Structured Peer Mentoring and Mathematics Achievement among Pre-Diploma Students: A Conceptual Paper

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ABSTRACT

Differences in mathematical preparedness among pre-diploma students highlight the need for academic support responsive to learners' initial capabilities. This conceptual paper develops a framework explaining the proposed relationship between structured peer mentoring and mathematics achievement, with particular attention to initially low-performing students. Grounded in Vygotsky's Sociocultural Theory, the paper adopts a conceptual model-development approach supported by a focused narrative synthesis of eight selected substantive publications from 2018–2026 and foundational theoretical literature. The synthesis integrates mentoring programme characteristics, guided peer interaction and baseline mathematics performance. Structured peer mentoring constitutes the independent variable, mathematics achievement the dependent variable, and Test 1 performance a baseline predictor. Peer explanation, guided practice and feedback are proposed to support the development of independent mathematical understanding within the Zone of Proximal Development. Two propositions address the mentoring–achievement relationship and the association between initial performance and subsequent overall course grades and course passing status. The framework provides a theoretical basis for organising academic support and examining subsequent achievement among pre-diploma students. No student-level analysis or hypothesis testing is undertaken, and the proposed relationships require empirical validation. Future evaluation must distinguish final examination scores from overall course outcomes and establish assessment comparability before interpreting score changes.

Keywords: structured peer mentoring; mathematics achievement; pre-diploma students; sociocultural theory; zone of proximal development; conceptual framework

INTRODUCTION

Pre-diploma education provides a transitional learning environment in which students prepare for diploma-level study. Differences in mathematical knowledge and readiness for independent problem-solving create a need for academic support responsive to learners' initial capabilities. This paper considers pre-diploma mathematics education at Universiti Teknologi MARA Perak Branch, Seri Iskandar Campus as its intended application context, rather than as the setting of an empirical investigation.

The proposed mentoring system draws on existing variation in student achievement. Students performing strongly in Test 1 are considered for mentor roles, while students requiring academic support participate as mentees. Academic mentoring includes organized subject support, follow-up on learning difficulties and guidance in preparing for assessment. Its tutoring component involves explanation and guided practice. This distinction matters because a supportive relationship alone is different from a documented intervention that systematically addresses mathematical misconceptions.

The problem addressed is the need for a coherent theoretical explanation connecting structured peer mentoring, initial mathematics performance and subsequent academic outcomes. Existing research offers evidence from different educational settings, but the studies reviewed do not directly establish these relationships among Malaysian pre-diploma mathematics students. The paper therefore integrates relevant

literature to clarify the proposed relationships without assuming the prevalence or causes of low achievement in the intended context.

Vygotsky's Sociocultural Theory explains how guided interaction can support learning beyond students' current independent capabilities. The conceptual challenge is to connect this explanation with identifiable mentoring practices and clearly defined achievement outcomes while recognising differences in baseline performance. Structured peer mentoring is consequently considered alongside Test 1 (T1) performance, with overall course grades and course passing status identified as outcomes for future evaluation.

This paper aims to conceptualise the relationship between structured peer mentoring and mathematics achievement among pre-diploma students. It also seeks to explain the proposed relationship between initial mathematics performance and subsequent overall course grades and course passing status, particularly among initially low-performing students. Vygotsky's Sociocultural Theory provides the theoretical foundation for explaining these relationships.

The paper addresses two research questions: how can structured peer mentoring support mathematics achievement among pre-diploma students (RQ1), and how is initial mathematics performance conceptually related to subsequent overall course grades and course passing status, particularly among initially low-performing students (RQ2)?

This paper contributes a theoretical framework connecting structured peer mentoring, baseline performance and mathematics achievement. It clarifies how guided interaction may support learning and provides a basis for designing academic support and conducting subsequent empirical evaluation among pre-diploma students.

The paper focuses on structured peer mentoring in pre-diploma mathematics education, with UiTM Perak Branch, Seri Iskandar Campus as the intended application context. Structured peer mentoring is the independent variable, mathematics achievement is the dependent variable, and T1 performance is a baseline predictor. Outcomes for future evaluation comprise overall course grades and course passing status.

