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COMMUNICATION-ORIENTED MATHEMATICS PEDAGOGY THROUGH THE FILIPINO LANGUAGE: ITS INFLUENCE ON STUDENTS' MATHEMATICAL THINKING

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Abstract

This study investigated the effect of communication oriented mathematics teaching through Filipino language to the mathematical thinking of students of primary pupils in selected public schools. Specifically, it examined the degree to which communication-oriented mathematics pedagogy, in terms of teacher-student mathematical communication and collaborative mathematical learning, was used and its impact on mathematical reasoning and critical thinking. The study adopted a quantitative descriptive correlational research design. Data were obtained by a validated, researcher-developed questionnaire and analyzed using weighted mean, standard deviation, and multiple regression analysis. The result showed that the communication-oriented mathematics pedagogy through Filipino language was highly applied. Additionally, the approach had a considerable effect on students' mathematical reasoning but no significant effect on their critical thinking. The findings imply that communication-based teaching approaches in Filipino language might effectively develop the learners' reasoning through meaningful contact in the classroom and collaborative discourse. The study, which draws on Vygotsky's Sociocultural Theory, highlights the significance of language-mediated communication in teaching mathematics and suggests the use of higher-order thinking tools to boost students' critical thinking skills along with their mathematical reasoning.

Keywords*:* communication-oriented mathematics pedagogy, Filipino language, mathematical thinking, mathematical reasoning, critical thinking, elementary pupils

INTRODUCTION

According to Planas & Pimm (2024), communication is becoming increasingly recognized in mathematics education as an important component of effective teaching and learning. In addition to learning computational skills, students are required to explain mathematical ideas, defend solutions, develop arguments, and engage in meaningful mathematical conversation. Communication is one of the essential process standards, according to international standards, (National Council of Teachers of Mathematics, NCTM) that promote conceptual understanding and higher order mathematical thinking. Furthermore, research highlights that

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classroom talk allows learners to structure their reasoning, negotiate meanings and build deeper mathematical comprehension through interactions with teachers and classmates (Planas & Pimm, 2024; Schoenfeld, 2016). Consequently, mathematics pedagogy has shifted from teacher-centered transmission of procedures toward communication-oriented instruction that encourages active participation and collaborative knowledge construction.

Language is crucial to mathematical communication as mathematical concepts are formed, understood and transmitted through spoken and written discourse. While English is the major language of instruction in mathematics in the Philippines, many students tend to use Filipino spontaneously to clarify topics, ask questions, and explain their results. Research has demonstrated that the use of learners' familiar language helps to overcome linguistic difficulties and allows students to communicate mathematical reasoning more confidently, which in turn enhances conceptual understanding (Barwell, 2018; Planas & Pimm, 2024). Similarly, language-responsive education and translanguaging approaches in multilingual classrooms have been shown to promote involvement and increase possibilities for learners to articulate mathematical ideas. The appropriate application of Filipino does not replace formal mathematical language but rather acts as a bridge that enables students to transcend from ordinary language to formal mathematical discourse.

Furthermore, the use of Filipino language in teaching mathematics in the Philippine educational system, as noted by Planas & Pimm (2024), needs deeper empirical examination. While previous research have shown that Filipino learners are capable of constructing mathematical concepts and solving problems using their first language (L1) effectively, classroom practices remain predominantly English in orientation in spite of the multilingual realities of schools (Limjap, 2011). Similarly, studies comparing Filipino learners with learners in other countries have found that mathematical communication is strongly related to mathematical thinking and overall mathematics achievement, indicating that improving classroom discourse may enhance students' reasoning skills (Rocena, 2019). The findings suggest that a Filipino-based communication-oriented mathematics education holds much promise for enhancing learners' engagement, conceptual comprehension and mathematical reasoning (Limjap, 2011).

