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ASSESSMENT OF INSTRUCTIONAL STRATEGIES, STUDENT ENGAGEMENT AND MATHEMATICAL PROFICIENCY AMONG INTERMEDIATE LEARNERS: A MEDIATION ANALYSIS

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ABSTRACT

Mathematical proficiency is a fundamental outcome of elementary mathematics education as it supports learners' conceptual understanding and problem-solving abilities. Despite the recognized importance of instructional strategies and student engagement in mathematics learning, limited studies have examined the mediating role of student engagement in the relationship between instructional strategies and mathematical proficiency among Grade 4 learners in a local Philippine context. This study investigated the relationship among instructional strategies, student engagement, and mathematical proficiency of 200 Grade 4 learners in Kalilangan West District, Bukidnon. Using a quantitative predictive-correlational design, data were collected through adapted questionnaires and a researcher-made mathematics proficiency test. Mean, standard deviation, frequency, percentage, canonical correlation analysis, multiple regression analysis, and Structural Equation Modeling (SEM) were used to analyze the data.Results showed that learners perceived instructional strategies and student engagement at a high level, with Behavioral Engagement obtaining the highest mean. However, mathematical proficiency was only at an average level, and Fractions emerged as the weakest competency area. Significant but weak relationships were found between instructional strategies and mathematical proficiency and between student engagement and mathematical proficiency. Student engagement significantly predicted mathematical proficiency, whereas instructional strategies did not contribute significantly when considered alongside student engagement. Furthermore, student engagement fully mediated the relationship between instructional strategies and mathematical proficiency. The findings suggest that instructional strategies enhance mathematical proficiency primarily by fostering learners' engagement. Future researchers are encouraged to

investigate other predictors of mathematical proficiency and employ longitudinal or experimental designs to validate and extend the present findings.

Keywords: *instructional strategies, student engagement, mathematical proficiency, mediation analysis, Grade 4 learners*

INTRODUCTION

Mathematics education plays an essential role in developing learners' ability to understand quantities, patterns, relationships, space, and logical procedures. At the elementary level, learners build foundational mathematical knowledge that supports more advanced learning in later grades. Mathematical proficiency is not limited to obtaining correct answers; it also involves conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition toward mathematics according to Kilpatrick et al. (2001). In the present study, however, Mathematical Proficiency is operationally defined more narrowly as the Grade 4 learners' performance in three competency areas: Fractions, Factors and Multiples, and Symmetry. This operational definition is aligned with the researcher-made achievement test used in the study and distinguishes mathematical proficiency from the broader concept of numeracy.

The need to strengthen foundational mathematics learning remains evident in the Philippine educational context. Although the Programme for International Student Assessment (PISA) measures the performance of 15-year-old learners and cannot be used as a direct assessment of Grade 4 learners, its results provide an important national background. In the PISA 2025 results, Filipino students obtained an average mathematics score of 371, compared with the Organisation for Economic Co-operation and Development (OECD) average of 463. Only 21% of Filipino students reached at least Level 2 in mathematics, which is considered the baseline level of proficiency in the assessment (OECD, 2025). While the results indicate improvement compared with the previous cycle, they also demonstrate the continuing need to strengthen mathematical foundations before learners reach secondary school. Early development of conceptual understanding, problem-solving ability, and mathematical confidence is therefore important in preparing learners for increasingly complex mathematical tasks.

One important factor associated with learners' mathematical development is the quality of classroom instruction. Instructional Strategies refer to the approaches and practices teachers use to explain concepts, present examples, ask questions, provide activities, give feedback, and connect new knowledge with learners' prior experiences. Mathematics instruction that elicits learners' ideas and builds on their mathematical thinking has been associated with improved student achievement, as stated by Kim et al. (2022). Similarly, Smit et al. (2023) found that interactive dialogue and formative feedback provide opportunities for learners to explain their reasoning, receive guidance, and correct misconceptions during mathematics lessons. These findings suggest that instructional practices may influence mathematics learning by creating opportunities for learners to think, participate, practice, and receive support. However, instructional strategies should

not be viewed as the only factor that determines achievement because the relationship between classroom practices and performance may also depend on learner-related variables.

Among these learner-related variables, Student Engagement is particularly important. A study by Fredricks et al. (2004) and Wong & Liem (2022) noted that student engagement refers to the ways learners become involved in the learning process and is commonly described through affective, behavioral, and cognitive dimensions. Affective Engagement involves learners' interest, enjoyment, pride, and feelings toward mathematics. Behavioral Engagement involves participation, attention, effort, task completion, and persistence. Cognitive Engagement involves mental effort, the use of learning strategies, connection of prior knowledge with new concepts, checking of answers, correction of mistakes, and persistence when tasks are difficult. These dimensions are distinct but related aspects of learners' involvement in academic activities and should be examined together when studying mathematics learning.

Previous studies have shown that engagement is related to mathematics learning and achievement. Quintero et al. (2022) found that cognitive-behavioral engagement helped explain differences in mathematics achievement among learners in Grades 4 to 6 who experienced varying levels of mathematics anxiety. Their findings are relevant to the present study because they involved learners within a similar elementary grade range and emphasized that learners' participation and mental involvement may be connected with mathematics performance. In addition, Wong and Liem (2022) emphasized that engagement must be clearly defined according to its dimensions and the learning context in which it is measured. Thus, examining Student Engagement in terms of affective, behavioral, and cognitive involvement may provide a more complete understanding of how learners respond to mathematics instruction.

The mathematical competencies included in the present study also involve different forms of conceptual and procedural understanding. Fractions require learners to understand part-whole relationships, magnitude, equivalence, and operations. In Purnomo et al. (2022), research has shown that elementary learners may perform certain fraction procedures without fully understanding the meaning of the operations involved. In the study of Björkhammer et al. (2024) found that focused instruction that emphasizes fraction magnitude, representations, and conceptual understanding has been found to improve learners' performance in fraction concepts and fraction arithmetic. These findings are important to the present study because Fractions were identified as a major area of assessment and a potential area of difficulty among the participating Grade 4 learners.