LITERATURE REVIEW

Theoretical Foundation

Vygotsky's Sociocultural Theory provides the theoretical foundation for explaining the proposed relationship between structured peer mentoring and mathematics achievement. The theory views learning as a socially mediated process in which knowledge develops through interaction, language and participation in shared activities. Its central concept, the Zone of Proximal Development (ZPD), distinguishes between learners' independent capabilities and the capabilities they can demonstrate with guidance from adults or more capable peers (Vygotsky, 1978).

Within pre-diploma mathematics education, this perspective supports mentoring arrangements in which academically capable students assist peers experiencing learning difficulties. Mathematical explanations, guiding questions and discussion of alternative solutions can help mentees address misconceptions and complete tasks beyond their current independent capabilities. The intended outcome is the development of understanding that students can subsequently apply without assistance.

Scaffolding represents an instructional approach consistent with the ZPD, although the term was not originally introduced by Vygotsky. In the proposed mentoring system, support includes modelling solutions, prompting mathematical reasoning, providing feedback and gradually withdrawing assistance. The theoretical emphasis is therefore on the quality and responsiveness of interaction, rather than the presence of a mentor alone.

This theoretical foundation informs both research objectives. It explains the proposed relationship between mentoring and mathematics achievement under the first objective and the importance of students' initial performance in determining appropriate learning support under the second objective.

Structured Peer Mentoring

Structured peer mentoring is conceptualised as an organised academic support programme involving mentor selection and preparation, scheduled learning sessions, guided mathematics practice, feedback and lecturer monitoring. Its tutoring component addresses subject knowledge, while its mentoring component provides continuing academic guidance. Distinguishing these functions establishes what the intervention involves and how it is expected to support learning.

Zhang et al. (2025) synthesised 27 experimental and quasi experimental studies of peer tutoring in higher education and reported a moderate positive effect on academic performance, with an overall Hedges' g of 0.480. Their findings provide a rationale for incorporating academic tutoring into a mentoring programme. These findings support the tutoring component of the proposed programme, but peer tutoring is not identical to broader mentoring. The pooled result does not establish effectiveness among Malaysian pre-diploma mathematics students.

Programme organisation also requires attention. Guerreiro and de Jesus (2025), reviewing 23 studies, highlighted mentor selection, matching, training and coordination as programme elements requiring clear description and evaluation. Their findings support treating structured mentoring as a defined set of practices rather than a general label for peer assistance. They do not establish that each programme element independently produces better academic outcomes.

Gehreke et al. (2024) reviewed peer mentoring during entry to higher education, focusing on integration, belonging and dropout intention. Their synthesis supports attention to students' transition needs while calling for stronger experimental evaluation. These outcomes are relevant to pre-diploma support but cannot be substituted for mathematics examination achievement. Le et al. (2024) likewise identified academic, retention, wellbeing and social benefits across higher education mentoring research. Together, these reviews broaden the rationale for sustained support without establishing a mathematics-specific effect in the intended Malaysian setting.

Together, these studies inform the proposed independent variable. Structured peer mentoring is expected to create regular opportunities for academic assistance, but its relationship with achievement depends on how mentoring is implemented and how students participate.

Scaffolding and Peer Interaction

Vygotsky's theory explains why mentoring may support achievement through guided interaction. Mentors can make mathematical reasoning explicit, identify errors and adjust assistance to learners' understanding. Support should progressively shift from mentor demonstration towards independent student problem-solving.

Li et al. (2024) examined four mathematics teachers' beliefs and scaffolding practices in cooperative learning. Their findings revealed variation in supervisory and facilitative roles and in the support provided during classroom interaction. This indicates that organising students into groups does not automatically produce effective scaffolding. Applied to peer mentoring, the study supports mentor preparation and lecturer guidance to maintain productive mathematical discussion. However, it did not examine mentoring-related changes in examination performance.

Relational conditions may also shape peer learning. Asare (2025), studying 350 senior high school students in Ghana, reported associations involving peer-assisted learning, self-efficacy and mathematics performance, alongside a moderating role for teacher–student relationships. Although the study drew on Vygotsky's perspective, its questionnaire-based design provides associative evidence rather than evidence of improvement in paired examination scores.

