance outcomes in engineering education, providing strong justification for addressing failure rates in Engineering Mathematics [35]. Incorporating active participation into lectures transforms classroom dynamics, making learning more engaging and stimulating while sustaining motivation in settings where disengagement is common. Cooperative learning has also been shown to significantly enhance both problem-solving and teamwork skills, reinforcing the rationale for adopting heterogeneous peer-learning groups in tutorials (Johnson, Johnson, & Smith, 1998). Furthermore, structured active learning interventions such as quizzes and small-group activities improve conceptual understanding, supporting the integration of pre- and post-lecture quizzes (Michael, 2006). Placement tests have likewise been recognized as essential diagnostics for identifying at-risk students during the transition to tertiary mathematics, justifying their integration into continuous assessment cycles [36].

While these studies provide strong evidence for active, collaborative, and diagnostic approaches, most have examined them in isolation. Few have investigated how such strategies can be integrated into a unified framework for sustained impact in foundational engineering mathematics. Addressing this gap is critical, as Engineering Mathematics not only determines progression rates but also shapes student confidence and preparedness for higher-level engineering subjects.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

This paper, therefore, investigates the effectiveness of a coordinated set of interventions weekly pre and post-quizzes, collaborative X-space tutorials, and written assessments implemented during the first six weeks of Engineering Mathematics. By explicitly aligning placement test results with subsequent quiz outcomes, the study explores how early diagnostics connect with continuous assessment to identify and support at-risk students. In doing so, it advances prior work by demonstrating the added value of combining multiple evidence-based methods into a unified, systematic framework. The findings contribute practical insights for enhancing student engagement and performance, as well as broader recommendations for strengthening institutional support mechanisms in large-class mathematics education [35-38].

2. LITERATURE REVIEW

To situate this study within the broader context of engineering education, prior research on active learning, formative assessment, peer collaboration, and diagnostic testing is reviewed. These pedagogical strategies provide the theoretical and empirical foundation for the coordinated approach proposed in this study. Active learning methods, in particular, have gained considerable traction in engineering education, with substantial evidence of their impact on student retention, motivation, and problem-solving skills [35].

Active learning has been shown to consistently improve student outcomes compared to traditional lectures, reinforcing the need to rethink delivery in foundational mathematics [35]. It also offers practical advantages in large classes, where structured engagement helps counter passivity and uneven participation, challenges especially relevant to high-enrolment Engineering Mathematics courses [39].

Formative assessment tools, such as pre- and post-quizzes, further strengthen learning by providing continuous feedback to both students and instructors. A meta-analysis of 225 STEM courses demonstrated that active learning methods including quizzes, problem-solving, and peer instruction, not only improved examination performance but also significantly reduced failure rates, underscoring the value of embedding low-stakes assessments into learning environments [40].

Collaborative environments also play a critical role in fostering peer learning, accountability, and knowledge sharing. Cooperative learning has been shown to consistently improve achievement, persistence, and teamwork skills, which are essential in engineering education [37]. Similarly, project-based and problem-based approaches have been shown to enhance motivation and conceptual understanding, while traditional “chalk and talk” methods hinder preparation for modern engineering practice [41]. These findings provide strong justification for the use of X-space tutorials, where heterogeneous groups are formed to encourage equitable peer learning.

Placement tests have long served as valuable diagnostic tools. Studies show that placement outcomes are strongly predictive of later academic performance, emphasizing their role as early-warning mechanisms for at-risk students [36]. Other research highlights that many first-year students exhibit mismatches between procedural and conceptual competence, reinforcing the need for diagnostics that capture both aspects of mathematical preparedness [42]. This aligns with the principle that assessment should be closely linked to learning objectives and employed as a formative tool to improve teaching and learning practices.

In parallel, broader stakeholder perspectives emphasize the importance of reframing engineering curricula to meet societal and interdisciplinary demands. Future engineers are

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

expected to acquire competencies that extend beyond disciplinary expertise, including problem-solving, social engagement, and integrated STEM/STEAM capacities [43].

Innovative mechanisms for continuous engagement have also been introduced. The Attention–Attendance–Preparation (AAP) Card method, designed specifically for large engineering classes, has proven effective by tracking attendance, student attention, and preparation while also collecting ongoing feedback. Evidence shows that this approach enhances engagement, identifies at-risk students earlier, and supports continual quality improvement. A bibliometric review further indicated that more than one-quarter of publications in the Journal of Engineering Science and Technology (2009–2025) are education-focused, reflecting the growing importance of research at the intersection of engineering practice and pedagogy [44].

Taken together, previous studies confirm the potential of active learning, formative assessment, peer collaboration, and diagnostic testing to improve outcomes in engineering education. However, most research has examined these strategies in isolation, yielding only fragmented insights. What remains underexplored is their combined effect within a unified and systematic framework, particularly in contexts where failure rates persist. Addressing this gap, the present study evaluates an integrated approach to Engineering Mathematics that deliberately links diagnostic testing, formative feedback, and peer collaboration. In doing so, it provides deeper insights into how these methods interact in practice and establishes the basis for the methodological framework that follows [35-38].

3. METHODS

The methodological design of this study was developed to address the gaps identified in prior research, where active learning and assessment strategies have often been applied in isolation. To create a more integrated model, established best practices in engineering education were combined. Classroom delivery incorporated peer feedback mechanisms, which are known to enhance critical thinking, accountability, and reflective learning through structured evaluation among peers [45]. Elements of reciprocal peer tutoring were also embedded, enabling students to alternate roles between "tutor" and "learner" in order to strengthen conceptual mastery through teaching as well as learning [46]. By merging these complementary strategies, the design was intended to strengthen both cognitive and collaborative dimensions of learning, creating a systematic framework that moves beyond fragmented applications reported in earlier work.