Factors and Multiples require learners to understand relationships involving multiplication, division, divisibility, and number structure. Hurst et al. (2021) reported that primary learners may know isolated procedures related to factors and multiples while still experiencing difficulty explaining the relationship between the two concepts. This suggests that instruction should not focus only on memorizing rules but should also help learners recognize and explain numerical relationships. Symmetry, on the other hand, requires visual and spatial reasoning. Learners may experience difficulty identifying lines

of reflection, recognizing equal distances from a line of symmetry, and applying symmetry properties to different figures. Götz and Gasteiger (2022) found that primary learners used different approaches in solving reflection tasks, some of which resulted in recurring errors. Crisci et al. (2024) likewise showed that carefully designed visual and paper-based activities can support learners' understanding of axial symmetry. These studies demonstrate that learners may perform differently across mathematical areas because each competency requires particular forms of understanding and reasoning.

Despite the importance of instructional practices and student engagement in mathematics learning, a research gap remains. Existing studies have commonly examined instructional practices and mathematics achievement, student engagement and achievement, or the effects of specific mathematics interventions separately. An example was the research of Kim et al. (2022) has documented relationships between ambitious mathematics instruction and achievement interactive dialogue and mathematical reasoning of Smit et al. (2023), and student engagement and mathematics achievement of Quintero et al. (2022). Other studies have examined learner-related mechanisms through which instructional practices may be associated with mathematics outcomes. Zhu and Kaiser (2022) found that instructional quality and social-emotional support were related to students' mathematics learning, while some relationships between teaching practices and achievement were not uniformly direct. Their findings suggest that learner variables may help explain how classroom instruction is connected with mathematics performance.

However, fewer studies have examined Instructional Strategies, multidimensional Student Engagement, and Mathematical Proficiency within one statistical model, particularly among Grade 4 learners in a local Philippine public-school setting. There is also limited local evidence regarding whether Student Engagement serves as a statistical pathway between instructional practices and performance in specific mathematics areas such as Fractions, Factors and Multiples, and Symmetry. The present study addresses this empirical gap by examining the levels of Instructional Strategies, Student Engagement, and Mathematical Proficiency; determining the relationships among these variables; estimating the unique predictive contribution of Instructional Strategies and Student Engagement; and testing whether Student Engagement statistically mediates the relationship between Instructional Strategies and Mathematical Proficiency.

The study is timely because Grade 4 learners are expected to develop essential mathematical competencies that serve as a foundation for more advanced learning. In Kalilangan West District, Bukidnon, variations in learners' mathematics performance indicated that some pupils continued to experience difficulty in demonstrating mastery of Fractions, Factors and Multiples, and Symmetry. At the same time, classroom observations and learner responses suggested that instructional practices and engagement were generally present at favorable levels. This situation creates an important practical concern: learners may report positive instructional experiences and high engagement while still demonstrating only limited or uneven mastery of mathematical concepts. Examining the three variables together may therefore clarify whether positive classroom practices are associated with mathematical performance

directly, indirectly through engagement, or only weakly because other learner and contextual factors are also involved.

The study also responds to a practical need by providing evidence that may guide the development of more focused mathematics interventions. In particular, the findings may inform the proposed Fraction Learning Stations, an instructional innovation that may use visual models, concrete materials, guided practice, collaborative tasks, games, and differentiated activities to strengthen learners' conceptual understanding of fractions while maintaining their affective, behavioral, and cognitive engagement. The proposed innovation is not assumed to be effective before implementation; rather, it is presented as a possible school-based response to the identified difficulty in Fractions and may be refined using the evidence generated by the study.

The present research used a quantitative predictive-correlational design with mediation analysis. Accordingly, the study examined statistical associations and indirect pathways rather than claiming that Instructional Strategies cause Student Engagement or that Student Engagement causes Mathematical Proficiency. The cross-sectional nature of the data does not establish temporal order or causation. Nevertheless, determining whether Student Engagement statistically mediates the relationship between Instructional Strategies and Mathematical Proficiency may provide useful evidence for understanding how classroom practices and learner involvement are connected in mathematics learning.

Ultimately, the study seeks to contribute local evidence for improving the teaching and learning of mathematics among Grade 4 learners. It recognizes that effective mathematics instruction involves more than presenting procedures and that learner engagement involves more than visible participation. Clear explanations, meaningful examples, guided questioning, feedback, opportunities to explain mathematical thinking, and appropriately challenging activities may be more beneficial when they encourage learners to become interested, active, persistent, and cognitively involved in the learning process. By examining Instructional Strategies, Student Engagement, and Mathematical Proficiency in one model, the study may support more responsive classroom instruction, targeted interventions, and school-based initiatives aligned with the goal of improving the quality and equity of mathematics education.

Research Questions

The study examined Instructional Strategies, Student Engagement, and Mathematical Proficiency among Grade 4 learners and tested whether Student Engagement mediated the relationship between Instructional Strategies and Mathematical Proficiency.

Specifically, it sought to answer the following questions:

1. What is the Grade 4 learners' assessment of the teachers' instructional strategies used on mathematical proficiency?

2. What is the Grade 4 learners' assessment of their engagement on mathematical proficiency in terms of:
    2.1. Cognitive;
    2.2. Affective; and
    2.3. Behavioral?
3. What is the participants' level of mathematics proficiency in terms of:
    3.1. Fractions;
    3.2. Factors and multiples; and
    3.3. Symmetry?
4. Are the participants' Instructional Strategies and Student Engagement significantly associated with their Mathematical Proficiency?
5. Do Instructional Strategies and Student Engagement significantly predict Mathematical Proficiency?
6. Does Student Engagement significantly mediate the relationship between Instructional Strategies and Mathematical Proficiency?

Null Hypotheses:

Research Questions 1 to 3 were descriptive and did not require null hypotheses. The following null hypotheses were tested at the .05 level of significance:

H_{o1}: There is no significant relationship between Instructional Strategies and Mathematical Proficiency.
H_{02}: There is no significant relationship between Student Engagement and Mathematical Proficiency.
H_{03}: Instructional Strategies and Student Engagement do not significantly predict Mathematical Proficiency.
H_{04}: There is no significant canonical relationship between Instructional Strategies and Mathematical Proficiency in terms of Fractions, Factors and Multiples, and Symmetry.
H_{05}: Instructional Strategies and Student Engagement are not significantly associated with the participants' Mathematical Proficiency.
H_{06}: Student Engagement do not significantly mediate the relationship between Instructional Strategies and Mathematical Proficiency.