Ortiz Galarza et al. (2026) investigated eight college near-peer mentors supporting informal mathematics learning among school students. Their findings emphasised mentor characteristics and roles supporting students' psychosocial functioning and engagement. This supports considering communication and supportive

interaction alongside academic competence when selecting mentors. Nevertheless, the setting differs from mentoring within a pre-diploma cohort, and the study did not establish effects on final grades or passing status.

The proposed framework therefore identifies dialogue, scaffolding and guided practice as theoretical processes connecting mentoring with achievement. These processes are not treated as measured mediating variables in the present conceptual paper. Self-efficacy and engagement likewise remain contextual considerations because the research objectives focus on mathematics achievement.

Mathematics Achievement

Alegre-Ansuategui et al. (2018) synthesised mathematics peer-tutoring research across educational stages and reported generally favourable academic outcomes. This provides subject-specific support for including explanation and guided practice in the framework. However, the pooled evidence concerns diverse tutoring arrangements and populations; it cannot establish that a broader mentoring programme will improve pre-diploma mathematics results. Its relevance is therefore theoretical and intervention-related rather than direct confirmation of P1.

Mathematics achievement constitutes the dependent variable and refers to students' demonstrated mathematics performance, represented by recorded final examination scores, overall course grades and course passing status. Consistent with the first objective and question, these indicators identify the outcomes that mentoring is proposed to support. The second objective and question concern the relationship between initial performance and subsequent grades and passing status, particularly among initially low-performing students. Within-student score change is a possible measure for future validation where assessment comparability is established.

These indicators represent related but distinct aspects of achievement. Assessment scores indicate numerical performance, grades classify performance within institutional categories, and passing status identifies whether students meet the applicable minimum requirement. Their definitions must remain consistent throughout the manuscript.

Interpretation of score change requires particular care. T1 and the final assessment may differ in content coverage, difficulty and weighting. Expressing both scores as percentages does not independently establish measurement comparability. Furthermore, final examination scores must be distinguished from overall course scores when grades incorporate coursework or other assessments.

Accordingly, improved final outcomes are proposed rather than assumed. Even where future paired records demonstrate improvement, a single-group comparison would not isolate mentoring from regular teaching, revision and other influences on achievement.

Baseline Performance and Subsequent Outcomes

Baseline mathematics performance is represented by T1, administered before mentoring implementation. It serves as an initial achievement measure and a predictor of subsequent outcomes. It is conceptually distinct from structured peer mentoring, which remains the intervention-related independent variable.

From a Vygotskian perspective, initial understanding informs the assistance required during learning. Students with weaker foundational knowledge may require more explicit explanations and repeated guided practice, whereas stronger students may require more challenging tasks and opportunities to articulate their reasoning. However, a total T1 score cannot fully identify a student's ZPD. Assessment errors and responses to assistance provide additional information about learning needs.

This distinction directly addresses the second research question concerning the relationship between initial performance and subsequent overall course grades and course passing status. An association between T1 and final outcomes indicates continuity or variation in achievement; it does not independently establish improvement attributable to mentoring.

For initially low-performing students, future evaluation should describe the proportions who subsequently fail the course, achieve a pass or attain higher course grades. Comparing later outcomes across predefined T1 groups can identify patterns without assuming that all students improve. Such comparisons do not represent movement between equivalent grading scales unless assessment comparability has been established.

P2 has a more limited evidential basis in the selected literature. T1 is included because prior understanding informs the support a student may require and provides a baseline for interpreting later outcomes. The reviewed studies do not directly validate the proposed association between T1 and final course outcomes in the intended cohort. P2 therefore remains a proposition for empirical examination, rather than an established finding. Moreover, T1 scores and later course grades represent different measures unless their comparability is demonstrated.

Literature Synthesis and Research Gap

The eight selected publications provides complementary foundations. Zhang et al. (2025) and Alegre-Ansuategui et al. (2018) inform the academic tutoring component, including mathematics-specific evidence. Guerreiro and de Jesus (2025), Gehreke et al. (2024) and Le et al. (2024) inform programme organisation and the broader transition-support role of mentoring in higher education. Li et al. (2024), Asare (2025) and Ortiz Galarza et al. (2026) inform instructional and relational processes relevant to peer-supported mathematics learning. These sources are integrated according to their distinct contributions, rather than treated as interchangeable evidence of a single intervention effect.

