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Family Support Shows Stronger Links to Mathematics Achievement Among Indonesian Boarding School Students

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Abstract

Purpose : Students' mathematics achievement is shaped by a combination of internal and external factors, with family support potentially playing an important role in boarding school contexts. This study investigates the factors associated with mathematics achievement among Grade VIII students and addresses the question of whether internal and external factors, particularly family-related factors, are associated with differences in achievement.

Method : A quantitative survey design was employed with 48 Grade VIII students from Muhammadiyah Boarding School Palopo, Indonesia, comprising 24 students from Grade VIII A and 24 from Grade VIII B. Data were collected through a validated and reliable questionnaire measuring internal and external factors and students' mathematics achievement, and were analyzed using ordinal logistic regression.

Results : The results indicate that no individual factor reached statistical significance at the 5% level. Nevertheless, parental upbringing and parental support demonstrated the strongest potential associations with mathematics achievement, with significance values of 0.072 and 0.108, respectively. The model explained 22.5% of the variation in students' mathematics achievement, while 77.5% was attributable to factors outside the model.

Conclusion : These findings suggest that family support may be more relevant than school-related factors in understanding mathematics achievement, highlighting the importance of strengthening parental engagement and home-based learning support while encouraging further research into the other factors that explain students' achievement.

Keywords: Family Support; Mathematics Achievement; Parental Support; Internal and External Factors; Boarding School Students.

1. Introduction

Mathematics achievement remains an important indicator of students' academic development because it reflects not only their mastery of mathematical concepts but also their ability to reason, solve problems, and apply knowledge in different situations. Across educational systems, disparities in mathematics achievement continue to attract attention because differences in learning outcomes may emerge from conditions within students as well as from the environments in which learning takes place. In the Indonesian context, mathematics is a core subject in basic and secondary education, yet students do not demonstrate uniform levels of achievement. Such variation is particularly important in boarding school settings, where students spend substantial amounts of

time within a structured educational environment while maintaining connections with their families. The present study was conducted at Muhammadiyah Boarding School Palopo, where the available school evidence indicated noticeable differences in students' mathematics achievement. The study documentation also identified inadequate learning motivation, limited family support, and less innovative teaching practices as possible concerns related to mathematics learning.

In this study, mathematics achievement refers to the level of academic success demonstrated by students in mathematics and operationalized through achievement categories based on students' learning scores. Rather than treating achievement as a continuous raw score, the study classified students' achievement into ordered categories—low, moderate, and high—to accommodate ordinal logistic regression analysis. The explanatory factors are divided into internal factors and external factors. Internal factors include students' interest, attitudes, adaptability, learning motivation, learning interest, and discipline, whereas external factors encompass parental upbringing, family economic conditions, parental support, teacher methods, learning environment, curriculum, and school discipline. For example, a student may possess adequate mathematical ability but demonstrate lower achievement when motivation and learning discipline are weak; alternatively, consistent parental encouragement and assistance with learning may provide additional support for sustained engagement. Thus, mathematics achievement should be understood as a multidimensional outcome rather than the product of a single classroom variable.

Previous research provides evidence that both student-related and environmental conditions can be associated with educational outcomes. In one study, Simamora et al. (2020) examined determinants of students' learning achievement and emphasized the contribution of multiple factors, including learning facilities and student attendance. The study is relevant because it positions achievement as an outcome influenced by a combination of educational conditions rather than by a single determinant. Similarly, Lestari (2015) investigated the relationship between family environment, learning motivation, and mathematics achievement among elementary school students. The findings reported in the present study's literature review indicate that both family environment and motivation were considered important in explaining mathematics achievement. This suggests that the learning process extends beyond the classroom and that family conditions may interact with students' personal motivation.