METHODOLOGY

Research Design

The study used a quantitative predictive-correlational research design with mediation analysis. In a correlational design, researchers examine the degree of association among variables without manipulating them; a predictive-correlational approach additionally uses predictor variables to estimate or explain an outcome variable according to Creswell & Creswell (2018) and Lodico et al. (2010). This design was appropriate since the study examined statistical relationships among naturally occurring variables without manipulating classroom instruction or assigning learners to

experimental conditions. Instructional Strategies served as the independent variable, Student Engagement served as the mediating variable, and Mathematical Proficiency served as the dependent variable.

Research Participants and Sampling Procedure

The participants consisted of 200 Grade 4 learners enrolled in selected public elementary schools in Kalilangan West District, Bukidnon, during School Year 2026–2027.The accessible population was approximately 250 Grade 4 learners. A total enumeration approach was used at recruitment, which means that all eligible learners in the participating schools were invited to take part rather than selecting only a smaller random sample. Eligible participants were officially enrolled Grade 4 learners who had been exposed to the mathematics competencies included in the test, were present during data collection, and had parental or guardian consent together with learner assent.

Data Gathering Procedure

Before data collection, the researcher secured the required institutional and school permissions before data collection. Ethical clearance was obtained from the appropriate Research Ethics Committee, followed by permission from the Schools Division Office, district officials, and participating school principals. The study involved minors, so parental or guardian informed consent and learner assent were required before participation.

Research Instruments

The study used two main instruments: an adapted questionnaire for Instructional Strategies and Student Engagement and a researcher-made Mathematical Proficiency Test.

The Instructional Strategies section questionnaire was adapted and modified from the Scale of Determining Instructional Strategies developed by Eristi et al. (2012) contained 18 items that asked learners about the teaching practices they experienced during mathematics lessons.

The Student Engagement section contained 21 items organized into three seven-item subscales: Affective Engagement, Behavioral Engagement, and Cognitive Engagement. The engagement items were guided by the multidimensional framework of Fredricks et al. (2004) and by relevant features of the Student Engagement in Schools Questionnaire of Hart et al. (2011). The statements were simplified and contextualized for Grade 4 mathematics learners.

The Mathematical Proficiency Test was a 16-item researcher-made test based on the Grade 4 competencies included in the study. Six items measured Fractions, four items measured Factors and Multiples, and six items measured Symmetry. Each correct answer received one point and each incorrect answer received zero. The test therefore produced an overall score from 0 to 16 together with separate subtest scores for the three mathematical areas. The instrument was researcher-made and should not be described as a standardized test.

Validity and Reliability

The adapted questionnaire and the Mathematical Proficiency Test were subjected to content validation before final administration. Experts with relevant backgrounds in mathematics education, elementary education, and research reviewed the items for clarity, appropriateness, alignment with the variables, and suitability for Grade 4 learners. Revisions were made when wording was unclear, too difficult, repetitive, or not aligned with the intended construct.

Statistical Analysis of Data

The study analyzed data from 200 Grade 4 learners using descriptive and inferential statistics. Means and standard deviations were used to describe the levels of instructional strategies, student engagement, and mathematical proficiency. Canonical correlation analysis, multiple regression analysis, and mediation analysis were used to examine the relationships among the variables.

Scope and Limitations

The study focused on Grade 4 learners from selected public elementary schools in Kalilangan West District, Bukidnon, during the School Year 2026-2027. It examined three major variables: Instructional Strategies, Student Engagement, and Mathematical Proficiency. Student Engagement was examined through Affective Engagement, Behavioral Engagement, and Cognitive Engagement, while Mathematical Proficiency was measured through Fractions, Factors and Multiples, and Symmetry.

The study used self-report data for Instructional Strategies and Student Engagement and a researcher-made achievement test for Mathematical Proficiency. The cross-sectional design allowed the study to examine associations, prediction, model fit, and statistical mediation, but it did not establish causal relationships. The results are therefore limited to the variables, instruments, participants, schools, and time period included in the study and should not be generalized automatically to other grade levels or settings.

RESULTS AND DISCUSSION

Grade 4 learners' assessment of the teachers' instructional strategies used on mathematical proficiency.

Table 1. Descriptive statistics for Instructional Strategies

Range	Description	Interpretation	Frequency	Percentage
4.51 – 5.00	Strongly Agree	Very High	84	42.00
3.51 – 4.50	Agree	High	73	36.50
2.51 – 3.50	Neutral	Moderate	38	19.00
1.51 – 2.50	Disagree	Low	5	2.50

Range	Description	Interpretation	Frequency	Percentage
1.00 – 1.50	Strongly Disagree	Very Low	0	0.00
	Total		**200**	**100.00**
	Mean		**4.17**	
	SD		**0.72**	
	Interpretation		**High**	

Table 1 presents the results that Instructional Strategies obtained a mean of 4.17 and a standard deviation of 0.72, which indicate a high level of implementation. This shows that learners generally agreed that their teachers used clear explanations, questioning, activities, guidance, feedback, and varied classroom practices to support mathematics learning. This finding is consistent with Kim et al. (2022), who emphasized that mathematics instruction becomes more effective when teachers elicit and build on learners' mathematical ideas. It is also supported by Smit et al. (2023), who highlighted the importance of interactive dialogue and formative feedback in mathematics instruction.

In general, Table 1 provides clear proof that the instructional practices among Grade 4 learners in Mathematics are quite positive. The general mean score of 4.17 (*SD* = 0.72) is classified as High, and 78.5 percent students rated the practices as High or Very High, which means that students have encountered almost all the strategies that are listed in their Mathematics lessons. A closer examination of the three highest-rated indicators shows which practices were most evident in the learners' reports. These were giving activities that help learners learn fractions (M=4.37, SD=1.07), giving learners time to think before answering mathematics questions (M=4.32,SD=1.12), and asking questions that help learners think about the lesson (M=4.24,SD=1.05). The 18 indicators had the same rating of "Agree." However, the relatively lower scores for the use of easy language, feedback, and approaches in teaching deserve some consideration. Therefore, the general results give a good picture of learners' attitude and the fields where some instructional methods could be used better.