However, these studies differ in educational level, intervention design and outcome measurement. Collectively, they do not directly establish how a structured mentoring system relates to comparable assessment changes, final grades and passing status among Malaysian pre-diploma mathematics students. The conceptual gap addressed here is the integration of programme structure, Vygotskian learning processes and baseline achievement within a coherent explanation of subsequent mathematics outcomes.

The framework makes two distinctions central to the research objectives and questions: the proposed relationship between mentoring and mathematics achievement, and the relationship between initial performance and subsequent outcomes. This prevents baseline achievement from being confused with the intervention and prevents observed improvement from being interpreted automatically as a mentoring effect.

Together, the tutoring and mentoring literature supports the rationale for P1, while the scaffolding literature explains the proposed learning processes. Evidence from higher education is relevant to programme design, and mathematics studies inform subject specific activities. Their different populations and outcomes restrict direct transfer to pre-diploma education. Baseline performance is retained as a separate predictor under P2, whose proposed relationship requires direct student-level testing.

Conceptual Framework and Propositions

The proposed framework positions structured peer mentoring as the independent variable and mathematics achievement as the dependent variable. T1 performance is included as a baseline predictor of final outcomes. Vygotsky's Sociocultural Theory provides the overarching explanation through social interaction, scaffolding and the development of independent mathematical understanding.

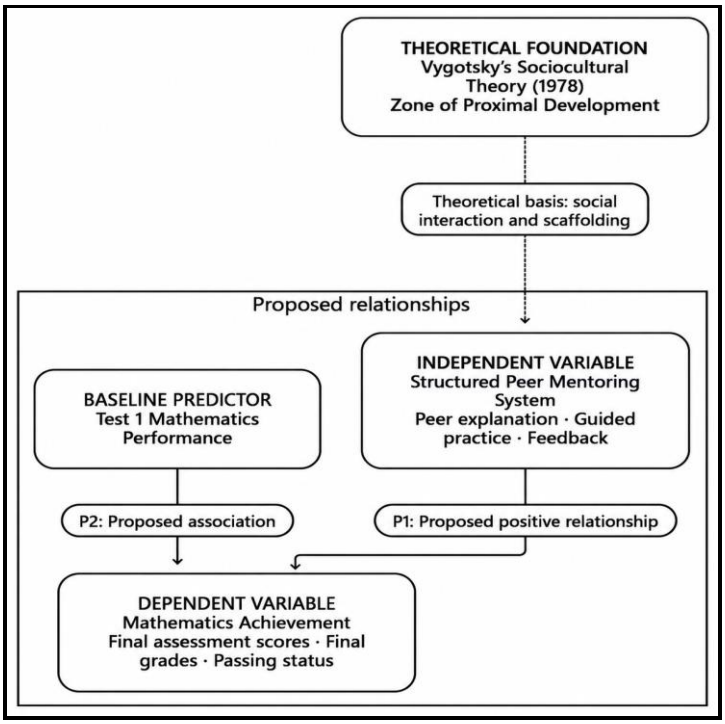
For the conceptual paper, these relationships are expressed as propositions:

P1: Participation in structured peer mentoring is proposed to be positively associated with subsequent mathematics achievement, accounting for initial mathematics performance. Guided peer interaction and scaffolding within the Zone of Proximal Development provide the theoretical explanation for this relationship.

P2: Initial mathematics performance is proposed to be associated with subsequent overall course grades and course passing status, including the distribution of outcomes among initially low-performing students.

P1 addresses the first objective and research question concerning the proposed mentoring–achievement relationship. P2 addresses the second objective and question concerning initial performance and subsequent overall course grades and course passing status. Both propositions require empirical validation; this paper develops their theoretical justification rather than estimating or testing the relationships.

Figure 1 Structured peer mentoring framework linking baseline performance and mathematics achievement



Note. Arrows indicate proposed relationships, not estimated effects. P1 links structured peer mentoring to mathematics achievement through theoretically specified learning processes. P2 links T1 performance to subsequent overall course grades and course passing status. Guided interaction and scaffolding are explanatory processes, not empirically established mediators. Final examination marks and overall course outcomes must be recorded separately.