In another study, Hariyanto et al. (2022) examined factors associated with mathematics learning motivation among students at SMK Avicena Tenjo. The study reported that 48.8% of the students were categorized as having high motivation and identified teacher follow-up, the school environment, and parental support as three important factors related to students' mathematics learning motivation. The implication is that students' engagement with mathematics may be strengthened through coordinated support from teachers, schools, and families rather than through student effort alone. In contrast, Sulasmi (2020), in a study of students at SMP Gajah Mada Medan, examined achievement from the perspective of learning management. The reported findings showed contributions from several learning-management indicators, including diligence, persistence, completing assignments, having a study schedule, and discipline, with student discipline emerging as the strongest factor. This finding highlights the potential importance of internal behavioral regulation in academic achievement and provides a useful contrast to studies emphasizing family or environmental factors.

Other research reported in the source literature also emphasizes the role of the school environment and teacher practices. Yusriani et al. (2022), for example, discussed efforts by teachers to address students' learning difficulties, while the present study's theoretical framework identifies teacher methods, curriculum, learning environment, and school discipline as external factors potentially related to achievement. In mathematics specifically, the literature reviewed in the study indicates that innovative and interactive teaching approaches may support students' interest and understanding, whereas monotonous instructional practices may make abstract mathematical concepts more difficult to understand (Oktaviani, 2017). Taken together, these studies suggest that mathematics achievement may emerge from the interaction of personal characteristics, family support, teacher practices, and school conditions.

Overall, the existing evidence establishes three important points. First, mathematics achievement is multidimensional and cannot reasonably be attributed to a single factor. Second, internal characteristics such as motivation, interest, and discipline have been repeatedly identified as potentially important components of successful learning. Third, external conditions—particularly family support, teacher practices, and the learning environment—can provide important contextual resources for students. The conceptual framework of the present study therefore combines six internal factors and seven external factors to examine mathematics achievement comprehensively. This integrated perspective is particularly relevant to boarding school students because their learning experiences are shaped simultaneously by institutional routines and family relationships.

Nevertheless, an important gap remains. Much of the evidence summarized in the study literature examines individual determinants, learning motivation, learning management, or general educational achievement separately. Less attention has been given to the simultaneous examination of a broad set of internal and external factors in a boarding school context, particularly among Indonesian junior secondary students. Moreover, the relative contribution of family-related factors compared with school-related factors remains insufficiently clear. This gap matters because boarding school students experience a distinctive educational arrangement: although they learn and live within a highly structured school environment, parental attitudes and support may continue to shape their academic experiences. The present study consequently moves beyond asking whether particular factors are theoretically relevant and instead examines which factors show the strongest statistical associations with mathematics achievement within this specific context.

Accordingly, this study aims to analyze the internal and external factors associated with mathematics achievement among Grade VIII students at Muhammadiyah Boarding School Palopo, Indonesia, with particular attention to the relative position of family-related factors. The study addresses three research questions: (1) Which internal factors are associated with students' mathematics achievement? (2) Which external factors are associated with students' mathematics achievement? and (3) Which factors demonstrate the strongest association with mathematics achievement? These questions correspond to the original hypotheses concerning the influence of internal factors, external factors, and differences in the dominance of these factors.

To address these questions, the study employs a quantitative survey design involving 48 Grade VIII students, consisting of 24 students from Grade VIII A and 24 from Grade VIII B. Data are collected through questionnaires measuring internal and external factors, while mathematics

achievement is represented through ordered achievement categories. The data are analyzed using ordinal logistic regression, an approach appropriate for examining relationships between multiple predictors and an outcome measured on an ordered scale. The analysis is expected to identify whether the proposed factors demonstrate statistically meaningful associations with achievement and, importantly, to determine which factors exhibit comparatively stronger relationships. Given the literature emphasizing both personal learning characteristics and family support, the study anticipates that several factors may contribute to achievement, while allowing the empirical analysis to determine their relative strength.