Grade 4 learners' assessment of their engagement on mathematical proficiency in terms of Cognitive, Affective, and Behavioral.

Table 2. Descriptive Statistics of the Participants' Cognitive Engagement

Range	Description	Interpretation	Frequency	Percentage
4.51 – 5.00	Strongly Agree	Very High	87	43.50
3.51 – 4.50	Agree	High	79	39.50
2.51 – 3.50	Neutral	Moderate	22	11.00
1.51 – 2.50	Disagree	Low	10	5.00

Range	Description	Interpretation	Frequency	Percentage
1.00 – 1.50	Strongly Disagree	Very Low	2	1.00
	Total		**200**	**100.00**
	Mean		**4.16**	
	SD		**0.83**	
	Interpretation		**High**	

Table 2 presents the results that Cognitive Engagement obtained a mean of 4.16 and a standard deviation of 0.83, which indicates a high level of cognitive engagement in mathematics. These results show that most of the respondents generally use thinking strategies and remain mentally involved while learning mathematics. Zhang et al. (2023) explained cognitive engagement in mathematics as the active use of learning strategies and mental effort, and their longitudinal study involving 623 secondary students showed that cognitive engagement had reciprocal links with students' motivation in learning mathematics. Joshi et al. (2022) found that cognitive engagement had an important place in mathematics learning and was significantly connected with behavioral, emotional, and social engagement. This indicates that learners commonly reported mental effort and the use of thinking strategies during mathematics tasks.

Among the 200 participants, 87 or 43.50 percent reported a very high level, while 79 or 39.50 percent reported a high level. Another 22 or 11.00 percent showed a moderate level, while 10 or 5.00 percent reported a low level and 2 or 1.00 percent reported a very low level. These results demonstrate that most learners use various cognitive strategies and stay engaged in the learning process while studying Mathematics. The high index of Cognitive Engagement indicates that learners are generally making effort when solving mathematics tasks. The findings suggest that learners learn to use the information they obtained before, verify their answers, and work on their assignments when the task becomes too complicated. All of these practices are crucial in mathematics education, as cognitive engagement implies the use of strategies, understanding the essence of the task, and acting in accordance with the right thinking strategy instead of merely completing the assignment.

Table 3. Descriptive Statistics for Affective Engagement

Range	Description	Interpretation	Frequency	Percentage
4.51 – 5.00	Strongly Agree	Very High	101	50.50
3.51 – 4.50	Agree	High	66	33.00
2.51 – 3.50	Neutral	Moderate	26	13.00
1.51 – 2.50	Disagree	Low	5	2.50
1.00 – 1.50	Strongly Disagree	Very Low	2	1.00

Range	Description	Interpretation	Frequency	Percentage
	Total		**200**	**100.00**
	Mean		**4.24**	
	SD		**0.82**	
	Interpretation		**High**	

Table 3 presents the results that Affective Engagement obtained a mean of 4.24 and a standard deviation of 0.82, which indicate a high level of learners' positive emotional connection to mathematics. These findings show that most of the participants generally have positive feelings and interest toward learning mathematics. Wong and Liem (2022) also describe affective engagement as one dimension of learning engagement, involving learners' feelings during learning activities. This suggests that positive feelings toward mathematics were common among the participants, although the ratings also show some variation in learners' experiences.

Looking more closely at the three highest-rated indicators, learners most strongly agreed that they felt proud when they answered mathematics questions correctly (M=4.34, SD=1.11), liked learning about factors and multiples (M=4.32, SD=1.01), and liked learning about symmetry (M=4.31, SD=1.01). The extremely high scores for pride lead to the conclusion that a good performance provides learners with a positive experience in their study. The ratings for factors and multiples and symmetry suggest that learners reported liking these topics, although this measures their affective response and does not itself demonstrate mastery of the topics. These facts together imply that students' positive feelings can be noted due to their achievements and preferences towards some particular branches of mathematics.

Overall, Table 3 presents a positive picture of the learners' affective involvement in mathematics. The high average shows that generally students felt interest, pleasure, pride and made positive responses towards mathematics. What is more, it is important to note that 83.50% of all participants belong to High or Very High categories, while only 3.50% are categorized as Low or Very Low. This proves the fact that the majority of students reacted positively towards mathematics, despite the fact that the results of the research show possible differences in students' experiences.

Table 4. Descriptive Statistics of the Participants' Behavioral Engagement

Range	Description	Interpretation	Frequency	Percentage
4.51 – 5.00	Strongly Agree	Very High	106	53.00
3.51 – 4.50	Agree	High	58	29.00
2.51 – 3.50	Neutral	Moderate	24	12.00
1.51 – 2.50	Disagree	Low	10	5.00

Range	Description	Interpretation	Frequency	Percentage
1.00 – 1.50	Strongly Disagree	Very Low	2	1.00
	Total		**200**	**100.00**
	Mean		**4.25**	
	SD		**0.85**	
	Interpretation		**High**	

Table 4 presents the descriptive statistics for Behavioral Engagement. The results show that the learners assessed their Behavioral Engagement high as shown in an overall mean of 4.16 and a standard deviation of 0.83. The results indicate that the participants demonstrated good behaviors such as attention, participation, effort, and realization of assignments during math classes. Deviation status confirms that participants' answers were stable. Looking more closely at the top three indicators, learners most strongly agreed that they tried to do their best in mathematics activities (M=4.33,SD=1.08), participated in mathematics activities (M=4.31,SD=1.11), and listened carefully while the teacher was teaching (M=4.26,SD=1.24). These items show that learners' reports of behavioral engagement include both effort and visible participation, as well as attention during instruction. The mean for listening was tied with answering questions, so those two indicators share the third-highest value. This profile is consistent with the description of behavioral engagement as learners' effort and involvement in learning activities (Wong & Liem, 2022).

The high level of Behavioral Engagement therefore shows that the pupils generally remain active and involved during mathematics lessons. The results indicate that they commonly listen, participate, answer questions, complete tasks, and exert effort during classroom activities. The importance of these behaviors lies in the fact that the more learners engage in such participation, the more opportunities they receive to exercise mathematical skills. This is consistent with the findings from research that emphasizes the significance of behavioral engagement in the process of learning, as it is characterized by a high level of activity in terms of the learners' involvement in the learning activities. Wong and Liem (2022) state that behavioral engagement indicates the active involvement of students in studying. Moreover, recent studies in the field of mathematics education demonstrate that the students involved in classroom activities reported higher levels of engagement.