Computer-supported collaborative learning (CSCL) strategies were further adopted to encourage collaboration, accountability, and leadership in group-based tasks. While originally developed for ICT-mediated environments, the principles were adapted to classroom settings to promote equitable participation and reflective teamwork [47]. These collaborative structures were then integrated into project-based learning (PBL) and aligned with the CDIO (Conceive–Design–Implement–Operate) framework to ensure that activities were interactive and authentic to real engineering problem-solving scenarios [48,49].

To evaluate outcomes, the study employed rubric-based competence assessment frameworks, which provide structured and transparent criteria that map student performance to clearly defined learning outcomes, thereby ensuring fairness and clarity [50,51]. In addition, lightweight Excel-based performance dashboards were implemented to support real-time monitoring of individual and group performance. These dashboards, inspired by learning analytics research, enabled timely instructional adjustments and facilitated student self-regulation [52].

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

The overall design also contextualized mathematics through field-specific problems, which have been shown to enhance relevance and motivation for engineering students [53]. Digital tools such as interactive e-textbooks and visualization environments were used to further enrich learning. Evidence from courses such as the University of Michigan's Calculus for the Modern Engineer demonstrates that integrating platforms like Julia, Wolfram Alpha Pro, and Large Language Models shifts the focus from manual calculations toward conceptual mastery and real-world applications [54]. Similarly, studies in South Africa show that multimedia-based interactive e-textbooks improve reasoning and conceptual understanding in engineering mathematics.

Placement and persistence issues were also addressed. A large-scale study involving more than 3,000 students confirmed that the ALEKS placement exam strongly influenced enrolment in Calculus I and persistence in engineering programs, though equity challenges for underrepresented groups remain [55]. This underlines the importance of aligning diagnostic tools with support systems to promote inclusivity. Courses redesigned around discipline-specific problems have also been shown to increase students' recognition of mathematics as central to their professional practice, though barriers such as low self-efficacy continue to hinder progression [56,57]. To address these challenges, dynamic visualization environments such as GeoGebra have been widely adopted. Research demonstrates that GeoGebra and its extensions, including augmented reality, significantly enhance engagement, geometric reasoning, and overall outcomes in mathematics education [58-61].

Data were systematically gathered during the first six weeks of the semester. Eight online pre- and post-quizzes were used to measure preparedness and assimilation of new concepts, while a written quiz was conducted under controlled conditions to evaluate independent mastery. A placement test was administered during orientation week to establish baseline competencies and to inform the formation of heterogeneous tutorial groups. By linking placement results with subsequent performance, the study was able to capture both preparedness and progression. This multi-layered approach is consistent with prior findings on peer tutoring, peer feedback, and collaborative learning frameworks, which emphasize the value of combining quantitative and qualitative indicators of student engagement [45-47].

Taken together, the methodology integrated peer-centered learning, collaborative frameworks, technology-enhanced assessment, and contextualized mathematics into a coherent design. This approach not only addressed the challenges of engagement, preparedness, and early failure identified in the introduction but also ensured alignment with best practices in engineering education.

4. RESULTS AND DISCUSSION

4.1. Participation

Student participation across all assessments remained consistently high, averaging 89% over the six weeks. This sustained level of engagement indicates that the integration of frequent, low-stakes assessments was effective in motivating students and maintaining commitment throughout the course. As presented in **Table 2**, participation varied slightly across individual quizzes but never dropped below 80%, underscoring the stability and robustness of the assessment design.

The highest participation was observed in the written quiz, where attendance exceeded 90%. This strong turnout can be attributed to the quiz's higher weighting in the grading scheme and its administration in a face-to-face, controlled setting. The finding highlights an important implication: students tend to prioritize assessments that carry greater academic value, demonstrating that assessment design directly shapes participation and engagement.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

In comparison, the online pre- and post-quizzes, although still well-attended, recorded slightly lower participation rates, reflecting their relatively lower stakes despite their essential role in reinforcing learning and providing continuous feedback.

Another notable trend was the relatively balanced participation between pre- and post-quizzes. No significant decline was observed between the beginning and end of lectures, suggesting that the lecture design (supported by cyclical pre- and post-assessments) was effective in maintaining student attention throughout the session. This finding indicates that students did not disengage after completing the pre-quizzes but remained motivated to attempt the post-quizzes, thereby validating the effectiveness of the continuous assessment cycle.

Comparable participation patterns have been reported in technical and vocational engineering contexts, where structured feedback and continuous assessment help sustain consistent engagement. In line with this, innovative integrated assessment tools have been shown to promote regular attendance and stable performance outcomes [61]. The present findings therefore reinforce that combining collaborative tutorials, online quizzes, and written evaluations can sustain high levels of participation, even in large-class mathematics settings.

Table 2. Participants' Performance Across Quizzes.

Quiz	% attendance
Pre-quiz 1	80
Post-quiz 1	90
Pre-quiz 2	88
Post-quiz 2	95
Pre-quiz 3	91
Post-quiz 3	87
Pre-quiz 4	85
Post-quiz 4	89
Written quiz	94

4.2. Quiz Performance

The overall average performance across all quizzes was 6.9 out of 10, indicating that students were generally able to engage with and apply the material presented in class. However, as shown in **Table 3**, performance varied across individual assessments, with some quizzes producing higher or lower averages depending on their timing and design. These fluctuations reflect the combined influence of quiz difficulty, cognitive demand, and students' preparedness at different stages of the course.