The study contributes to the literature by bringing together internal, family, and school-related factors within a single analytical framework and examining them in an Indonesian boarding school setting. Its principal novelty lies not in assuming that parental support determines achievement, but in empirically comparing family-related factors with a broader range of student and school factors. This distinction is important because the eventual findings show that no individual factor reaches statistical significance at the 5% level, although parental upbringing and parental support demonstrate the strongest potential associations, with significance values of 0.072 and 0.108, respectively. The full model explains 22.5% of the variation in mathematics achievement, leaving 77.5% attributable to factors outside the variables examined. These results provide a more nuanced understanding of family support: it emerges as the strongest potential factor in this setting, but not as a statistically confirmed determinant. Theoretically, the study therefore cautions against overly deterministic explanations of mathematics achievement; practically, it supports closer school–family collaboration while recognizing the need to investigate additional factors that account for the substantial unexplained variation in students' achievement.

2. Method

Research Design

This study employed a quantitative survey design to examine the association between students' mathematics achievement and a set of internal and external factors. The quantitative approach was selected because the study sought to measure the investigated constructs numerically and examine their statistical relationships with mathematics achievement. The research was conducted at SMP Muhammadiyah Boarding School Palopo, South Sulawesi, Indonesia, during the second semester of the 2025/2026 academic year.

The dependent construct was mathematics achievement, operationalized as students' academic achievement in mathematics based on school records. Because the statistical model required an ordinal outcome, students' original mathematics scores were classified into three ordered categories: low, moderate, and high, coded as 1, 2, and 3, respectively.

The independent constructs comprised two groups. The internal factors included student interest, attitude/behavior, adaptability, learning motivation, learning interest, and learning discipline. The external factors included parental upbringing, family economic condition, parental support, teacher teaching strategy, learning environment, curriculum, and school discipline. The principal construct highlighted in the present article, family support, was operationalized through the provision of learning facilities, parental supervision and assistance, encouragement and advice, and parental involvement in school activities.

Participants and Sample

The target population consisted of Grade VIII students enrolled at SMP Muhammadiyah Boarding School Palopo during the 2025/2026 academic year. The population was selected because the students experienced a relatively comparable educational context, including mathematics instruction, boarding-school routines, school discipline, and social interactions. The total population comprised 48 Grade VIII students.

A total sampling technique was employed because the population was relatively small and all eligible members could be included in the study. Consequently, the sample consisted of all 48 Grade VIII students, distributed equally between Class VIII A (n = 24) and Class VIII B (n = 24).

The source document does not specify separate exclusion criteria; therefore, the reproducible sampling criterion supported by the study is enrollment as an active Grade VIII student at the research site during the study period. No additional demographic characteristics beyond class membership are reported in the source methodology.

Instruments and Materials

Data were collected using a student questionnaire and school-documentation records. The questionnaire employed a four-point frequency response scale: Always, Often, Sometimes, and Never. The questionnaire was developed from predetermined indicators covering the internal and external factors examined in the study.

The internal-factor items measured students' motivation, learning interest, discipline, interest in mathematics, attitudes/behavior, and adaptability. For example, learning motivation included willingness to understand learning materials, willingness to complete assignments, desire to achieve high academic results, and persistence when encountering learning difficulties. Adaptability included students' ability to adjust to changes in learning activities, cope with learning difficulties, adapt their learning approaches, respond to new situations, and manage emotions during learning.

The external-factor items covered parental upbringing, family economic condition, parental support, teacher teaching strategy, learning environment, curriculum, and school discipline. Parental support was specifically measured through four indicators: provision of learning facilities, supervision and assistance with learning, encouragement and advice, and involvement in school activities. Teacher strategy was measured through clarity of instruction, variation in teaching methods, use of learning media, and opportunities for students to ask questions and participate in discussion.

Mathematics achievement was obtained through documentary records of students' mathematics grades, such as report-card grades or examination/evaluation records. The original scores were subsequently classified into three ordinal categories—low, moderate, and high—and coded numerically for statistical analysis.

Instrument validity and reliability

Content validity was assessed by three expert validators, consisting of two Mathematics Education lecturers from UIN Palopo and one mathematics teacher from SMP Muhammadiyah Boarding School Palopo. The experts evaluated the questionnaire, and the resulting content-validity evidence was calculated using Aiken's V. The instrument obtained an overall Aiken's V index of 0.88.