Summary of participants' level of Student Engagement across three dimensions.

Table 5. Summary of Grade 4 learners' assessment of their engagement on mathematical proficiency.

Student Engagement	Mean	SD	Interpretation
Affective Engagement	4.24	0.82	High

Student Engagement	Mean	SD	Interpretation
Behavioral Engagement	4.25	0.85	High
Cognitive Engagement	4.16	0.83	High
Overall	**4.22**	**0.77**	**High**

Note. Mean scores were interpreted using the following ranges:
1.00–1.50 = Very Low, 1.51–2.50 = Low, 2.51–3.50 = Moderate, 3.51–4.50 = High, and 4.51–5.00 = Very High.

Table 5 presents the results of an overall mean of 4.22 and a standard deviation of 0.77, which indicate a high level of Student Engagement across all three dimensions. Behavioral Engagement obtained the highest mean of 4.25, followed closely by Affective Engagement at 4.24, while Cognitive Engagement obtained the lowest mean of 4.16. This finding agrees with Maamin et al. (2021) also examined student engagement through affective, behavioral, and cognitive dimensions and found that all three dimensions had significant relationships with mathematics achievement. The findings suggest that the participants demonstrate a balanced form of student engagement. Maintaining the three dimensions may therefore help provide pupils with regular opportunities to participate, remain interested, and use suitable thinking strategies during mathematics lessons.

The high level across all three dimensions is also consistent with the findings of Xia et al. (2022), who examined mathematics motivation and engagement among 1,538 primary school students and stressed the value of viewing student engagement as a multidimensional construct. Their study showed that pupils may display different patterns of engagement, which means that their participation, feelings, and learning effort should be considered together when examining their mathematics learning. This supports the present finding since the participants reported high levels across the three dimensions, although Behavioral Engagement was slightly higher than the other dimensions.

The conclusion can be made that the participants show a uniform pattern of student engagement that includes both active participation and positive attitude to learning, with mental effort applied while doing mathematics tasks. The lower mean value of Cognitive Engagement can also indicate that cognitive activity still requires additional attention, even though it shows relatively high levels. Hence, a mix of three engagement types would be useful for giving students additional chances to participate, be interested, and be effective thinkers in mathematics classes.

The participants' level of mathematics proficiency in terms of Fractions, Factors and Multiples, and Symmetry.

Table 6. Descriptive Statistics of the Participants' Mathematical Proficiency in Fraction

Range	Interpretation	Frequency	Percentage
5.40 – 6.00	Outstanding	5	2.50
4.50 – 5.39	Very Good	33	16.50

Range	Interpretation	Frequency	Percentage
3.00 – 4.49	Average	67	33.50
1.50 – 2.99	Fair	51	25.50
0.00 – 1.49	Poor	44	22.00
Total		**200**	**100.00**
Mean		**2.78**	
SD		**1.51**	
Interpretation		**Fair**	

Table 6 presents the results that Fractions obtained a mean of 2.78 and a standard deviation of 1.51, which indicate fair level of mastery in Fractions. Purnomo et al. (2022) likewise found that elementary school pupils experienced difficulty in understanding fraction multiplication, particularly when they needed to interpret a fraction as part of a quantity. This finding supports the present result since the poor mastery shown by many participants may also reflect difficulty in understanding the meaning of fractions rather than simply carrying out computations. Limitations in conceptual understanding, thus, were observed to be intertwined with the difficulties they faced even when the students were able to use some procedures.

This result supports the one at hand since some of the students represented by lower performances would probably experience substantial difficulties understanding what fractions mean, not only computation. The notion of Fair mastery signifies then the need for strengthening how fraction concepts should be taught and practiced. Developing strong conceptual understanding can somehow aid the pupil in overcoming the further complexity of fraction tasks when they arise. Björkhammer et al. (2024) found that fifth-grade pupils who received a whole-class fraction intervention performed significantly better in fraction concepts and fraction arithmetic than pupils who received the usual instruction. The findings suggest that fractions remain an area that needs more attention among the participants.

Table 7. Participants' level of mathematics proficiency in factors and multiples

Range	Interpretation	Frequency	Percentage
3.60 – 4.00	Outstanding	22	11.00
3.00 – 3.59	Very Good	70	35.00
2.00 – 2.99	Average	65	32.50
1.00 – 1.99	Fair	34	17.00
0.00 – 0.99	Poor	9	4.50

Range	Interpretation	Frequency	Percentage
Total		**200**	**100.00**
Mean		**2.31**	
SD		**1.02**	
Interpretation		**Average**	

Table 7 presents results that Factors and Multiples obtained a mean of 2.31 and a standard deviation of 1.02, which indicate average mastery of Factors and Multiples. These results show that most of the participants have some understanding of factors and multiples, although their level of mastery still varies across the sample size. Hurst et al. (2021) similarly found that primary school pupils generally knew some ideas about factors and multiples, although many had difficulty connecting and explaining these ideas when the questions were presented in another form. Sutarto et al. (2021) found several misconceptions among fourth-grade pupils concerning greatest common factor and least common multiple, including weak understanding of multiplication and prime numbers, confusion between factors and multiples, and incorrect ways of finding the least common multiple. The findings show that Factors and Multiples remain an area where the participants need further practice and clearer conceptual instruction.

Among the participants in the research, 70 or 35 % of the participants made it to the level of very good mastery, while 65 or 32.5 % of the students showed average mastery. Additionally, 34 students or 17 % of the sample were capable of reaching fair mastery, with 22 students or 11 % being able to reach outstanding mastery and 9 students or 4.5 % only scoring poor mastery. Therefore, these results show that the majority of the participants understood factors and multiples well, but there was still a sizable level of differences in mastery levels. Another interesting finding is that 67.5 % of the participants demonstrated either very good or average mastery, while 21.5 % made it to either fair or poor mastery. This pattern indicates that most learners possessed very good knowledge and understanding of the topic.