METHODOLOGY

This paper adopts a conceptual model-development approach informed by a focused narrative synthesis. Drawing on Jaakkola's (2020) guidance on conceptual research, it integrates literature on structured peer mentoring and mathematics achievement, with Vygotsky's (1978) Sociocultural Theory providing the explanatory foundation. Eight substantive publications from 2018 to 2026 were purposively selected for their relevance to peer-supported mathematics learning and mentoring in higher education. The synthesis supports construct definition and proposition development without claiming the comprehensive coverage of a systematic review or the statistical aggregation of a meta-analysis.

The publications are considered according to their relevance to peer-supported academic learning, mentoring programme organisation and mathematics learning processes. Studies from higher education and school settings provide complementary perspectives, although differences in populations and interventions limit their direct applicability to pre-diploma students. Foundational literature establishes the theoretical concepts, while recent publications inform their application to the proposed mentoring framework.

The analysis compares the selected publications in terms of educational context, intervention characteristics, research design and achievement measures. Particular attention is given to distinguishing peer tutoring from broader mentoring support and separating reported associations from intervention effects. This critical comparison identifies relevant patterns while preserving the methodological boundaries of the original studies.

The literature is synthesised to define the principal constructs and establish the theoretical logic of their relationships. Structured peer mentoring constitutes the independent variable, mathematics achievement the dependent variable, and Test 1 performance a baseline predictor. Peer explanation, guided practice and feedback are interpreted as learning processes consistent with the Zone of Proximal Development. These processes explain the proposed relationship rather than constitute measured mediating variables.

Framework development links the constructs through two propositions. The first proposes that structured peer mentoring supports mathematics achievement through guided interaction and scaffolding. The second proposes an association between initial mathematics performance and subsequent overall course grades and course passing status, particularly among initially low-performing students. Each proposition is aligned with the corresponding research objective and question to maintain consistency across the manuscript.

No student-level analysis or statistical hypothesis testing is conducted. The methodological contribution is the development of an explicit, theory-informed framework for future empirical validation. Such validation would require documented mentoring implementation, authenticated assessment records and clearly defined grading criteria. Interpretation of changes between Test 1 and final assessment scores would additionally depend on assessment comparability.

Proposed implementation protocol

This procedure is proposed for future use and has not been tested in this paper. Before mentoring begins, the lecturer should set the topics, schedule, number of mentees per mentor, materials and criteria for additional support. T1 should be administered before mentoring. Mentors should be selected based on T1 results, accurate explanations, communication skills and willingness to participate. Mentees should be matched according to learning needs and availability. Selection criteria and changes should be recorded.

Mentors should be trained to explain solutions, identify difficulties, provide feedback, correct misunderstandings and seek lecturer assistance. Each session could include a short understanding check, mentor demonstration, guided practice, mentee explanation and an independent task. Support should gradually decrease as students become more independent. These proposed steps apply scaffolding and require evaluation.

Session records should document attendance, duration, topics, completed tasks, errors, feedback and follow-up actions. The lecturer should review records and observe selected sessions using a common checklist to correct explanations and adjust support. Evaluation should check whether planned sessions occurred, activities were completed and feedback was provided. Attendance alone does not demonstrate engagement or learning.

Outcome definitions and assessment comparability

Future evaluation should separately record each student's T1 and final examination marks, maximum possible marks, coursework marks and weights, overall course score, official grade and passing status. Overall scores and passing decisions should follow institutional rules, including any minimum examination requirement. Passing the course does not automatically qualify a student for diploma progression, as other requirements may apply. Before comparing T1 and final examination scores, researchers should check whether their content, thinking skills assessed, marking criteria, difficulty and testing conditions are comparable. Converting marks to percentages does not make the assessments equivalent. If they differ substantially, scores should be reported separately rather than interpreted as improvement. Future studies could use comparable pre- and post-mentoring tests based on the same assessment plan, with some common questions and checks to ensure consistent standards.