Internal consistency reliability was assessed using Cronbach's alpha. The questionnaire obtained a reliability coefficient of 0.67, which the source study classified as meeting its reliability criterion. Thus, the questionnaire was considered suitable for data collection.

Procedure and Data Collection

Data collection followed a sequential procedure. First, the researcher obtained permission to conduct the study at SMP Muhammadiyah Boarding School Palopo and identified the Grade VIII population. Second, all 48 eligible Grade VIII students were included through total sampling. Third, the questionnaire measuring internal and external factors was administered to the students using the predetermined four-point frequency scale. Fourth, the researcher collected students' mathematics achievement records from authorized school documentation. The source methodology specifies that permission was obtained from the school before the academic records were accessed.

Fifth, the completed questionnaires were checked and the responses were converted into numerical scores according to the predetermined scoring procedure. Sixth, the mathematics achievement records were converted into the three ordinal categories and coded as 1 (low), 2 (moderate), and 3 (high). Finally, the questionnaire and achievement data were entered into the statistical software for analysis.

The study did not involve an intervention, experimental treatment, or manipulation of the instructional process. It was therefore conducted as an observational survey in which information on students' characteristics and learning contexts was collected without altering the existing educational conditions.

Data Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS). The analysis proceeded from descriptive examination to ordinal regression analysis.

First, descriptive statistics were used to summarize the distributions and scores of the investigated variables. Second, because mathematics achievement was represented by three ordered categories, ordinal logistic regression was used to examine the relationship between the internal and external factors and the ordered mathematics-achievement outcome. The model included the specified internal and external constructs as predictors.

Before hypothesis testing, the study assessed the statistical requirements of the ordinal logistic regression model, including model fit and the parallel-lines/proportional-odds assumption. The analysis sequence documented in the study included descriptive statistics, model-fit testing, testing of the parallel-lines assumption, examination of pseudo-R^2, and hypothesis testing through the ordinal logistic regression model.

Statistical decisions were based on a 5% significance level (α=.05). A predictor was considered statistically significant when its corresponding significance value was below .05. The analysis also compared the relative statistical strength of the predictors to identify which factors demonstrated the strongest association with mathematics achievement. The analysis was conducted after the questionnaire had been established as valid and reliable.

Ethical Considerations

The study involved human participants and access to students' academic records; therefore, data collection was conducted with authorization from the participating school. The source

methodology explicitly indicates that permission from the school was obtained before students' academic records were accessed.

Because the source manuscript does not explicitly document the name of an institutional ethics committee, ethics approval number, written parental consent procedure, or assent procedure, these details are not added here to avoid introducing unsupported methodological information. For reporting purposes, participants' questionnaire responses and academic records should be treated as confidential research data, with individual students not identifiable in the analysis or publication.

3. Results

Participant Distribution and Descriptive Statistics

The study included 48 Grade VIII students, comprising 24 students from Class VIII A and 24 students from Class VIII B. Descriptive analysis showed that the mathematics achievement variable had scores ranging from 1 to 3, with a mean of 1.85 and a standard deviation of 0.743. Across the predictor variables, the observed mean scores ranged from 6.90 to 10.23. The highest mean was recorded for student behavior/attitude (10.23), whereas school discipline had the lowest mean (6.90).

Table 1. Descriptive Statistics of Study Variables

Variable	N	Minimum	Maximum	Mean	SD
Student interest	48	8	12	9.75	—
Behavior/attitude	48	8	12	10.23	—
Adaptability	48	6	8	7.12	—
Learning motivation	48	6	9	7.25	—
Learning interest	48	6	9	7.48	—
Learning discipline	48	6	9	7.38	—
Parental upbringing	48	6	9	7.38	—
Family economic condition	48	6	9	7.25	—
Parental support	48	6	8	7.29	—
Teacher method	48	5	8	7.02	—
Curriculum	48	5	8	6.96	—
Learning environment	48	4	8	6.92	—
School discipline	48	6	8	6.90	—
Mathematics achievement	48	1	3	1.85	**0.743**

Instrument Validity and Reliability

All 28 questionnaire items met the item-validity criterion. The critical value was r = 0.2845, while the observed item correlations ranged from 0.3318 to 0.6141. Thus, every questionnaire item exceeded the specified critical value. The questionnaire demonstrated a Cronbach's alpha of 0.852 across 28 items.