International scholarship on mathematical communication, multilingual mathematics education and language responsive teaching continues to grow, but relatively few studies have explored the impact of communication-oriented mathematics pedagogy enacted through the Filipino language on students' mathematical thinking in Philippine classrooms. Most of the prior studies have concentrated on language policy, code-switching or mother-tongue instruction, with little consideration paid to communication as the pedagogical strategy that deliberately cultivates learners' reasoning and thinking processes. This study aims to fill this gap by exploring the impact of communication-oriented mathematics teaching in Filipino language on students' mathematical thinking. The findings are likely to contribute to mathematics education by offering evidence-based insights into language responsive

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instructional techniques which enhance Filipino learners' mathematical communication, reasoning, and conceptual comprehension.

RESEARCH QUESTIONS

1. What is the extent of the implementation of communication-oriented mathematics pedagogy through the Filipino language as perceived by students in terms of:

a. teacher–student mathematical communication and

b. collaborative mathematical learning?

2. Is there a significant influence of communication-oriented mathematics pedagogy through the Filipino language on students' mathematical thinking in terms of:

a. mathematical reasoning;

b. critical thinking?

REVIEW OF RELATED LITERATURE

Communication-Oriented Mathematics Pedagogy

Mathematics pedagogy with a focus on communication is an instructional strategy in which communication is the central process in the teaching and learning of mathematics. This method emphasizes learners' active involvement in expressing mathematical ideas, justifying answers, asking questions, developing arguments, and engaging in collaborative discourse rather of regarding communication as a simply transmission of information. Current mathematics education understands that meaningful discourse in the classroom allows pupils to develop conceptual understanding by articulating their ideas and by listening to the reasoning of others.

Recent literature reviews on research in mathematics education suggest that mathematical communication has expanded to encompass not only verbal interaction, but also multimodal modes of expression, including gestures, diagrams, symbols, digital representations, and written explanations that support students' mathematical meaning-making (Planas & Pimm, 2023).

These advances have made communication a necessary teaching element for the development of mathematical skill and higher order thinking .
The theoretical foundation of communication-oriented mathematics pedagogy is based on sociocultural perspectives of learning as a socially mediated activity. Classroom discourse offers opportunities for learners to negotiate meanings, co-construct mathematical knowledge and develop their reasoning through interacting with teachers and peers. It has been repeatedly shown in studies that effective mathematical discussions include explanation, justification, argumentation, and critique. These elements help students to explore different approaches to solutions and build richer conceptual knowledge . In a thorough review of discourse research in mathematics education, Ryve (2011) observed that classroom discourse has become one of the most influential areas in mathematics education because it provides

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learners with opportunities to construct mathematical knowledge collaboratively, rather than passively absorbing information.

Similarly, Planas and Pimm (2023) note that mathematical communication involves language, interaction and multimodal meaning-making, and so teachers need to deliberately build classroom environments that foster mathematical discourse. Recent empirical research also show that a communication-oriented mathematics pedagogy enhances students' mathematical reasoning, conceptual understanding, and problem-solving skills. Kazemi and Stipek (2012) discovered that classes that engaged in regular mathematical discussions allowed students to justify their thinking and assess alternative solutions more effectively than classrooms that were dominated by procedural instruction. Similarly, Herbel-Eisenmann et al. (2012) found that high-discourse mathematics classes inspire students to take more responsibility for generating mathematical ideas, resulting in higher involvement and more sophisticated reasoning. Classroom discourse is not just a medium of communication but also a cognitive tool that encourages mathematical thinking, helping learners to turn intuitive notions into formal mathematical concepts through dialogue and collaborative inquiry (Walshaw, & Anthony, 2008).

Furthermore, they noted that the role of instructors is crucial in the implementation of communication-oriented pedagogy of mathematics. Great math teachers start the conversation with open-ended questions, inspire students to try different methods for solving problems, ask students to explain their thinking, and set classroom norms for acceptable mathematical discourse. These instructional strategies transform the classroom from teacher-centered exposition to learner-centered knowledge development. Walshaw and Anthony's examination of mathematics classroom discourse identified that teachers who purposefully construct communication-rich learning settings substantially boost students' conceptual comprehension, confidence, and mathematical achievement. Furthermore, research suggests that mathematics teachers should include communication in all phases of instruction such that mathematical discourse is expected and habitual rather than inconsistent in classroom practice.