Table 3. Average marks of participants across quizzes.

Quiz	Average mark
Pre-quiz 1	7.5
Post-quiz 1	6.8
Pre-quiz 2	5.9
Post-quiz 2	7.0
Pre-quiz 3	7.0
Post-quiz 3	6.9
Pre-quiz 4	7.6
Post-quiz 4	7.2
Written quiz	6.3

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

A clear trend emerged in the earlier weeks: pre-quizzes typically yielded higher marks than the corresponding post-quizzes. For instance, the first pre-quiz recorded an average score above 7.5, while the related post-quiz fell below 7.0. This suggests that students were more confident in recalling prerequisite knowledge than in applying newly introduced material during lectures. Such results were expected, as post-quizzes were deliberately designed to be more challenging, thereby promoting deeper engagement with new concepts. At the same time, the decline underscores the importance of careful calibration to ensure that assessments remain demanding enough to encourage persistence without discouraging learners.

In contrast, post-quiz performance showed notable improvement in later weeks. By Week 4, the post-quiz average approached or even exceeded that of the corresponding pre-quiz. This progression indicates that students had adapted to the rhythm of pre- and post-assessments, developed strategies to work more effectively with new material, and demonstrated increasing confidence in applying concepts within the same lecture cycle.

The written quiz, however, recorded the lowest average score (approximately 6.3). Unlike the online assessments, this quiz was completed individually under controlled conditions, without the benefit of peer collaboration or external resources. The lower scores highlight the gap between performance in collaborative settings and independent mastery. While this outcome may seem discouraging, it served a valuable diagnostic purpose by revealing individual accountability and the extent to which group-based learning translated into personal understanding.

These patterns are consistent with prior research. Reciprocal peer tutoring has been shown to produce early fluctuations in performance, with students struggling initially before consolidating their understanding through peer explanation [46]. Similarly, project-based and CDIO-oriented tasks often yield lower early performance before subsequent improvement emerges as students adapt to increasing complexity [48,49]. In line with these findings, the results of this study suggest that performance variations across quizzes are not solely attributable to difficulty level, but also represent the natural process of adaptation to active and collaborative learning environments.

4.3. Failure Rates

Failure rates provide an important perspective on how students adapted to the assessment cycle and whether active learning interventions effectively supported weaker learners. As shown in **Table 4**, the highest failure rate occurred in Pre-quiz 2, where nearly one-third of students (33%) did not achieve a passing score. This sharp increase suggests that many students were still adjusting to the demands of the active learning environment and may not have adequately prepared for prerequisite knowledge checks in the early weeks. It also illustrates the diagnostic power of initial assessments, which often expose foundational gaps most clearly, particularly among students with weaker mathematical backgrounds.

Following this early peak, failure rates declined progressively across subsequent quizzes, stabilizing at around 15-18% in later weeks. This downward trend indicates that students gradually adapted to the continuous assessment cycle and benefited from the reinforcing effect of repeated pre- and post-quizzes, peer-learning tutorials, and group discussions. The consistency of these improvements suggests that sustained exposure to formative assessments enabled at-risk students to narrow the performance gap, demonstrating the positive influence of structured active learning on engagement and incremental mastery.

The written quiz, however, recorded a higher failure rate of 22.5% compared to most online quizzes. This outcome can be attributed to the stricter conditions under which it was

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

conducted, with no peer collaboration, external aids, or immediate feedback available. Unlike the online quizzes, which emphasized reinforcement and group support, the written quiz tested independent mastery under exam-like conditions. While this result may appear concerning, it serves a valuable diagnostic function by highlighting the distinction between performance supported by collaborative environments and performance under individual accountability.

These findings are consistent with prior research showing that reciprocal peer tutoring can initially expose weaknesses before producing long-term gains [45]. Similarly, studies of project-based and CDIO-oriented assessments have observed that lower early performance is often followed by improvement as students adapt to increasing complexity [48,49]. The failure trends observed in this study, therefore, reflect a similar trajectory of initial struggle followed by adaptation and gradual mastery. More importantly, the results emphasize the value of combining low-stakes collaborative assessments with higher-stakes individual evaluations to ensure that students are both supported in their learning and held accountable for their independent progress.

Table 4. Percentage of Failure Across Quizzes

Quiz	% of failure
Pre-quiz 1	3
Post-quiz 1	16
Pre-quiz 2	33
Post-quiz 2	20
Pre-quiz 3	20
Post-quiz 3	17
Pre-quiz 4	14
Post-quiz 4	17
Written quiz	22

4.4. Placement Test Correlation

The placement test, conducted during orientation week, provided a valuable baseline for assessing students' preparedness and its relationship to subsequent quiz performance. As shown in **Tables 5** and **6**, students who passed the placement test were consistently more successful in later assessments: 79% passed the quizzes, while only 21% underperformed. This clear distinction demonstrates the predictive validity of the placement test, confirming its role as an effective early diagnostic tool for identifying students likely to succeed in a continuous assessment environment.

