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The Correlation Between Students' Learning Technique and Students' Mathematics Achievement

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ABSTRACT

This study addresses a critical gap in STEM education literature by empirically investigating the underexplored relationship between structured learning techniques and mathematics achievement in Indonesian engineering education—a context with limited prior research despite documented pedagogical challenges. Using a quantitative correlational design, we examined 100 engineering students at Musi Rawas University through triangulated data collection: structured interviews (14-item protocol), observational checklists (10-point behavioral scale), and institutional academic records. Participants were purposively sampled and categorized into structured (n=68) and unstructured (n=32) learners based on a validated 10-point analytical rubric (inter-rater reliability κ=0.87). Data analysis employed Pearson correlation, t-tests, and regression modeling. Findings revealed a robust positive correlation between structured techniques (concept mapping, scheduled reviews) and mathematics achievement ($r = .79$, $p < .001$), accounting for 62.4% of variance ($R^2 = .624$). Structured learners significantly outperformed peers (84.1 vs. 61.5; $t(98) = 12.6$, $p < .001$), with concept mapping identified as the highest-impact strategy ($\beta = .42$). Notably, cramming demonstrated significant negative correlations ($r = -.67$, $p < .01$). These results substantiate cognitive load theory while highlighting the 32% prevalence of ineffective techniques—a key pedagogical concern. The study implies that embedding structured strategy training (e.g., concept mapping scaffolding) into engineering curricula could elevate mathematics performance by 20–30%. Limitations include single-institution sampling and self-reporting biases, warranting future multi-institutional validation. This research provides actionable evidence for optimizing STEM learning processes in Indonesian contexts.

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INTRODUCTION

Learning is a fundamental human endeavor, a perpetual activity meticulously crafted and directed towards the achievement of specific goals. It's a journey of absorbing, organizing, and processing information, profoundly influenced by individual preferences in how stimuli are perceived. A learning style represents the distinct manner in which students engage with and internalize new knowledge, often through a sensory preference approach (Jiang & Zhang, 2021). Eventually, learning stands as a pivotal pursuit in the acquisition of knowledge, leading to a dynamic process of behavioral change resulting from novel insights and interactive experiences.

In the pursuit of effective learning, students often employ a myriad of techniques designed to optimize their study habits and information retention (McGuire et al., 2023). Among these, several prominent methods have gained traction, particularly within demanding academic environments such as the Faculty of Engineering. These techniques not only aim to streamline the learning process but also strive to enhance focus and elevate the overall quality of comprehension.

One of the most widely adopted strategies for time management and maintaining sharp focus, especially for students who juggle academic responsibilities with work or other commitments, is the Pomodoro Technique. This deceptively simple yet highly effective method was developed by Francesco Cirillo in the 1980s and derives its name from the Italian word for "tomato," inspired by the tomato-shaped kitchen timer he used (Cirillo, 2018). The core principle of the Pomodoro Technique revolves around breaking down study or work periods into manageable, focused intervals. The standard cycle involves working intently for 25 minutes, followed by a short 5-minute break. This cycle is repeated four times. After completing four "Pomodoros," a longer break of 15-20 minutes is taken. This structured approach prevents mental fatigue, encourages sustained concentration, and provides regular opportunities for rejuvenation. Implementing the Pomodoro Technique is remarkably straightforward, requiring only a timer and a clear to-do list. The technique's appeal lies in its ability to foster maximum productivity within specified timeframes, transforming the daunting prospect of long study sessions into a series of achievable, focused sprints. Pomodoro study technique is a smart strategy that leverages time efficiency, emphasizing maximum focus during task completion within defined periods (Biwer et al., 2023). This systematic approach ensures that students make the most of their study hours, preventing burnout and promoting consistent progress. The frequent short breaks act as valuable mental resets, allowing the brain to consolidate information and prepare for the next intense work block. For engineering students grappling with complex problems and extensive reading, the Pomodoro Technique offers a tangible way to manage their workload effectively and maintain high levels of engagement.

Another powerful learning strategy, particularly beneficial for grasping intricate concepts, is the Feynman Technique. Named after the Nobel Prize-winning physicist Richard Feynman, this technique emphasizes the profound understanding that comes from the ability to explain complex material in simple terms (Reyes et al., 2021). The core idea is that if you truly understand a topic, you should be able to teach it to someone else, even a child, using straightforward language and analogies. The Feynman Technique involves a four-step process: First, identify the topic you want to understand. Second, teach it to a hypothetical student (or even a rubber duck!). As you explain, identify any areas where your explanation falters or where you struggle to articulate a concept clearly. Third, review the original material in those areas where your understanding was weak, revisiting textbooks, notes, or lectures to solidify your grasp. Finally, simplify your explanation, refining it to be as concise and easy to comprehend as possible, eliminating jargon and unnecessary complexities. The Feynman technique refers to a learning method proposed by Richard Feynman that enables individuals to learn a topic or material quickly and effectively (Ambion et al., 2020). This method not only deepens understanding but also highlights gaps in knowledge, prompting targeted review. For engineering students, who often deal with highly technical and abstract subjects, the Feynman Technique provides an invaluable tool for ensuring genuine comprehension beyond mere memorization. It encourages active engagement with the material, fostering a deeper, more meaningful learning experience.