Proposed empirical evaluation

Future research should use student codes to link assessment results with mentoring participation. Institutional ethics approval and relevant permissions should be obtained, and the analysis plan should be prepared before examining outcomes. Researchers should document recruitment, mentor and mentee roles, sample size,

missing data and withdrawals. Mentors and mentees should be analysed separately because selection based on T1 results creates differences in initial achievement. A justified T1 cut-off should be set in advance to identify low-performing students. Records linking student codes to identities should be stored securely and separately from the analysis data.

When assessments are comparable, changes in individual scores may be analysed using a paired-samples t-test or a suitable alternative, such as the Wilcoxon signed-rank test. Results should report the size of the change, confidence intervals and effect sizes. If T1 and final examinations are not comparable, researchers should examine final examination performance using T1 as a baseline predictor rather than interpret score differences as learning gains. Final examination marks should be reported separately from overall course grades and course passing status. If T1 forms part of the overall course score, this overlap should be considered when interpreting P2.

To examine P1, future studies should compare students receiving mentoring with a suitable comparison group while accounting for initial achievement. Random assignment is preferable when feasible and ethical. Otherwise, a quasi-experimental design should address differences in participant selection and other factors that may affect outcomes. Regression analysis may examine the relationship between mentoring participation and achievement while adjusting for T1 performance and, where appropriate, grouping within mentors or classes. Findings should be interpreted cautiously because participation may also reflect students' motivation or support needs.

To examine P2, researchers should report overall course grades and pass rates across predefined T1 performance groups, focusing particularly on initially low-performing mentees. Results should show the proportions who fail, pass or achieve higher grades. These comparisons describe how initial performance relates to later outcomes; they do not necessarily indicate improvement between equivalent assessments. Differences in mentoring participation and missing data should also be considered. A study involving only one group cannot establish that mentoring caused improvement, as regular teaching, revision and other factors may also influence achievement.

LIMITATIONS AND FUTURE RESEARCH

This conceptual paper proposes a framework for structured peer mentoring but does not provide original student data to demonstrate its effectiveness. Neither proposition has been statistically tested. The narrative synthesis draws on eight selected publications and foundational theoretical literature. Although relevant to the framework, these sources do not represent a comprehensive review of all available evidence.

Differences in educational settings, mentoring approaches and assessment methods also limit their application to Malaysian pre-diploma students. Sources were purposively selected, no systematic search, independent screening, formal assessment of study bias or statistical pooling was undertaken. The selected evidence does not directly establish programme effectiveness in the intended Malaysian pre-diploma setting.

The proposed mentoring programme requires preliminary testing and adaptation to the intended setting. Differences in content, difficulty, marking and weighting between T1 and final assessments may affect the interpretation of score changes, even when both are expressed as percentages. Overall course grades must also be distinguished from final examination marks because they may include T1 and coursework. Differences in attendance, mentoring quality and access to other academic support may influence student outcomes.

Future research should test the proposed mentoring activities, record how consistently they are delivered, and analyse student participation alongside assessment results. Comparable assessments and an appropriate comparison group would strengthen the evaluation. Particular attention should be given to initially low-performing students and whether outcomes vary according to their starting performance and level of participation. Further evidence is required before concluding that the framework is effective or suitable for wider use.

CONCLUSION

This paper conceptualises the relationship between structured peer mentoring and mathematics achievement, while recognising baseline performance among pre-diploma students. It explains how peer dialogue, guided practice and feedback may support learners in progressing from assisted problem-solving towards independent mathematical understanding. The framework also recognises Test 1 performance as a baseline predictor relevant to subsequent grades and passing status, particularly among initially low-performing students.

The contribution lies in distinguishing the proposed role of mentoring from the relationship between initial and subsequent achievement. Mentor preparation, organised learning activities and responsive assistance provide the conceptual basis for academic support, while the two propositions establish relationships for future investigation.

As a conceptual paper, the study does not demonstrate achievement gains or establish causal mentoring effects. Its interpretation is bounded by the selected literature and differences between the reviewed settings and pre-diploma education. Empirical validation requires documented mentoring implementation, clearly defined outcomes and comparable assessments. The framework thus provides an explicit theoretical foundation for evaluating structured peer mentoring in pre-diploma mathematics education.

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