In contrast, students who attended but failed the placement test displayed more mixed outcomes. While 43% of these students improved and passed subsequent quizzes, the majority (57%) continued to struggle. This result highlights that although active learning interventions such as collaborative tutorials and frequent quizzes can help weaker students recover, a significant proportion still face persistent challenges. These findings align with previous research emphasizing that technical and vocational students often encounter barriers when transitioning to advanced coursework without adequate diagnostic feedback [62]. This underscores the importance of using placement tests not merely as a one-off diagnostic, but as a trigger for targeted remedial strategies such as supplemental instruction and structured tutorials.

As further summarized in Table 5, students who passed the placement test demonstrated the highest consistency in subsequent quizzes compared to those who failed or did not attempt the test. Students who did not sit for the placement test achieved a moderate pass rate (64%), but their outcomes were less reliable, suggesting that missing the diagnostic test reduced opportunities for early support. This pattern reflects preparedness challenges frequently documented in engineering education [61] and reinforces the value of early, evidence-based intervention strategies.

These findings are also supported by research highlighting the usefulness of rubric-driven assessment tools for guiding timely support to at-risk learners [50]. By combining placement test results with continuous formative assessments, this study demonstrates how a multi-layered diagnostic framework can both confirm the reliability of baseline testing and provide ongoing opportunities to identify and assist struggling students. More importantly, the framework establishes a mechanism in which early detection is coupled with structured interventions, enabling students not only to adapt but also to progressively close performance gaps.

Table 5. Students' performance before the placement test (PT) and after taking the different quizzes (QZ).

	Attended and passed PT (60%)	Attended but failed PT (12%)	Did not attend PT (28%)
Failed QZ	21%	57%	36%
Passed QZ	79%	43%	64%

Table 6. Comparison Between Students' Performance in the Placement Test (PT) and Quizzes (QZ).

Category	Failed QZ (%)	Passed QZ (%)
Attended and passed PT	20	79
Attended but failed PT	57	43
Did not attend PT	35	65

Finally, this study contributes new insights into mathematics education by confirming the strong predictive relationship between early placement outcomes and subsequent quiz performance, as summarized in **Table 7**.

Table 7. Previous studies on mathematics

No	Title	Ref.
1	Praxeological analysis of international mathematical literacy questions for developing numeracy assessments	[63]
2	Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model	[64]
3	Augmented reality (AR) for geometry based on prior mathematical knowledge	[65]
4	Effect of peer-tutoring strategy on senior secondary school students' achievement in mathematics	[66]
5	Structural equation modelling of factors influencing confidence in mathematics	[67]
6	Efforts to increase the interest of junior high school students in mathematics lessons using the TikTok learning tool	[68]
7	Global research trends of mathematics literacy in elementary school: A bibliometric analysis	[69]
8	How to teach fraction for empowering student mathematics literacy: Definition, bibliometric, and application using digital module	[70]
9	Investigating students' difficulties in numeracy: A focus on linear functions and the tools dimension	[71]
10	Factors that affect the performance of selected high school students from the third district of Albay in International Mathematics Competitions	[72]

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

Table 7 (continue). Previous studies on mathematics

No	Title	Ref.
11	Development Sky Class application to calculate turtle using the concept of number patterns: Preliminary phase	[73]
12	Math readiness and its effect on the online academic performance of science, technology, engineering, and mathematics students	[74]
13	Integration of GeoGebra and web: An innovative solution for guided discovery learning on triangle congruence material to improve conceptual understanding for prospective mathematics teacher students	[75]
14	Unveiling ethnomathematics: Mathematical activities in the Kandala of the Marori Men-Gey tribe	[76]
15	Junior high school students in solving mathematical ill-structured problems: Analyzing using Harel theory	[77]
16	Lower secondary students epistemological obstacle in solving mathematical literacy task: Focus on plane geometry	[78]
17	Enhancing critical thinking in geometry with GeoGebra: A focus on cubes and cuboids	[79]
18	Enhancing elementary students' mathematical representation skills through VBA-based digital learning media in Microsoft Excel	[80]
19	Difficulties encountered by the students in learning mathematics	[81]
20	The development of worksheet based on realistic mathematics assisted by online flipbook	[82]
21	Technology exploration of augmented reality MathCityMap to increase mathematical proficiency	[83]
22	Designing a STEM-RME-based mathematics e-module to enhance high school students' numeracy	[84]
23	Ethnomathematics integration in mathematics classroom: Impacts and insights assisted by ATLAS.ti 23	[85]
24	Teaching basic mathematics and technology to elementary students with autism	[86]

5. CONCLUSION

This six-week study demonstrates that embedding active learning strategies into Engineering Mathematics can significantly enhance student engagement, support performance, and reduce failure rates. The integration of pre- and post-quizzes, collaborative tutorials, and diagnostic testing created a structured learning cycle that not only sustained participation but also provided meaningful insights into student learning trajectories. Key conclusions include:

(i) Sustained engagement: Participation levels remained consistently high, averaging 89%, with no quiz falling below 80%. This highlights the effectiveness of frequent, low-stakes assessments in keeping students actively involved.

(ii) Performance dynamics: Average scores of 6.9/10 revealed meaningful engagement with course material, though performance fluctuated depending on quiz type and timing. Post-quizzes, while more challenging, encouraged deeper application of new concepts and showed improvement over time.

(iii) Failure trends: Failure rates peaked early (33% in Pre-quiz 2) but declined steadily to 15-18% in later weeks, reflecting the adaptive effect of repeated exposure to active learning and peer-supported assessments.