Ordinal Logistic Regression Model Fit

The ordinal logistic regression model was evaluated using model-fitting statistics. The −2 Log Likelihood decreased from 101.384 for the intercept-only model to 90.791 for the final model. The model-fitting test produced a χ^2 value of 10.593 (df = 13, p = .645).

Table 2. Model Fitting Information

Model	−2 Log Likelihood	χ^2	df	p
Intercept only	101.384	—	—	—
Final	90.791	10.593	13	.645

Test of the Parallel-Lines Assumption

The proportional-odds assumption was assessed using the Test of Parallel Lines. The null hypothesis model had a −2 Log Likelihood of 90.791, while the general model had a −2 Log Likelihood of 68.763. The resulting chi-square statistic was 22.028 (df = 13, p = .055).

Table 3. Test of Parallel Lines

Model	−2 Log Likelihood	χ^2	df	p
Null hypothesis	90.791	—	—	—
General	68.763	22.028	13	.055

Explained Variation of the Model

Three pseudo-R^2 measures were obtained. The Cox and Snell value was 0.198, the Nagelkerke value was 0.225, and the McFadden value was 0.104.

Table 4. Pseudo-R^2 Statistics

Pseudo-R^2 measure	Value
Cox and Snell	0.198
Nagelkerke	0.225
McFadden	0.104

Associations Between Internal and External Factors and Mathematics Achievement

The ordinal logistic regression analysis examined 13 predictor variables. At the prespecified significance level of .05, none of the predictors reached statistical significance. The smallest p-value was observed for parental upbringing (p = .072), followed by parental support (p = .108). The remaining predictors had p-values ranging from .254 to .995.

Table 5. Ordinal Logistic Regression Results

No.	Predictor	p-value	α	Statistical result
1	Student interest	.995	.05	Not significant
2	Behavior/attitude	.556	.05	Not significant
3	Adaptability	.874	.05	Not significant
4	Learning motivation	.259	.05	Not significant
5	Learning interest	.837	.05	Not significant
6	Learning discipline	.856	.05	Not significant
7	Parental upbringing	.072	.05	Not significant
8	Family economic condition	.375	.05	Not significant
9	Parental support	.108	.05	Not significant

10	Teacher method	.373	.05	Not significant
11	Curriculum	.552	.05	Not significant
12	Learning environment	.565	.05	Not significant
13	School discipline	.254	.05	Not significant

Among the internal factors, p-values were .995 for student interest, .556 for behavior/attitude, .874 for adaptability, .259 for learning motivation, .837 for learning interest, and .856 for learning discipline. Among the external factors, p-values were .072 for parental upbringing, .375 for family economic condition, .108 for parental support, .373 for teacher method, .552 for curriculum, .565 for learning environment, and .254 for school discipline.

Comparison Between Grade VIII A and Grade VIII B

The mean scores of the two classes were compared across all study variables. The mean values were closely distributed between the two groups. For mathematics achievement specifically, Class VIII A recorded a mean score of 1.83, whereas Class VIII B recorded 1.88.

Table 6. Mean Scores by Class

Variable	Grade VIII A	Grade VIII B
Student interest	9.71	9.79
Behavior/attitude	10.17	10.29
Adaptability	7.13	7.13
Learning motivation	7.21	7.29
Learning interest	7.46	7.50
Learning discipline	7.33	7.42
Parental upbringing	7.33	7.43
Family economic condition	7.21	7.29
Parental support	7.25	7.33
Teacher method	7.00	7.04
Curriculum	6.92	7.00
Learning environment	6.88	6.96
School discipline	6.88	6.92
Mathematics achievement	1.83	1.88

The largest difference between the two classes among the reported predictor means was 0.12 for behavior/attitude, while adaptability had identical mean scores of 7.13 in both classes. The mathematics achievement means differed by 0.05.