Table 8. Participants' level of mathematics proficiency in symmetry

Range	Interpretation	Frequency	Percentage
5.40 – 6.00	Outstanding	10	5.00
4.50 – 5.39	Very Good	40	20.00
3.00 – 4.49	Average	89	44.50
1.50 – 2.99	Fair	36	18.00
0.00 – 1.49	Poor	25	12.50

Range	Interpretation	Frequency	Percentage
Total		**200**	**100.00**
Mean		**3.34**	
SD		**1.48**	
Interpretation		**Average**	

Table 8 presents the results that Symmetry obtained a mean of 3.34 and a standard deviation of 1.48, which indicate average level mastery of symmetry. These findings show that most of the participants have some understanding of symmetry, although many have not yet reached a higher level of mastery. Götz and Gasteiger (2022) likewise found that primary school pupils showed several difficulties when working with reflection tasks, especially when they needed to consider important properties such as perpendicularity and equal distance from the line of reflection. Crisci et al. (2024) found that fifth-grade pupils developed better understanding of axial symmetry when they worked with visual programming and paper-based tasks that required them to construct symmetrical images and identify important properties of symmetry. The findings show that Symmetry remains an area where the participants need further practice and clearer guidance.

Out of 200 students who took part in the study, only 89 or 44.50% have advanced level of knowledge as well as 40 or 20.00 percent in very good level of knowledge. Another 36 or 18.00 percent showed fair mastery, while 25 or 12.50 percent showed poor mastery and only 10 or 5.00 percent reached outstanding mastery. The results of the study confirm that despite the fact that students have some level of understanding of the topic, still their knowledge is not sufficient to deem them as professionals in the area. The distribution also shows that 69.50 percent of the participants were classified under very good mastery or average mastery, while 30.50 percent were under fair, poor mastery or no mastery.

Table 9. Summary Table of Participant's Mathematical Proficiency

Range	Interpretation	Frequency	Percentage
14.40 – 16.00	Outstanding	2	1.00
12.00 – 14.39	Very Good	38	19.00
8.00 – 11.99	Average	77	38.50
4.00 – 7.99	Fair	74	37.00
0.00 – 3.99	Poor	9	4.50

Range	Interpretation	Frequency	Percentage
Total		**200**	**100.00**
Mean		**8.42**	
SD		**3.04**	
Interpretation		**Average**	

Table 9 presents the results that Mathematical Proficiency obtained a mean of 8.42 and a standard deviation of 3.04, which indicate average level of Mathematical Proficiency. These results show that most of the participants have developed some mathematical skills, although many have not yet reached a high level of mastery.

Cahyaningsih et al. (2023) explained that mathematical proficiency involves several connected abilities and found that primary school pupils improved their mathematical proficiency after receiving problem-based learning compared with pupils who received expository instruction. Abbas et al. (2022) found among 572 Year 5 pupils that performance in fraction addition was stronger in procedural questions than in conceptual questions, which showed that some pupils could carry out procedures even when their understanding of the underlying concepts remained limited. The findings show that Mathematical Proficiency remains an area that needs further strengthening among the participants.

This finding is related to the present study since the participants were assessed across fractions, factors and multiples, and symmetry, and the fair level of Mathematical Proficiency may show that some skills are already present while deeper understanding still needs development. The pupils may benefit from lessons that combine conceptual understanding, correct procedures, problem solving, and guided practice rather than focusing only on obtaining correct answers. Giving pupils more chances to explain their solutions, connect ideas across topics, and apply mathematics in different tasks may also help them move from fair or poor mastery toward satisfying and excellent mastery.

To determine whether the participants' Instructional Strategies and Student Engagement are significantly associated with their Mathematical Proficiency.

Table 10. Canonical Correlation Analysis Between Mathematical Proficiency and Instructional Strategies

Variable	Cross loading	R_c	R_c^2	F(3,196)	p
Instructional Strategies	-0.26				
Mathematical Proficiency		0.26	0.07	4.885	0.003
Fractions	-0.21				
Factors and Multiples	-0.20				

Variable	Cross loading	R_c	R_c^2	F(3,196)	p
Symmetry	0.01				

**Significant at 0.05 two-tailed alpha level.*

Table 10 presents the result of a significant weak canonical correlation between Mathematical Proficiency and Instructional Strategies, F(3, 196) = 4.885, p = .003, Rc = .26, Rc^2 = .07. The significant result indicates that Instructional Strategies and Mathematical Proficiency are statistically related, although the strength of the relationship is weak. The squared canonical correlation further shows that the two canonical variates share about 7 percent of their variance, which means that a large part of the variation in Mathematical Proficiency is still related to other factors that were not included in this analysis.

The significant relationship is consistent with Osborne's (2021) findings that teacher instructional practices had statistically significant relationships with mathematics achievement even after several student and school factors were considered. Kim et al. (2022) also found significant associations between mathematics instruction and student achievement among elementary school learners. The significant finding has an important implication for mathematics instruction since the instructional practices used by teachers are related to pupils' mathematical performance, but the weak Rc value shows that instructional strategies represent only one part of the learning process.

The cross-loadings show that Fractions had the largest contribution to the canonical relationship at −.21, followed closely by Factors and Multiples at −.20, while Symmetry had a very small cross-loading of .01. The negative signs should not be interpreted as showing that better Instructional Strategies are related to poorer performance, since the direction of a canonical function can be reversed without changing its statistical meaning. The absolute values instead show that Fractions and Factors and Multiples are more closely represented in the significant canonical relationship than Symmetry. The results indicate that the association of Instructional Strategies with Mathematical Proficiency is realized mostly through children's performance in Fractions and Factors and Multiples.