(iv) Predictive diagnostics: Placement test results were strongly correlated with later outcomes of 79% of students who passed the placement test consistently succeeded in quizzes. In contrast, weaker or absent students showed inconsistent progress, underscoring the placement test's value as an early intervention tool.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

From these findings, the following recommendations are proposed:

(i) Balance assessment difficulty: Calibrate post-quizzes to remain challenging yet progressive, ensuring they promote deep understanding without discouraging weaker learners.

(ii) Expand collaborative learning: Strengthen peer-learning structures such as X-space tutorials and reciprocal tutoring, particularly to support students struggling in early assessments.

(iii) Target remedial support: Provide structured follow-up for students failing the placement test or performing poorly in initial quizzes, including remedial tutorials or supplemental instruction.

(iv) Address absenteeism: Implement compulsory diagnostic alternatives for students absent from placement tests to prevent hidden risk factors.

(v) Increase weight of written assessments: As written quizzes revealed the largest performance gap under individual conditions, greater emphasis on these assessments is recommended to ensure accountability and independent mastery.

Future work should extend the analysis across an entire semester to examine long-term impacts on exam performance and knowledge retention. Such evidence will provide stronger guidance for curriculum design, institutional policy, and the broader application of active learning in mathematics-intensive engineering courses.

6. AUTHORS’ NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

7. REFERENCES

[1] Abidin, Z., Herman, T., Wahyudin, W., and Farokhah, L. (2025). Bibliometric analysis using vosviewer with publish or perish of computational thinking and mathematical thinking in elementary school. *ASEAN Journal for Science Education*, *4*(1), 7-16.

[2] Al Husaeni, D.F., Haristiani, N., Wahyudin, W., and Rasim, R. (2024). Chatbot artificial intelligence as educational tools in science and engineering education: A literature review and bibliometric mapping analysis with its advantages and disadvantages. *ASEAN Journal of Science and Engineering*, *4*(1), 93-118.

[3] Anwar, N.B.B., and Minghat, A.D. (2024). Industrial engineering students’ readiness towards industrial revolution 4.0 at technical and vocational university: Literature review. *ASEAN Journal for Science Education*, *3*(1), 95-112.

[4] Arifiani, I., Nurul.H, L., and Rahmawan, S. (2025). Problem based learning (PBL) learning model for increasing learning motivation in chemistry subject: Literature review with bibliometric analysis. *ASEAN Journal for Science Education*, *4*(1), 17-30.

[5] Assem, H.D., Owusu, M., Issah, S., and Issah, B. (2024). Identifying and dispelling students’ misconceptions about electricity and magnetism using inquiry-based learning in selected junior high schools. *ASEAN Journal for Science Education*, *3*(1), 13-32.

[6] Camilon, K.F., Dupitas, J.E.A., Cajandig, A.M.C., Cuba, B.A.A., Valdez, A.G., Abelito, J.T., and Marcella, A.M.A. (2025). Perceptions of senior high school science, technology, engineering, and mathematics (STEM) students toward STEM and non-STEM courses: A comparative qualitative study. *ASEAN Journal for Science Education*, *4*(2), 105-112.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

[7] Fiandini, M., Hofifah, S.N., Ragadhita, R., and Nandiyanto, A.B.D. (2024). How to make a cognitive assessment instrument in the merdeka curriculum for vocational high school students: A case study of generating device materials about the stirling engine. *ASEAN Journal for Science Education*, *3*(1), 65-86.

[8] Fiandini, M., Mukhamedov, G.I., Khimmataliev, D.O., and Nandiyanto, A.B.D. (2025). Advancing sustainability and green engineering in mechanical engineering education: Concepts, research trends, challenges, and implementation strategies. *ASEAN Journal for Science and Engineering in Materials*, *4*(2), 169-224.

[9] Gatchalian, C.B., Handig, J.E.R., and Baluyot, F. (2024). Utilization of visual basic software and its effect on students' computer programming performances. *ASEAN Journal for Science Education*, *3*(2), 155-172.

[10] Glushchenko, V.V. (2024). The paradigm of curriculum differentiation in higher IT education. *ASEAN Journal for Science Education*, *3*(1), 87-94.

[11] Hashim, S., Luta, G.R.A., and Nincarean, D. (2024). Adaptive strategies for technical and vocational education and training (TVET) science educators: Navigating online home-based learning. *ASEAN Journal for Science Education*, *3*(2), 113-128.

[12] Ibrahim, A., Bolaji, H.O., and Abdulraheem, A.J. (2025). Accessibility and utilization of artificial intelligence (AI)-based intelligent tutoring systems (ITS) and information and communication technology (ICT) in enhancing biology education. *ASEAN Journal for Science Education*, *4*(2), 93-104.

[13] Ibrahim, I.M., Suryadi, K., Darmawan, C., and Nurbayani, S. (2024). Examining climate change issues for improving cross-generation awareness in 21st century agenda: A bibliometric approach. *ASEAN Journal for Science Education*, *3*(2), 173-182.

[14] Kamraju, M. (2025). The ethical and educational implications of greenwashing in corporate sustainability practices. *ASEAN Journal for Science Education*, *4*(1), 45-52.

[15] Lasisi, A.K., Hassan, A.A., and Abdulkareem, H.B. (2024). Impact of single parenting on academic performance of junior secondary school students in mathematics. *ASEAN Journal for Science Education*, *3*(2), 129-138.

[16] Muhayyo, D., and Muhabbat, H. (2024). Towards designing technology for classroom role-play. *ASEAN Journal for Science Education*, *3*(2), 139-154.