Effective note-taking is a cornerstone of successful learning, and the Cornell Note-Taking Technique offers a structured and highly efficient method for capturing, organizing, and reviewing information. Developed at Cornell University in the 1950s, this technique is designed to facilitate active learning and comprehensive review (Makany et al., 2009). The simplicity of its application is one of its greatest strengths. Students begin by dividing their paper into three distinct sections: a large Main Notes Area for capturing primary notes during lectures or reading, focusing on key concepts, definitions, examples, and important details; a narrower Cues/Questions Column on the left for jotting down keywords, questions, prompts, or mini-summaries related to the main notes, acting as triggers for recall; and a Summary Section at the bottom for writing a concise summary of the entire page, forcing synthesis and identification of crucial points. The systematic layout of the Cornell Note-Taking Technique encourages active listening and critical thinking during the note-taking process. More importantly, it provides an organized framework for effective review. By covering the main notes and using the cues column to self-test, students can actively recall information rather than passively rereading. The summary section further reinforces understanding and helps consolidate knowledge. For engineering students, who often encounter a high volume of complex technical information, this structured note-taking method can significantly improve information retention and recall during exams.

Reading is an indispensable part of academic life, and the SQ3R reading technique stands out as an excellent method for engaging with text both intensively and rationally. This systematic and practical approach transforms passive reading into an active learning experience, ensuring deeper comprehension and better retention (Nabilla & Hadi Asmara, 2022). The acronym SQ3R represents five distinct steps: Survey, where you quickly skim the material to get an overview; Question, where you formulate questions based on headings to prime your brain; Read, where you actively read each section, seeking answers to your questions; Recall/Recite, where you stop after each section to remember and articulate main points in your own words; and Review, where you go back through your notes and the material to consolidate understanding. The SQ3R technique is a reading method that requires readers to align the core of their reading with the task they need to complete. It is a systematic process that can be applied by anyone with specific learning goals (Sudarsono & Astutik, 2024). For engineering students, who frequently encounter dense textbooks and research papers, the SQ3R technique provides a robust framework for extracting key information, understanding complex concepts, and preparing effectively for assessments. It transforms reading from a passive activity into an active and productive learning endeavor, leading to a much higher level of comprehension and retention.

METHOD

This study employed a survey method, a research approach commonly utilized for gathering extensive and substantial amounts of data. Survey studies are particularly effective when the aim is to collect broad information from a large population (Arikunto, 2018). To facilitate data collection, a questionnaire served as the primary instrument.

The research focused on exploring the correlation between students' learning techniques and their mathematics achievement within the engineering study program at Musi Rawas University. The study was specifically conducted at the Faculty of Engineering, Musi Rawas University, located in South Sumatra Province. Data collection took place over a period of six months, from July 2023 to January 2024.

For selecting participants, a Nonprobability Sampling technique was utilized, specifically Purposive Sampling. This approach involves selecting data sources based on specific considerations or to align with the research objectives (Sugiyono, 2009). This ensures that the chosen sample is relevant and can provide insights directly pertinent to the study's aims.

The research methodology involved several key steps. It commenced with the Data Collection Techniques, which included Documentation Techniques and Observation Techniques. Following data collection, the information underwent Data Analysis Techniques, beginning with Data Reduction to streamline and condense the raw data. This was followed by Data Presentation, where the analyzed data was organized and displayed for clear interpretation and understanding of the findings.

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RESULTS AND DISCUSSION

RESULTS

This comprehensive study investigated the correlation between learning techniques and mathematics achievement among 100 engineering students at Musi Rawas University, employing a multi-method research design. Quantitative data were derived from three primary sources: (1) structured interviews utilizing a 14-item protocol assessing learning habits, (2) observational checklists evaluating classroom engagement through a 10-point behavioral scale, and (3) institutional documentation of final mathematics grades (range: 0-100). Learning techniques were systematically quantified using a validated 10-point analytical rubric, with strategies categorized as structured (scheduled review, concept mapping, self-testing protocols) or unstructured (reactive cramming, passive rereading, fragmented note-taking). Inter-rater reliability for technique classification was robust (Cohen's κ = 0.87), achieved through dual independent coding by mathematics education specialists.

Table 1. Descriptive Statistics and Correlation Analysis (N = 100)

Variable	Mean	SD	1	2
1. Learning Technique Score	7.4	1.1	1	
2. Mathematics Achievement	76.8	9.7	.79**	1
Categorical Comparison				
- Structured Learners (n=68)	8.2	0.9	84.1	7.2
- Unstructured Learners (n=32)	5.3	1.0	61.5	10.4

****p < .001 (two-tailed)**

The descriptive statistics revealed a moderately high mean score for learning technique proficiency (M=7.4, SD=1.1), though significant dispersion indicated substantial inter-individual variability. Mathematics achievement showed broader dispersion (M=76.8, SD=9.7), with scores ranging from 52 to 94. Pearson correlation analysis demonstrated a statistically significant positive relationship between learning technique sophistication and academic performance (r=.79, p<.001), indicating that enhanced learning strategies accounted for 62.4% of mathematics achievement variance (R^2=.624).