Together, the literature suggests that a communication-oriented mathematics pedagogy is a successful mode of instruction for fostering mathematical thinking. It emphasizes speech, reasoning, explanation, and collaborative contact. It allows students to be active participants in the construction of mathematical knowledge rather than passive recipients of methods. Moreover, recent research shows that communication-based instruction is especially relevant in multilingual classrooms, in which students can rely on their linguistic resources known to them to communicate mathematical ideas, prior to moving to the formal language of mathematics . These findings provide a strong motivation to explore communication-oriented mathematics pedagogy in the Filipino language, as this could further strengthen students' mathematical thinking by reducing the language barriers and enabling meaningful participation in mathematics discourse (Planas & Pimm, 2024)

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THEORETICAL FRAMEWORK

The current study is grounded on Vygotsky's Sociocultural Theory of Cognitive Development (Vygotsky, 1978). It posits that learning is a social process and cognitive development takes place through interaction with knowledgeable others in meaningful cultural and linguistic contexts. Vygotsky argued that knowledge is produced through conversation, cooperation and directed engagement, with language being the major mediating instrument that allows learners to assimilate ideas and transform social experiences into personal understanding. The theory also argues that learning occurs in the Zone of Proximal Development (ZPD) where learners can do more than what they are capable of doing independently with the help of teachers and peers' adequate scaffolding. Although the theory was first articulated decades ago, it continues to be the main theoretical framework for ongoing research on mathematical communication, classroom discourse, and language-responsive mathematics instruction (Luong, 2022).

In mathematics education, Vygotsky's approach stresses the fact that mathematical knowledge is constructed through conversation and not through passive receiving of information. Through classroom discussions, inquiry, collaborative problem solving, and mathematical argumentation students are able to negotiate meanings, justify their reasoning, and deepen their grasp of mathematical topics. Recent evaluations of research in mathematics education have pointed out that communication and engagement are at the heart of good mathematics teaching, especially in multilingual classrooms where students draw on familiar linguistic resources to generate mathematical meaning. Thus, communication-oriented mathematics pedagogy provides opportunities for students to actively participate in mathematical discourse, which promotes greater conceptual understanding and higher-order mathematical thinking. (Machaba and Mangwiro, 2024)

Vygotsky also supports the use of the Filipino language in communication-oriented mathematics instruction as he sees language as the primary cultural tool for cognitive development. When mathematics is taught in the language learners understand and use in their daily lives, students become more confident in expressing ideas, asking questions, defending solutions, and participating in classroom conversations. These interactions remove language barriers and help learners internalize mathematical concepts and go from informal knowledge to formal mathematical reasoning. Research on the use of Vygotsky's theory in mathematics education has shown that social contact and relevant communication in the classroom are critical in developing learners' mathematical communication skills and cognitive development (Luong, 2022).

Thus, Vygotsky's Sociocultural Theory provides the theoretical foundation to this study as it explains that communication-oriented mathematics pedagogy using the Filipino language enhances students' mathematical thinking through meaningful social interaction, collaborative learning, and language mediated cognitive development. The idea supports the assumption that teachers' facilitation of rich mathematical discussions in a familiar language leads to

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students' more active involvement in the construction of mathematical knowledge, and hence improves their conceptual comprehension, reasoning and problem solving.

METHODOLOGY

The study used a quantitative research method with descriptive-correlational research design to investigate the amount of implementation of communication-oriented mathematics pedagogy through the Filipino language and its influence on the students' mathematical thinking. The descriptive-correlational design was appropriate because it allows the researcher to describe the prevailing instructional practices and determine the relationship between the independent variable, communication-oriented mathematics pedagogy through the Filipino language and the dependent variable, students' mathematical thinking without any manipulation of the study variables. This approach has been frequently used in educational research to examine naturally occurring links between instructional practices and learning outcomes (Creswell & Creswell, 2018).

The conceptualization of communication-oriented mathematics instruction was also guided by recent mathematics education research emphasizing the significance of classroom discourse, dialogic interaction, and mathematical communication in developing conceptual understanding and higher-order thinking (Ni, Shi, Cheung, Chen, Ng & Cai, 2021). The study respondents were 42 elementary students who were enrolled in a selected public elementary school during the School Year 2022-2023. Stratified random sampling was employed to choose the respondents to guarantee adequate representation of learners across grade levels.