[17] Nelvarina, N., Agustina, T.W., and Solikha, M. (2024). Can the inquiry learning model improve students' system thinking skills?. *ASEAN Journal for Science Education*, *3*(1), 55-64.

[18] Nordin, N.A.H.M. (2022). Correlation between process engineering and special needs from bibliometric analysis perspectives. *ASEAN Journal of Community and Special Needs Education*, *1*(1), 9-16.

[19] Ogundele, A.G., Umar, I.Y., and Idris, A.M. (2025). The emergence of new technologies in metalwork/automobile industries: Issues, challenges and opportunities in emanating from for delivery of technical education on a pandemic era. *ASEAN Journal for Science Education*, *4*(1), 1-6.

[20] Padmore, E.A., and Ali, C.A. (2024). Exploring effective differentiated instruction in the teaching and learning of mathematics. *ASEAN Journal for Science Education*, *3*(1), 41-54.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

[21] Pratiwi, D.T., Zahratunnisa, F., and Rahmawan, S. (2025). The impact of project-based learning (PjBL) on students' motivation and learning outcomes: A literature review. *ASEAN Journal for Science Education*, *4*(1), 53-58.

[22] Rahmiyanti, H. (2024). Bibliometric analysis on artificial intelligence research in Indonesia vocational education. *ASEAN Journal for Science Education*, *3*(2), 183-192.

[23] Saadu, U.T., Obafemi, K.E., Olaniyan, A.O., Sulyman, H.T., Ajayi, O., and Abubakar, A.Y. (2024). Retaining female students in school: Intervention for improving menstrual hygiene. *ASEAN Journal for Science Education*, *3*(1), 33-40.

[24] Saidirasilovna, U.N. (2025). Preparing future geography teachers through problem-based learning technology: A short review. *ASEAN Journal for Science Education*, *4*(1), 39-44.

[25] Salman, A.A., and Yahaya, O. (2025). Perception of early childhood education lecturers on the use of virtual learning. *ASEAN Journal for Science Education*, *4*(1), 31-38.

[26] Shinde, S.M., and Shinde, M.B. (2025). Integrating TPACK for soft skills and communication in engineering education: Definition, concept, strategies, challenges, and opportunities. *Indonesian Journal of Multidiciplinary Research*, *5*(1), 1-20.

[27] Sulyman, H.T., Salaudeen, M., and Jimoh, F.A. (2025). Effect of preparatory homework on pupils' academic performance in basic science. *ASEAN Journal for Science Education*, *4*(2), 85-92.

[28] Susilawati, A. (2024). A bibliometric analysis of global trends in engineering education research. *ASEAN Journal of Educational Research and Technology*, *3*(1), 103-110.

[29] Susilawati, A., Al-Obaidi, A.S.M., Abduh, A., Irwansyah, F.S., and Nandiyanto, A.B.D. (2025). How to do research methodology: From literature review, bibliometric, step-by-step research stages, to practical examples in science and engineering education. *Indonesian Journal of Science and Technology, 10*(1), 1-40.

[30] Vicera, W.J.C. (2025). Development and validation of CalTech (calculator techniques) exercises manual. *ASEAN Journal for Science Education*, *4*(2), 59-64.

[31] Villavecencio, R.D., Layno, P.J.S., Tumangday, B.T., Estrella Jr, A.D., Mailla Jr, F.A., Abusama, H.P., Mecida, S.V., and Valdez, D.M. (2025). Utilization of dynamic visualization tools: Enhancing students' motivation and engagement in biology education. *ASEAN Journal for Science Education*, *4*(2), 65-84.

[32] Wahyudi, W., Setiawan, A., Suhandi, A., and Samsudin, A. (2024). Technology-supported project-based learning: Trends, review and future research in science, technology and engineering education. *ASEAN Journal of Science and Engineering*, *4*(1), 119-126.

[33] Rahman, A. A., Kaniawati, I., Riandi, R., Hendayana, S., and Rahman, T. (2024). Low-cost Arduino to foster the engineering design process in STEM education. *Journal of Engineering Science and Technology, 19*, 35–42.

[34] Fiandini, M., Nandiyanto, A. B. D., and Muktiarni, M. (2024). Experimental demonstration for teaching the concept of steam engine power plant to vocational students to support the sustainability development goals (SDGs) and its comparison to Indonesian Merdeka curriculum. *Journal of Engineering Science and Technology, 19*(5), 1878–1905.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

[35] Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education, 93*(3), 223–231.

[36] Kajander, A., and Lovric, S. (2009). Transition from secondary to tertiary mathematics: McMaster University experience. *International Journal of Mathematical Education in Science and Technology, 40*(7), 927–944.

[37] Johnson, D., Johnson, R., and Smith, K. (1998). Cooperative learning returns to college: What evidence is there that it works? *Change: The Magazine of Higher Learning, 30*(4), 26–35.

[38] Michael, J. (2006). Where's the evidence that active learning works? *Advances in Physiology Education, 30*(4), 159–167.

[39] Felder, R. M., and Brent, R. (2009). Active learning: An introduction. *ASQ Higher Education Brief, 2*(4), 1–5.

[40] Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., and Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111*(23), 8410–8415.

[41] Mills, J., and Treagust, D. (2003). Engineering education – Is problem-based or project-based learning the answer? *Australasian Journal of Engineering Education, 3*(2), 2–16.