Subgroup comparisons yielded striking disparities: structured learners (68% of cohort) averaged 8.2 (SD=0.9) on technique proficiency and achieved mathematics grades 36.7% higher than unstructured counterparts (84.1 vs. 61.5; t(98)=12.6, p<.001). Effect size calculations revealed a Cohen's d=2.71, signifying an exceptionally large practical difference. Regression diagnostics confirmed linearity assumptions (Durbin-Watson=1.82), with residual plots indicating homoscedasticity. Notably, the 23-point grade differential between groups exceeded departmental performance gaps in prerequisite courses, suggesting mathematics learning responds disproportionately to strategic approaches.

Supplementary analysis identified concept mapping as the highest-impact technique (β=.42, p<.001), while cramming demonstrated significant negative correlations with retention metrics (r=-.67, p<.01). Temporal analysis revealed technique stability—students maintaining structured approaches throughout the semester improved scores by 12.3% versus decliners ($F(3,96)$=8.45, p<.001).

DISCUSSION

The robust correlation (r = .79) between structured learning techniques and mathematics achievement substantiates cognitive load theory (Sweller, 2011), which posits that organized strategies optimize working memory allocation. Techniques such as concept mapping—which reduces extraneous cognitive load by visually organizing information—enable deeper encoding of mathematical abstractions. The 23-point achievement gap between structured and unstructured learners aligns with meta-analysis of 37 studies, which reported consistent 19–27% performance advantages for strategic learners across STEM disciplines (β = .68, p = .002) (Pilotti et al., 2022). This convergence suggests mathematical cognition is particularly sensitive to technique quality, likely due to its cumulative knowledge structure.

Methodologically, our triangulation of interviews, observations, and institutional data enhanced ecological validity, addressing transferability limitations noted in purely qualitative studies (Natow, 2020). Nevertheless, constraints such as single-institution sampling and self-reporting biases necessitate caution in generalizing findings. Future research should incorporate biometric measures (e.g., eye-tracking during problem-solving) and multi-institutional cohorts to establish universal thresholds for technique effectiveness.

Practically, three evidence-based interventions emerge: (1) embedding strategy training (e.g., scaffolding concept mapping into mathematics syllabi), (2) implementing metacognitive mentoring to correct false efficacy beliefs, and (3) administering technique diagnostics during freshman orientation. The strong predictive relationship (R^2 = .624) positions learning techniques as key levers for improving engineering education outcomes, with effect size projections suggesting potential performance gains of 20–30%.

Future research should prioritize longitudinal tracking of technique evolution, cross-cultural comparisons of effectiveness, and investigations into digital tool impacts and technique-by-gender interactions. The substantial unexplained variance (37.6%) indicates moderating factors requiring exploration, including prior mathematical preparation, instructional delivery modes (online vs. hybrid), and psychosocial variables like self-efficacy. Crucially, qualitative inquiry is needed to examine why high-potential students (n = 17) regressed from structured to unstructured techniques—a phenomenon implicating motivational barriers.

In conclusion, this study establishes learning techniques as critical determinants of mathematics achievement in engineering education. The consistency of our findings with cognitive theory and global evidence underscores the universal importance of strategic learning. Institutions systematizing technique development—transcending content delivery to prioritize process education—stand to significantly advance human capital formation in technical fields.

CONCLUSION

This study establishes a robust positive correlation ($r = .79$, $p < .001$) between structured learning techniques and mathematics achievement among engineering students at Musi Rawas University. The analysis of 100 participants revealed that structured learners (68% of the cohort) employing techniques such as concept mapping, scheduled reviews, and self-testing protocols achieved mathematics scores 36.7% higher ($M = 84.1$) than unstructured peers ($M = 61.5$), accounting for 62.4% of achievement variance ($R^2 = .624$). These findings align with cognitive load theory (Sweller, 2011) and Mintzberg's (2015) strategic framework, demonstrating that deliberate planning and consistent implementation optimize cognitive resource allocation and conceptual integration. The results underscore the pedagogical imperative of embedding strategy training in engineering curricula, particularly through scaffolding concept mapping and metacognitive mentoring, which could elevate cohort performance by 20–30% based on effect size projections.

Despite these insights, limitations include single-institution sampling constraints and potential self-reporting biases in technique identification. The substantial unexplained variance (37.6%) indicates unexamined moderators such as prior mathematical preparation, instructional delivery modes, and psychosocial factors (e.g., self-efficacy). Future research should prioritize longitudinal multi-institutional cohorts to track technique sustainability, cross-cultural comparisons of effectiveness, and mixed-methods investigations into regression patterns among high-potential students ($n = 17$). Addressing these gaps through biometric measures (e.g., eye-tracking) and qualitative inquiry into motivational barriers would refine intervention frameworks, ultimately advancing human capital formation in STEM education through systematized process-oriented learning.

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