Summary of Principal Findings

The final ordinal logistic regression model included 13 predictors and yielded $\chi^2(13) = 10.593$, $p = .645$, with a parallel-lines test of $\chi^2(13) = 22.028$, $p = .055$. The Nagelkerke pseudo-R^2 was .225. None of the 13 predictors reached the $p < .05$ criterion. The two smallest p-values were observed for parental upbringing ($p = .072$) and parental support ($p = .108$). The class-level descriptive comparison also showed closely aligned mean scores between Grade VIII A and Grade VIII B, including mathematics achievement scores of 1.83 and 1.88, respectively.

4. Discussion

This study examined whether internal and external factors were associated with mathematics achievement among Grade VIII students at Muhammadiyah Boarding School Palopo. The central finding is that none of the examined factors demonstrated a statistically significant association with mathematics achievement at the 5% level. Nevertheless, family-related factors—particularly parental upbringing and parental support—showed the strongest statistical signals among the predictors examined. The findings therefore do not support a simple explanation in which students' mathematics achievement is determined predominantly by motivation, discipline, teacher practices, or school conditions. Instead, the results suggest that mathematics achievement in this boarding-school context is likely shaped by a broader combination of factors, many of which were not captured by the present model. The model accounted for approximately one-fifth of the variation in achievement, indicating that substantial explanatory space remains outside the variables investigated.

The first research question concerned the relationship between internal factors and mathematics achievement. The findings do not provide empirical support for the hypothesis that the examined internal factors significantly influence mathematics achievement. Student interest, behavior or attitude, adaptability, learning motivation, learning interest, and learning discipline did not reach the predetermined significance criterion. Accordingly, the hypothesis concerning the significant contribution of internal factors was not supported.

This result should not be interpreted as evidence that motivation, discipline, interest, or student behavior are irrelevant to mathematics learning. Rather, within this particular sample and model, their measured variation was insufficient to establish statistically reliable differences in mathematics achievement. This distinction is important because educational processes are rarely determined by isolated variables. A student may report high motivation or discipline while still obtaining similar achievement outcomes to peers because instructional quality, prior mathematical knowledge, cognitive ability, peer influences, assessment practices, or other contextual factors may simultaneously operate.

The second research question examined external factors, including parental upbringing, family economic condition, parental support, teacher methods, curriculum, learning environment, and school discipline. This hypothesis was also not supported in its statistical form, because none of the external predictors reached the 5% significance threshold. However, the pattern of coefficients provides an important nuance: parental upbringing and parental support were the two family-related variables closest to the significance criterion. The original study similarly identifies these two variables as the strongest potential factors among those examined.

The third research question concerned the most dominant factor. Here, the evidence partially supports the expectation that family-related factors would occupy a prominent position, but it does not support the stronger claim that parental support was a statistically confirmed determinant. In other words, the findings support a relative pattern, not a statistically significant causal conclusion. This distinction is particularly important for a Scopus-level article because a p-value above .05 should not be reframed as evidence of a confirmed effect.

The relatively stronger position of parental upbringing and parental support can be understood through a home–school learning perspective, in which academic achievement develops

through interactions between students and the environments surrounding them. Family support may provide learning resources, supervision, encouragement, advice, and emotional reinforcement. The questionnaire itself operationalized parental support through provision of learning facilities, assistance and supervision, encouragement and advice, and parental involvement in school activities.

Such support may be particularly relevant for mathematics because mathematical learning often requires sustained practice, persistence when encountering difficult problems, and regular feedback. Parents may contribute to these processes indirectly by establishing routines, monitoring study behavior, encouraging persistence, or communicating expectations regarding academic achievement. Parental upbringing may also influence how students respond to academic difficulty: students who experience consistent expectations and encouragement may be more likely to maintain engagement when mathematics becomes challenging.

However, the boarding-school context introduces an important qualification. Students spend considerable time under school supervision, which may reduce the direct day-to-day influence of parents compared with students attending conventional day schools. Consequently, parental support may operate indirectly rather than through direct assistance with daily mathematics learning. The fact that family variables emerged as the strongest potential predictors despite this institutional context makes them worthy of further investigation, but the present design cannot establish the mechanism through which they operate.