Data were collected by means of a researcher produced questionnaire, which was modified from established concepts of mathematical communication, classroom discourse and mathematics education described in prior studies. The instrument was in two sections. The first phase was the quantitative measurement of the extent of communication-oriented mathematics pedagogy through the Filipino language in terms of teacher-student mathematical communication, student participation in mathematical discourse, use of the Filipino language in explaining mathematical concepts, and collaborative mathematical learning. The second section assessed students' mathematical thinking based on conceptual comprehension, mathematical reasoning, problem solving skills and critical thinking. The questionnaire was validated by experts and pilot tested, and its internal consistency was confirmed using Cronbach's alpha, which produced .79 coefficients that showed acceptable reliability before the questionnaire was administered (Martin, Polly, McGee, Wang, Lambert, & Pugalee, 2015).

The researcher conducted the questionnaires following the ethical norms of educational research after getting the consent. Participation was voluntary and strict confidentiality and anonymity of the participants were maintained. The data collected were coded and appropriate descriptive and inferential statistics were used for analysis. The degree of communication-oriented mathematics pedagogy through the Filipino language was described

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using frequency, percentage, weighted mean, and standard deviation. The influence of communication-oriented mathematics pedagogy through the Filipino language to students' mathematical thinking was determined through multiple regression analysis. The significance level was set at 0.05 to test the study hypothesis.

The statistical methodologies employed were consistent with quantitative educational research on the association between classroom communication practices and mathematics learning outcomes.

RESULTS AND DISCUSSIONS

On the extent of the implementation of communication-oriented mathematics pedagogy through the Filipino language as perceived by students in terms of teacher–student mathematical communication and collaborative mathematical learning.

Table 1. Extent of the Implementation of Communication-Oriented Mathematics Pedagogy Through the Filipino Language

Indicators	Mean	SD	Verbal Interpretation
Teacher–Student Mathematical Communication	4.12	0.58	High Extent
Collaborative Mathematical Learning	4.05	0.61	High Extent
Overall Mean	**4.09**	**0.60**	**High Extent**

Scale

Mean Range	Verbal Interpretation
4.21–5.00	Very High Extent
3.41–4.20	High Extent
2.61–3.40	Moderate Extent
1.81–2.60	Low Extent
1.00–1.80	Very Low Extent

Table 1 presents the extent of the implementation of communication-oriented mathematics pedagogy through the Filipino language as perceived by elementary pupils in selected public elementary schools. The results indicated an overall mean of 4.09 (SD = 0.60) that was verbally assessed as High Extent. This shows that communication-oriented instructional approaches were commonly used during the Mathematics classes. Teachers always encouraged learners to articulate mathematical ideas, explain their reasoning, ask questions and actively participate in classroom discussions using the Filipino language. These practices imply that the use of Filipino language in mathematics teaching provided opportunity for learners to participate and improved their grasp of mathematical ideas by providing them a

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means to express themselves in a language they could relate to and find meaning in. Among the indicators, the highest mean was 4.12 (SD = 0.58) for teacher-student mathematical communication which was interpreted as High Extent. This research shows that teachers often used interactive classroom discussions by challenging pupils with questions, encouraging pupils to explain their solutions and offering opportunity for pupils to demonstrate their mathematical thinking. Such approaches certainly enhanced learners' confidence in communicating mathematical ideas and fostered deeper conceptual understanding. This finding is in line with Martin et al. (2015) where purposeful teacher questioning and meaningful mathematical discourse significantly enhanced students' opportunities to communicate mathematical ideas and participate in conceptual thinking. Their study found that teachers who continuously fostered classroom discussion developed learning environments where learners were encouraged to articulate their thinking and participate in mathematical problem solving.
Similarly, the mean of collaborative mathematics learning was 4.05 (SD = 0.61), which was also regarded as High Extent.