Table 11. Canonical Correlation Analysis Between Mathematical Proficiency and Student Engagement

Variable	Cross loading	R_c	R_c^2	F(9,472)	p
Student Engagement					
Affective Engagement	-0.24	0.29	0.08	2.190*	0.022
Behavioral Engagement	-0.26				
Cognitive Engagement	-0.29				

Variable	Cross loading	R_c	R_c^2	F(9,472)	p
Mathematical Proficiency					
Fractions	-0.26				
Factors and Multiples	-0.23				
Symmetry	-0.09				

**Significant at 0.05 two-tailed alpha level.*

Table 11 presents the result of a significant weak canonical correlation between Mathematical Proficiency and Student Engagement, F(9, 472) = 2.190, p = .022, Rc = .29, Rc^2 = .08. The significant result indicates that Student Engagement and Mathematical Proficiency are statistically related, although the strength of the relationship is weak. The squared canonical correlation shows that the two canonical variates share about 8 percent of their variance, which means that Student Engagement is related to Mathematical Proficiency but does not account for most of the differences in pupils' mathematics performance. The significant result is consistent with Maamin et al. (2021), who found that affective, behavioral, and cognitive engagement were significantly related to mathematics achievement among 1,000 secondary school students. Reinhold et al. (2021) also found that engagement had an important role in learning fractions among sixth-grade pupils who used an electronic mathematics textbook. The findings suggest that strengthening Student Engagement may be useful in supporting Mathematical Proficiency, particularly by helping pupils remain mentally active and behaviorally involved during mathematics lessons.

To determine whether Instructional Strategies and Student Engagement significantly predict Mathematical Proficiency.

Table 12. Regression Analysis of Instructional Strategies and Student Engagement on Mathematical Proficiency

Predictor	Unstandardized Coefficients		β	95% CI		t	p
	B	SE		Lower	Upper		
Constant	4.86	1.23		2.42	7.29	3.939*	<.001
Instructional Strategies	-0.94	0.59	-0.223	-2.10	0.23	-1.586	0.114
Student Engagement	1.77	0.56	0.449	0.68	2.87	3.194*	0.002
Model Summary							

Predictor	Unstandardized Coefficients		β	95% CI		t	p
	B	SE		Lower	Upper		
R=0.276 R^2=0.076 Adj R^2=0.067 F(2,197)=8.142* p<.001							

*Note. B = unstandardized beta coefficient, SE = standard error, β = standardized beta coefficient, 95% CI = 95% confidence interval, t = t statistic, p = probability value. *Significant at 0.05 two-tailed alpha level.*

Model Equation: MP = 1.77SE + 4.86

Legend: MP = Mathematical Proficiency, SE = Student Engagement

Table 12 presents the regression model was statistically significant, F (2, 197) = 8.142, p < .001, with R = .276, R^2 = .076, and adjusted R^2 = .067. The R^2 indicates that Instructional Strategies and Student Engagement together accounted for 7.6 percent of the variance in Mathematical Proficiency, while the adjusted value indicates an estimated 6.7 percent after considering the number of predictors included in the model and the remaining 93.3 percent is explained by other factors. The result shows that the predictors, when considered together, have a significant relationship with Mathematical Proficiency, although most of the variation in mathematical performance remains related to factors outside the model. The result implies that although the regression model was statistically significant, Instructional Strategies and Student Engagement explained only a small proportion of the differences in learners' Mathematical Proficiency. This interpretation is supported by Zhu and Kaiser (2022), who found that the relationships among teaching practices, learner-related variables, and mathematics achievement were not uniformly direct, suggesting that classroom instruction operates together with other student-level factors.

To determine whether Student Engagement significantly mediates the relationship between Instructional Strategies and Mathematical Proficiency.

Table 13. Model Fit Indices

Index	Estimate	Cut-off Criterion	Interpretation
Cmin/df	1.809	Between 0 and 3	Excellent
CFI	0.989	≥0.90	Excellent
SRMR	0.035	≤0.08	Excellent
RMSEA	0.064	<.08	Excellent
PClose	0.266	>0.05	Excellent

Note. Cmin/df = Minimum Discrepancy divided by Degrees of Freedom; CFI = Comparative Fit Index; SRMR = Standardized Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; PClose = Probability of Close Fit. Source: Hu and Bentler (1999), "Cutoff Criteria for Fit Indexes in Covariance Structure Analysis

Table 13 presents the results that the model achieved excellent fit based on all reported criteria. The Cmin/df value of 1.809 fell within the acceptable range of 0 to 3, indicating a good level of parsimonious fit. The Comparative Fit Index (CFI) of 0.989 exceeded the cut-off criterion of 0.90, which indicates that the model fits the data very

well. The Standardized Root Mean Square Residual (SRMR) value of 0.035 was below the threshold of 0.08, showing minimal residual differences between the observed and estimated covariance matrices. Taken together, these indices indicate that the mediation model was statistically acceptable and appropriate for interpreting the structural relationships among the variables.

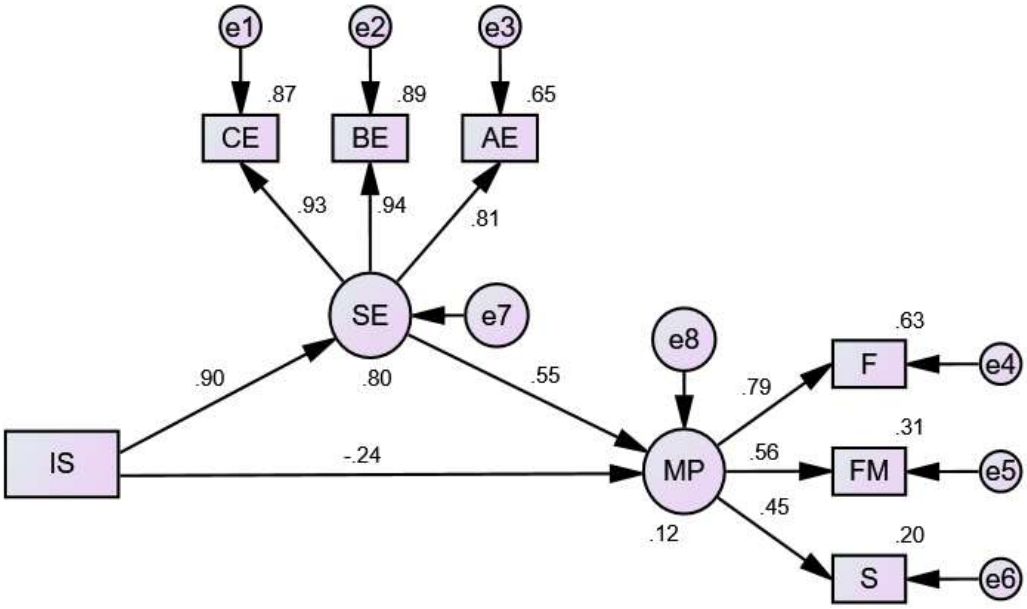


Figure 2. Mediation Analysis Best-fit Model on Instructional Strategies, Student Engagement, and Mathematical Proficiency

Legend: IS = Instructional Strategies, SE = Student Engagement, CE = Cognitive Engagement, BE = Behavioral Engagement, AE = Affective Engagement, MP = Mathematical Proficiency, F = Fractions, FM = Factors and Multiples, S = Symmetry

Figure 2 presents the best-fit mediation model showing the relationships among Instructional Strategies, Student Engagement, and Mathematical Proficiency. Overall, the pattern of coefficients shows that Instructional Strategies strongly influence Student Engagement, which in turn serves as an important mediating pathway linking Instructional Strategies with Mathematical Proficiency.