The findings both converge with and diverge from previous research. Eni Lestari (2015), for example, examined the relationship between family environment, learning motivation, and mathematics achievement and identified family environment and motivation as relevant explanatory factors. The present study is broadly consistent with the family-support dimension of that research because parental upbringing and support produced the strongest statistical signals. Nevertheless, the absence of statistically significant predictors in the present study indicates a weaker relationship than might be expected from studies reporting significant associations.

A similar pattern can be observed in Hariyanto et al. (2022), who investigated factors associated with mathematics learning motivation among students at SMK Avicena Tenjo. Their study identified teacher follow-up, school environment, and parental support as important factors related to students' motivation. The present findings are compatible with the relevance of parental support, but they differ in outcome: Hariyanto et al. focused on mathematics learning motivation, whereas the present study examined mathematics achievement. Parental support may therefore be more directly related to motivational processes than to achievement outcomes themselves.

In contrast, Sulasmi's (2020) research identified student discipline as the strongest factor in explaining learning achievement. The present study did not reproduce this pattern; learning discipline was not among the strongest predictors. This discrepancy may reflect differences in participants, educational setting, measurement instruments, or analytical strategy. Importantly, the present study involved only 48 students in a boarding-school environment and simultaneously entered 13 predictors into the ordinal logistic regression model. Such contextual and methodological differences make direct comparison of effect patterns difficult.

The broader literature included in the source study also supports the multidimensional character of academic achievement. Simamora et al. (2020) examined determinants of students'

learning achievement, while Anjani et al. (2024) specifically analyzed factors associated with mathematics achievement. The present study extends this line of inquiry by bringing a relatively broad collection of internal and external factors into one ordinal regression model within an Indonesian boarding-school context.

Theoretically, the findings contribute to a more cautious understanding of multifactorial models of mathematics achievement. The study does not confirm a single dominant psychological, family, or school determinant. Instead, the results suggest that achievement should be conceptualized as an outcome emerging from several interacting conditions, with the current variables accounting for only part of the observed variation.

This is particularly important because the source study originally conceptualized achievement through a broad framework of internal and external factors. The empirical results indicate that a theoretically plausible factor does not necessarily become a statistically significant predictor when tested simultaneously with many other constructs. The distinction between theoretical relevance and empirical explanatory power is therefore an important contribution of the study.

The family-support pattern also suggests that future models should investigate mediating or interacting mechanisms rather than assuming direct effects. For example, parental support may influence achievement through learning motivation, study discipline, mathematics self-efficacy, or engagement. Such pathways cannot be tested with the present cross-sectional model but provide a potentially stronger theoretical direction.

For schools and mathematics teachers, the findings suggest that interventions should not focus exclusively on one student characteristic or classroom practice. Although no individual factor demonstrated a statistically significant relationship with achievement, schools should continue strengthening students' motivation, interest, attitudes, and learning discipline while maintaining supportive instructional environments.

More importantly, the relative prominence of parental variables supports stronger school–family collaboration. Teachers and school administrators can establish regular communication with parents, provide guidance on supporting mathematics learning at home, and encourage parents to monitor study routines without replacing students' responsibility for learning. The original study similarly recommends closer cooperation between schools and parents because family factors emerged as the strongest potential contributors.

At the policy level, the findings caution against one-dimensional interventions. Programs designed to improve mathematics achievement in boarding schools should consider student characteristics, family relationships, instructional quality, school climate, and other contextual factors simultaneously.

Several limitations should be considered when interpreting these findings. *First*, the sample size was small. Only 48 Grade VIII students participated, all from one boarding school. The limited sample reduces statistical power and restricts the generalizability of the findings to other Indonesian schools or boarding-school populations.

Second, the sampling context was highly specific. Because all participants came from Muhammadiyah Boarding School Palopo, institutional culture, boarding arrangements, school discipline, and local educational conditions may have shaped the observed relationships.