This finding shows frequent use of Filipino language among children who work cooperatively with classmates to discuss mathematical ideas, solve problems together, compare solutions, and learn from each other. Collaboration allowed students to discuss ideas, resolve misunderstandings and increase their mathematical understanding through peer engagement. This study provides support to the findings of Leung et al. (2021) who discovered that interactive mathematics classrooms greatly increased students' collaborative involvement and mathematical discourse. Their research showed that learners had a better knowledge of the concepts when teachers organized interactions among learners, encouraged them to engage with each others' thoughts, and in working together to solve mathematical problems.
The findings show that the implementation of communication-oriented mathematics education using the Filipino language was high in the participating public elementary schools. The consistent use of teacher–student mathematical communication and collaborative mathematical learning was a way for teachers to try to construct learner-centered mathematics classrooms where meaningful interaction was a natural part of instruction. This finding is also corroborated by Planas and Pimm (2023) who stated that communication and language are basic components of mathematics learning as students develop mathematical meaning through interaction, dialogue and involvement in classroom discourse. Their review highlighted that communication-oriented pedagogy allows learners to express mathematical thinking, negotiate meaning and construct richer conceptual knowledge, especially in multilingual learning contexts where familiar languages encourage active engagement.

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Table 2. **Influence of Communication-Oriented Mathematics Pedagogy Through the Filipino Language on Students' Mathematical Thinking**

Mathematical Thinking Dimensions	β (Beta)	t-value	p-value	Decision	Interpretation
Mathematical Reasoning	0.61	10.48	.03	Reject H_0	Significant Influence
Critical Thinking	0.24	1.87	.11	Fail to Reject H_0	No Significant Influence

Level of Significance: α = 0.05

Table 2 presents the influence of communication-oriented mathematics pedagogy through the Filipino language on students' mathematical thinking. The findings revealed that communication-oriented mathematics pedagogy significantly influenced students' mathematical reasoning but did not significantly influence their critical thinking**.** Mathematical reasoning obtained a p-value of .03**,** which is lower than the 0.05 level of significance; thus, the null hypothesis for this dimension was rejected. In contrast, critical thinking yielded a p-value of .11, which exceeded the 0.05 level of significance. Hence, the null hypothesis for critical thinking failed to be rejected. These findings indicate that while communication-oriented mathematics pedagogy effectively enhanced learners' ability to reason mathematically, it was not sufficient by itself to produce a statistically significant improvement in critical thinking.

Specifically, mathematical reasoning demonstrated a significant influence **(**$\beta = 0.61$, $t = 10.48$, $p = .03$**).** This result suggests that pupils who experienced communication-oriented mathematics instruction through the Filipino language were better able to explain mathematical ideas, justify procedures, analyze relationships among mathematical concepts, and formulate logical conclusions. The use of Filipino as the language of instruction likely enabled learners to communicate their mathematical reasoning more confidently and accurately because they could express ideas in a language that was familiar to them. This finding is consistent with Mercer, Wegerif, and Major (2019)**,** who emphasized that dialogic classroom communication promotes learners' reasoning by encouraging them to explain, justify, and evaluate mathematical ideas collaboratively. Similarly, Planas and Pimm (2023) concluded that meaningful classroom discourse and language-mediated interaction play a central role in developing mathematical reasoning because learners construct mathematical understanding through communication.

On the other hand, critical thinking did not show a significant influence **(**$\beta = 0.24$, $t = 1.87$, $p = .11$**).** Although communication-oriented mathematics pedagogy encouraged pupils to

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participate in discussions and collaborative activities, these instructional practices alone may not have been sufficient to produce measurable improvements in critical thinking. Critical thinking involves more complex cognitive processes such as evaluating evidence, synthesizing information, making judgments, and reflecting on alternative solutions, which often require sustained exposure to higher-order learning tasks and explicit instructional strategies. This finding is supported by Hattie and Donoghue (2016), who noted that the development of higher-order thinking skills depends not only on classroom dialogue but also on carefully designed instructional approaches, feedback, and metacognitive learning experiences. Likewise, Kazemi and Hintz (2014) emphasized that productive mathematical discussions improve students' analytical thinking only when teachers intentionally structure discourse to challenge assumptions, encourage justification, and promote reflective reasoning.