Table 14. Mediation Analysis of Instructional Strategies on Mathematical Proficiency through Student Engagement

Effect Type	Estimate	p
Total	0.419	0.022
Direct	-0.397	0.114
Indirect	0.816	0.003

**Significant at 0.05 two-tailed alpha level.*

Table 14 presents the mediation analysis results for the effect of Instructional Strategies on Mathematical Proficiency through Student Engagement. The total effect was statistically significant (Estimate = 0.419, p = 0.022), which indicates that Instructional Strategies have a significant overall relationship with Mathematical Proficiency. The findings indicate the presence of full statistical mediation, meaning that Student Engagement significantly mediates the relationship between Instructional Strategies and Mathematical ProficiencyThus, Instructional Strategies do not influence Mathematics Proficiency directly in statistically significant terms when Student Engagement is considered. In fact, Instructional Strategies in relation to Mathematics Proficiency operate through Student Engagement. In other words, effective instructional strategies lead to an increase in mathematical proficiency due to the positive effect of these strategies on students' engagement during mathematics classes. Therefore, simply using the instructional strategies may not result in an increase in mathematical proficiency unless these strategies are well incorporated into students' engagement.

Table 15. Mediation Analysis Summary Table

Path	Total Effect	Direct Effect	Indirect Effect	Mediation
IS > SE > MP	0.419*	-0.397	0.816*	Full

**Significant at 0.05 two-tailed alpha level.*

Table 15 summarizes the mediation analysis for the relationship between Instructional Strategies and Mathematical Proficiency through Student Engagement. The total effect of Instructional Strategies on Mathematical Proficiency was statistically significant at 0.419, $p < .05$, which shows that Instructional Strategies had a significant overall relationship with Mathematical Proficiency. This pattern indicates full mediation, which means that the significant relationship between Instructional Strategies and Mathematical Proficiency operates through Student Engagement rather than through a significant direct pathway. The findings therefore show that Student Engagement serves as an important mechanism that explains how Instructional Strategies are related to Mathematical Proficiency.

Improving instructional strategies may be more useful when teachers also ensure that pupils actively respond to those strategies through participation, interest, and mental effort. The result also supports the earlier regression finding where Student Engagement significantly predicted Mathematical Proficiency while Instructional Strategies did not provide a significant unique direct contribution when both variables were considered together.

Conclusions

The study concludes that Grade 4 learners experienced a high level of instructional strategies and demonstrated a high level of student engagement, with Behavioral Engagement obtaining the highest mean. However, their overall Mathematical Proficiency was only at the Average level, with Fractions emerging as the weakest area, while Factors and Multiples and Symmetry also showed Average Mastery based on their respective

mean scores. Instructional Strategies and Student Engagement were significantly but weakly associated with Mathematical Proficiency. Student Engagement significantly predicted Mathematical Proficiency and fully statistically mediated the relationship between Instructional Strategies and Mathematical Proficiency. This indicates that instructional strategies may be associated with better mathematical performance primarily when they promote learners' affective, behavioral, and cognitive engagement. However, because the study used a cross-sectional predictive-correlational design, the findings should be interpreted as statistical associations and mediation, not as evidence of causation.

Recommendations

Mathematics teachers should continue using clear explanations, guided questioning, meaningful activities, varied teaching approaches, and timely, understandable feedback while strengthening learners' engagement through interactive and collaborative tasks. Differentiated instruction, visual models, concrete materials, guided practice, and the proposed Fraction Learning Stations should be implemented to improve learners' conceptual understanding, particularly in Fractions. Additional visual and hands-on activities may also be used to strengthen learning in Factors and Multiples and Symmetry. School administrators and mathematics coordinators should provide adequate instructional resources and professional development focused on concept-based and engagement-centered mathematics instruction. Future researchers should examine other factors such as prior knowledge, mathematics anxiety, self-efficacy, and home support, using larger samples and longitudinal, experimental, or quasi-experimental designs to further evaluate effective mathematics interventions.

Compliance with Ethical Standards

The authors declare that this study was conducted in accordance with the ethical principles governing research involving human participants, particularly minors. Prior to data collection, informed consent was obtained from the parents or legal guardians of the participants, and assent was obtained from the learners themselves. Participation was voluntary, and the respondents were informed of their right to refuse participation or withdraw from the study at any time without penalty, disadvantage, or effect on their grades, school standing, or access to regular school services. The anonymity and confidentiality of the participants were maintained throughout the study by using participant codes instead of names and by presenting the findings only in aggregated form. Data were collected, stored, processed, and reported in accordance with applicable data-privacy requirements, and access to the research records was limited to authorized persons. The authors took appropriate measures to safeguard the participants' physical, emotional, and educational well-being during the data-gathering process, and no respondent was intentionally exposed to unnecessary risk, discomfort, or harm. The authors further declare that no conflict of interest exists in the conduct, analysis, or reporting of this study. Plagiarism, fabrication, falsification, misrepresentation, and improper appropriation of other authors' ideas or words were strictly avoided, and all sources used in the study were properly acknowledged and cited. The interpretation of the findings was undertaken objectively and based on the collected evidence, without intentional bias or manipulation of the results. The findings were used solely for academic

and research purposes and were not used to evaluate, penalize, or identify individual learners, teachers, classes, or schools. For full disclosure, artificial intelligence was used only to assist with language refinement, organization, and preliminary editing of portions of the manuscript. The authors remained responsible for the accuracy, originality, ethical compliance, interpretation, verification of sources, and final approval of all content presented in the study.

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