[42] Engelbrecht, J., Harding, A., and Potgieter, M. (2005). Undergraduate students' performance and confidence in procedural and conceptual mathematics. *International Journal of Mathematical Education in Science and Technology, 36*(7), 701–712.

[43] Ferreira, C., Gabriel, B., Valente, R., and Figueiredo, C. (2024). Engineering education challenges and strengths: Reflecting on key-stakeholder's perspectives. *Frontiers in Education, 9,* 1297267.

[44] Al-Obaidi, A. S. M. (2025). A bibliometric review of publications in the Journal of Engineering Science and Technology (JESTEC) (2009–2025). *ASEAN Journal of Educational Research and Technology, 4*(3), 267–294.

[45] Tien, D. T. K. (2019). The positive effect of peer feedback in an engineering group project. *Journal of Engineering Science and Technology, Special Issue 1/2019,* 57–66.

[46] Zulkifli, N. N., Abd Halim, N. D., and Yahaya, N. (2018, November). The impact of online reciprocal peer tutoring on students' academic performance. *Journal of Engineering Science and Technology, Special Issue on i-CITE 2018,* 10–17.

[47] Cheong, A. C. H., and Sivanesan, S. (2022, May). To evaluate the collaboration competency in engineering education by using computer support collaboration learning (CSCL) method. *Journal of Engineering Science and Technology, Special Issue on SIET2022,* 1–11.

[48] Al-Atabi, M. (2011, April). CDIO curriculum for mechanical engineering undergraduate programme. *Journal of Engineering Science and Technology, 6*(2), 251–259.

[49] Al-Atabi, M., and Chin, S. B. (2007, December). A case study in project-based learning using flow visualisation. *Journal of Engineering Science and Technology, 2*(3), 290–297.

[50] Ana, A., Yulia, C., Jubaedah, Y., Muktiarni, M., Dwiyanti, V., and Maosul, A. (2020, December). Assessment of student competence using electronic rubric. *Journal of Engineering Science and Technology, 15*(6), 3559–3570.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

[51] Subekti, S., Ana, A., and Astuti, T. (2021, February). E-rubric to measure employability skills. *Journal of Engineering Science and Technology, 16*(1), 852–859.

[52] Gallagher, T., Slof, B., van der Schaaf, M., Toyoda, R., Tehreem, Y., Fracaro, S. G., and Kester, L. (2024). Reference frames for learning analytics dashboards: The progress and social reference frame and occupational self-efficacy. *Journal of Computer Assisted Learning, 40*(3), 816–832.

[53] Christensen, R. B., Jensen, T., and Madsen, K. (2023). Transforming first-year calculus with field-specific problems. *arXiv, 2302*, 05904.

[54] Grizzle, J. (2025). Calculus for the modern engineer: Putting the joy back in learning advanced mathematics. *arXiv, 2501*, 10406.

[55] Ryan, O., Sajadi, S., Barrera, S., and Jaghargh, R. T. (2025, January). Understanding the effects of a math placement exam on Calculus 1 enrollment and engineering persistence. *Education Sciences, 15*(2), 154.

[56] Christensen, O., Dahl, C. M., and Fajstrup, L. (2023, February). Field-specific calculus courses for engineering students: Increasing relevance through contextualized problems. *arXiv Preprint*, *2302*, 05904.

[57] Christensen, R. B., Dahl, B., and Fajstrup, L. (2023, February). Transforming first-year calculus teaching for engineering students – Blocks with field specific examples, problems, and exams. *arXiv Preprint*, 2302, 05904.

[58] Ziatdinov, R., and Valles, J. (2022). Synthesis of modeling, visualization, and programming in GeoGebra as effective STEM teaching. *arXiv, 2202*, 01415.

[59] Rahma, Q. Z., Rohendi, D., Yayat, Y., and Morin, S. (2025, June). Enhancing engineering math understanding for mechanical engineering education students via Van Hiele phases and GeoGebra. *Journal of Mechanical Engineering Education, 12*(1), 31–40.

[60] Ruslau, M. F. V., Dadi, O., and Nurlianti. (2025, April). The impact of GeoGebra AR on students' geometric thinking based on Van Hiele theory. *Journal of Honai Math, 8*(1), 115–128.

[61] Noaman, N. M. (2024, April). Innovative Excel-based assessment system: Enhancing student outcomes in engineering education. *Journal of Engineering Science and Technology, 19*(2), 648–669.

[62] Mustapha, R., Rahim, Z. L. A., and Azman, M. N. A. (2014, December). Exploring the problems faced by technical school students in learning engineering courses. *Journal of Engineering Science and Technology, 9*(6), 690–701.

[63] Aisyah, A., Priatna, N., Juandi, D., and Priatna, B. A. (2025). Praxeological analysis of international mathematical literacy questions for developing numeracy assessments. *Journal of Engineering Science and Technology, 20*(3), 33–40.

[64] Akinoso, S.O. (2023). Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model. *Indonesian Journal of Educational Research and Technology*, *3*(1), 79-90.

[65] Angraini, L. M., Kusuma, D. A., Wahyuni, R., Susilawati, A., and Reza, D. (2025). Augmented reality (AR) for geometry based on prior mathematical knowledge. *Journal of Engineering Science and Technology, 20*(2), 182–189.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

[66] Awofala, A.O.A., and Agbolade, F.O.O. (2024). Effect of peer-tutoring strategy on senior secondary school students' achievement in mathematics. *ASEAN Journal for Science Education*, *3*(1), 1-12.