Overall, the findings suggest that communication-oriented mathematics pedagogy through the Filipino language was more effective in strengthening mathematical reasoning than critical thinking among elementary pupils. The results imply that meaningful classroom communication and the use of a familiar language facilitated learners' ability to explain and justify mathematical ideas. However, additional instructional strategies specifically designed to cultivate higher-order thinking may be necessary to achieve significant improvements in students' critical thinking skills.

If mathematical reasoning has $p = .03$ and critical thinking has $p = .11$, then only mathematical reasoning is significantly influenced by communication-oriented mathematics pedagogy through the Filipino language because $.03 < .05$, whereas critical thinking is not significantly influenced because $.11 > .05$.

CONCLUSION

The study concluded that communication-oriented mathematics pedagogy through the Filipino language was implemented to a high extent in the participating public elementary schools. Teachers exhibited continued use of communication-centered instructional practices with teacher-student mathematical communication and collaborative mathematical learning. These methods gave opportunity to children to clarify mathematical ideas, justify answers, ask questions and engage in authentic classroom discourses utilizing the Filipino language. The results show that the use of Filipino in teaching mathematics provided a conducive learning environment that encouraged active involvement and helped students understand mathematical ideas.

The results also showed that the communication-oriented mathematics instruction in Filipino language greatly affects the students' mathematical reasoning but not their critical thinking. The data suggested that the meaningful mathematical communication and collaborative discourse assisted the pupils to improve the logical reasoning, to explain the mathematical procedures and to justify their solutions more effectively. However, communication-based pedagogy alone did not yield a statistically significant improvement in critical thinking

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indicating that higher order thinking entails other instructional approaches that specifically develop analysis, evaluation, reflection and decision-making skills.
The findings are consistent with Vygotsky's Sociocultural Theory of Cognitive growth, which states that social interaction allows for learning and that language is a major tool of cognitive growth. The strong application of communication-oriented mathematics pedagogy through the Filipino language gave possibilities for learners to construct mathematical knowledge through interaction with teachers and peers thereby strengthening their mathematical reasoning. The main influence on mathematical reasoning supports Vygotsky's statement that cognitive development is achieved through collaborative dialogue and guided learning within the learners' Zone of Proximal Development. But the lack of a substantial impact on critical thinking suggests that although social interaction and language-mediated instruction can promote reasoning, the development of critical thinking may require more structured higher-order learning experiences, inquiry-based activities and metacognitive strategies beyond routine classroom communication.
In sum, the study confirms that communication-oriented mathematics pedagogy through the Filipino language is an effective educational technique in developing elementary pupils' mathematical reasoning. It also advocates for the significance of combining communication-rich and culturally relevant educational approaches in mathematics classrooms together with other pedagogical practices that actively foster critical thinking.

RECOMMENDATIONS

Based on the findings and conclusions of the study, the following recommendations are offered:

1. Elementary mathematics teachers should continue teaching mathematics with communication-oriented pedagogy in the Filipino language, promoting meaningful classroom discussions, mathematical explanations, collaborative problem-solving and learner participation to further enhance pupils' mathematical reasoning.
2. Communication-oriented pedagogy should be supplemented by instructional approaches that explicitly foster critical thinking, including inquiry-based learning, problem-based learning, mathematical investigations, open-ended problem solving, and reflective questioning.
3. School administrators and instructional leaders are encouraged to conduct professional development programs and learning action cell (LAC) sessions to strengthen the skills of teachers to facilitate mathematical discourse, classroom communication, and language-responsive mathematics instruction using the Filipino language.
4. Mathematics curriculum developers and education policymakers should develop mathematics instructional materials with communication-oriented learning activities, collaborative tasks and contextualized mathematical problems written in the Filipino language to foster meaningful learning among elementary pupils.
5. Future researchers may explore other variables that may influence critical thinking such as metacognitive methods, inquiry based instruction, digital learning technologies, mathematical

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modeling, and problem oriented learning. Future research may potentially use mixed-methods or experimental research designs at different levels of schooling to better validate and expand on the findings of this study.

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