Third, the study used a cross-sectional quantitative design. Data were collected at one point in time, preventing conclusions about temporal ordering or causality. Consequently, the finding that parental variables were the strongest potential predictors should not be interpreted as proof that parental support causes higher mathematics achievement.

Fourth, most explanatory variables were measured through self-reported questionnaire responses. Students may have responded according to social expectations or their perceptions rather than objectively observable behaviors. The original study itself recommends improving the questionnaire so that items are sharper and better differentiate respondents' answers.

Fifth, the model captured only part of the variation in mathematics achievement. The source study reports that the investigated variables explained 22.5% of the variation, leaving 77.5% outside the model. This indicates that important predictors were not included.

Future research should address these limitations through larger, multi-school samples involving different types of Indonesian schools, including boarding and non-boarding schools. Comparative studies could ask: Does parental support have a different relationship with mathematics achievement among boarding-school and day-school students?

Second, researchers should consider longitudinal designs to determine whether changes in parental support precede changes in mathematics achievement. A longitudinal research question could be: How does sustained parental support across an academic year relate to changes in students' mathematics achievement?

Third, future studies should investigate variables omitted from the present model, including prior mathematics achievement, mathematics self-efficacy, cognitive ability, peer influence, teacher quality, instructional strategies, digital learning access, attendance, and socioeconomic characteristics. This recommendation is consistent with the original study's call to add variables capable of explaining the substantial unexplained proportion of achievement variation.

Finally, future research could employ structural equation modeling or mixed-method designs to examine whether parental support affects achievement indirectly through motivation, discipline, self-efficacy, or learning engagement. Such designs would move the literature from identifying correlations toward explaining the processes through which family and school contexts shape mathematics learning.

Overall, this study demonstrates that mathematics achievement among Grade VIII students at an Indonesian boarding school cannot be adequately explained by any single internal or external factor examined in the model. Although parental upbringing and parental support emerged as the strongest potential family-related factors, neither reached the conventional threshold for statistical significance. The findings therefore provide a more nuanced contribution than a simple claim that "family support affects achievement." They indicate instead that family support warrants particular attention while remaining embedded within a broader and partly unexplained system of influences. By examining student, family, teacher, curriculum, and school factors simultaneously, the study contributes context-specific evidence from an Indonesian boarding-school setting and highlights the need for more comprehensive, longitudinal, and multi-site research. In practical terms, improving mathematics achievement should involve both school-based support and meaningful family engagement, while future research should identify the additional factors responsible for the substantial variation that remains unexplained.

5. Conclusion

This study examined the internal and external factors associated with mathematics achievement among Grade VIII students at Muhammadiyah Boarding School Palopo, Indonesia. It specifically sought to determine which student, family, and school-related factors were associated with differences in students' mathematics achievement and which factors demonstrated the strongest relationship.

The findings lead to four main conclusions. First, none of the examined internal factors—including interest, attitude, adaptability, motivation, learning interest, and learning discipline—showed a statistically significant association with mathematics achievement. Second, none of the examined external factors reached the 5% significance level. Third, among the predictors examined, parental upbringing and parental support demonstrated the strongest potential associations with mathematics achievement, although neither was statistically significant. Fourth, the overall model explained 22.5% of the variation in mathematics achievement, indicating that a substantial proportion remained associated with factors outside the model.

The study contributes to theory by demonstrating the importance of viewing mathematics achievement as a multidimensional and context-dependent outcome, rather than assuming that a single student, family, or school factor determines achievement. Practically, the findings encourage educators and school leaders to maintain comprehensive support for students while strengthening school–family collaboration, particularly through communication with parents, learning guidance, and support for students' study routines.

Future research should employ larger and multi-school samples, longitudinal designs, and broader explanatory variables to identify the factors underlying the substantial unexplained variation in mathematics achievement. Improving measurement instruments and examining indirect pathways through motivation, self-efficacy, discipline, and learning engagement may also provide a more comprehensive explanation of mathematics achievement among Indonesian boarding-school students.

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