[67] Bendol,R.L., and Dalayap Jr., R.H. (2025). Structural equation modelling of factors influencing confidence in mathematics. *ASEAN Journal of Educational Research and Technology*, *4*(2), 107-124.

[68] Dermawan, R., Muktiarni, M., and Mupita, J. (2022). Efforts to increase the interest of junior high school students in mathematics lessons using the tik tok learning tool. *ASEAN Journal for Science Education*, *1*(2), 81-88.

[69] Farokhah, L., Herman, T., Wahyudin, W., and Abidin, Z. (2024). Global research trends of mathematics literacy in elementary school: A bibliometric analysis. *Indonesian Journal of Educational Research and Technology*, *4*(3), 279-290.

[70] Farokhah, L., Herman, T., Wahyudin, W., Khasanah, L.A.I.U., Zulfadhli, M., Abidin, Z., Huda, M.M., and Ariffiando, N.F. (2025). How to teach fraction for empowering student mathematics literacy: Definition, bibliometric, and application using digital module. *ASEAN Journal of Science and Engineering*, *5*(1), 77-102.

[71] Inayah, S., Darhim, D., Prabawanto, S., Jupri, A., and Septiani, S. (2025). Investigating students' difficulties in numeracy: A focus on linear functions and the tools dimension. *Journal of Engineering Science and Technology, 20*(2), 150–157.

[72] Jose, M.T.N.S. (2022). Factors that affect the performance of selected high school students from the third district of Albay in International Mathematics Competitions. *ASEAN Journal for Science Education*, *1*(1), 9-16.

[73] Kania, N., Kusumah, Y. S., Dahlan, J. A., and Nurlaelah, E. (2024). Development Sky Class application to calculate turtle using the concept of number patterns: Preliminary phase. *Journal of Engineering Science and Technology, 19*, 85–93.

[74] Lagcao, Y.G.D., Dechavez, J.P.A.D., Goleng, D.J.G., Lagca, Y.G.D., Tangkli, K.Y.M., and Vicera, W.J.C. (2023). Math readiness and its Effect on the online academic performance of science, technology, engineering, and mathematics students. *ASEAN Journal for Science Education*, *2*(1), 33-38.

[75] Maizora, S., Suryadi, D., Juandi, D., Dasari, D., and Muchlis, E. E. (2025). Integration of GeoGebra and web: An innovative solution for guided discovery learning on triangle congruence material to improve conceptual understanding for prospective mathematics teacher students. *Journal of Engineering Science and Technology, 20*(3), 25–32.

[76] Marlissa, I., Turmudi, T., Juandi, D., and Wahyudin, W. (2025). Unveiling ethnomathematics: Mathematical activities in the Kandala of the Marori Men-Gey tribe. *Journal of Engineering Science and Technology, 20*(3), 121–128.

[77] Morin, S., Suryadi, D., Prabawanto, S., and Sulistiyo, D. (2025). Junior high school students in solving mathematical ill-structured problems: Analyzing using Harel theory. *Journal of Engineering Science and Technology, 20*(3), 1–8.

[78] Murni, S., Suryadi, D., and Prabawanto, S. (2025). Lower secondary students epistemological obstacle in solving mathematical literacy task: Focus on plane geometry. *Journal of Engineering Science and Technology, 20*(3), 49–56.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045

[79] Nurhikmayati, I., Darhim, D., Dahlan, J. A., and Prabawanto, S. (2025). Enhancing critical thinking in geometry with GeoGebra: A focus on cubes and cuboids. *Journal of Engineering Science and Technology, 20*(3), 65–72.

[80] Payung, Z., Kusumah, Y. S., Mulyaning, E. C., and Avip, B. (2025). Enhancing elementary students' mathematical representation skills through VBA-based digital learning media in Microsoft Excel. *Journal of Engineering Science and Technology, 20*(3), 137–144.

[81] Radiamoda, A.A. (2024). Difficulties encountered by the students in learning mathematics. *Indonesian Journal of Educational Research and Technology*, *4*(1), 63-70.

[82] Rahmawati, I., Sa'dijah, C., Hidayat, A., Subanji, S., Susilawati, A. (2025). The development of worksheet based on realistic mathematics assisted by online flipbook. *Journal of Engineering Science and Technology*, *20*(3), 81-88.

[83] Rohimah, S. M., Putri, S. A., Nurdiansah, Y., and Supriyadi, E. (2024). Technology exploration of augmented reality MathCityMap to increase mathematical proficiency. *Journal of Engineering Science and Technology, 19*(5), 1990–2002.

[84] Saputri, V., Kusumah, Y. S., Turmudi, T., and Jupri, A. (2025). Designing a STEM-RME-based mathematics e-module to enhance high school students' numeracy. *Journal of Engineering Science and Technology*, *20*(3), 177-184.

[85] Supriyadi, E., Turmudi, T., Dahlan, J. A., and Juandi, D. (2024). Ethnomathematics integration in mathematics classroom: Impacts and insights assisted by ATLAS.ti 23. *Journal of Engineering Science and Technology, 19*, 67–74.

[86] Triwahyuningtyas, D., Hudha, M. N., Tyas, D. A., Widiaty, I., Nandiyanto, A. B. D., Permanasari, A., and Hamidah, I. (2020). Teaching basic mathematics and technology to elementary students with autism. *Journal of Engineering Science and Technology*, *15*(3), 1589-1595.

DOI: https://doi.org/10.17509/ijost.v11i2.89683
p- ISSN 2528-1410 e- ISSN 2527-8045