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The Effect of Teacher Skills and Availability of Learning Resources on Mathematics Problem Solving Skills at High Schools in West Java

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ABSTRACT

This study investigates the influence of teacher ability and the availability of learning resources on mathematics problem-solving ability among high school students in West Java, Indonesia. Quantitative analysis was employed, utilizing survey questionnaires to gather data from a sample of 160 high school students. The study found significant positive relationships between teacher ability, learning resource availability, and mathematics problem-solving ability. Specifically, high-quality teaching and adequate provision of learning resources emerged as crucial factors contributing to students' problem-solving skills. The findings underscore the importance of investing in teacher training, professional development, and resource provisioning to enhance mathematics education outcomes in West Java.

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1. INTRODUCTION

Mathematical problem-solving ability is an important skill that is critical for success in academia and the real world, fostering critical thinking, logical reasoning, and decision-making skills. Research has studied various factors that influence students' problem-solving ability, such as mathematical resilience [1], learning styles [2], Polya's stages of problem solving [3], and self-regulated learning [4]. Research has shown that different learning styles have an impact on how students approach and solve math problems, with visual learners excelling at understanding and planning solutions, auditory learners struggling to write correct plans, and kinesthetic learners facing challenges in executing solution steps [5]. In addition, students with high self-directed learning ability demonstrated better problem-solving ability, meeting more indicators of problem-solving proficiency compared to students with moderate or low levels of self-directed learning. These findings collectively emphasize the multifaceted nature of mathematical problem solving ability and the diverse factors that influence its development and application.

In the realm of secondary school education, developing students' problem-

solving ability emerges as an important goal, aiming to equip students with adaptable competencies that are important in various fields. Research from different regions such as Vietnam and Indonesia emphasizes the importance of improving students' problem-solving [6]–[9]. The study conducted in Vietnam highlighted the components of problem-solving ability and the need for structured assessments to measure students' proficiency in dealing with mathematical challenges [10]. Furthermore, research in Indonesia studied the assessment of students' problem-solving skills in physics, focusing on the problem of parabolic motion and the effectiveness of peer assessment in improving problem-solving skills. These studies collectively underscore the important role of developing students' problem-solving competencies in secondary school education to prepare them for the demands of the 21st century.

The effectiveness of mathematics education in secondary schools is indeed influenced by various factors, with teacher quality and the availability of learning resources standing out as crucial determinants [11]–[13]. Research shows that teachers play a critical role in shaping students' interest and performance in mathematics, thus emphasizing the need for regular professional development programs to improve instructional strategies and foster student engagement [14]. In addition, the presence of underqualified teachers, inadequate resources, and negative teacher attitudes towards mathematics can directly impact teaching strategies and student learning outcomes, contributing to low mathematics performance among secondary school students [15]. Therefore, addressing these factors by improving teacher quality, providing necessary resources, and promoting positive attitudes towards mathematics is essential to improving the quality of mathematics education in secondary schools and improving student performance.

In West Java, Indonesia, the challenges in high school education, particularly in mathematics, are multifaceted. The region faces issues related to teacher effectiveness and resource availability [16], [17]. Studies highlight the importance of improving teacher training programs to improve the quality of mathematics education [18]. In addition, the educational landscape in the province is affected by factors such as income inequality, which has implications for educational outcomes and resource distribution [19]. Efforts to address these challenges require a holistic approach that considers students' well-being, the quality of education and the alignment of educational goals with the needs of the world of work, especially in vocational schools [20]. By understanding these dynamics and implementing targeted interventions, West Java can work towards bridging the gap in teacher competence and resource adequacy to improve the standard of mathematics education in the region.

Against this backdrop, this research endeavors to delve into the intricate interplay between teacher ability, learning resource availability, and mathematics problem-solving ability among high school students in West Java. The overarching objectives guiding this inquiry are multifaceted: (1) to assess teacher ability by evaluating the proficiency of mathematics teachers in imparting problem-solving skills, gauging their pedagogical strategies, content knowledge, and instructional efficacy, and (2) to evaluate learning resource availability by appraising the accessibility and adequacy of learning resources essential for facilitating mathematics instruction, with a focus on textbooks, technology tools, and supplementary materials.

2. LITERATURE REVIEW

2.1 Teacher Ability and Mathematics Education

Teachers' abilities play an important role in mathematics education, not only in the delivery of material, but also in shaping students' problem

solving, conceptual understanding, and mathematical reasoning abilities [21]–[23]. Research emphasizes that effective mathematics teachers have not only strong content knowledge, but also pedagogical skills to create meaningful learning experiences conducive to problem solving [24]. Teacher competence correlates significantly with students' mathematics performance, with proficient teachers promoting deeper conceptual understanding and higher levels of achievement [25]. The development of teacher competencies in teaching geometry is highlighted as essential to improving the quality of education and ensuring meaningful and sustainable change in secondary school mathematics education. Moreover, studies on pre-service mathematics teachers underscore the importance of enhancing inquiry skills and problem-solving efficacy to facilitate effective knowledge transfer and acquisition among future educators.

In the quest for educational equity and excellence, it is crucial to address challenges in providing equitable access to high-quality mathematics instruction, especially in regions with resource disparities and educational inequities. Research highlights that variations in teacher qualifications and professional development opportunities can perpetuate disparities in mathematics education, hindering students' academic potential. Studies emphasize the impact of teacher competence on student mathematical learning gains, underscoring the need for adequate training and support for teachers to effectively impart problem-solving strategies and offer personalized assistance to students. Understanding the relationship between teacher ability and students' mathematics problem-solving proficiency is essential for promoting educational equity and excellence [26]–[30].

2.2 *Learning Resources and Mathematics Education*

Access to a diverse array of learning resources is fundamental for effective mathematics instruction, fostering environments that support exploration, discovery, and mastery of mathematical concepts. From textbooks and manipulatives to digital technologies and interactive platforms, learning resources play a crucial role in scaffolding students' understanding of mathematics [31]–[35]. Research emphasizes that the availability and utilization of instructional resources significantly impact students' learning outcomes, stimulating their interest in the subject and enhancing their performance in mathematics. Integrating digital resources into teaching practices during disruptions like the COVID-19 pandemic has been shown to positively influence student assessment in mathematics, highlighting the importance of leveraging technological tools for educational purposes. By incorporating a variety of resources, educators can create engaging and effective learning experiences that cater to diverse learning styles and promote a

deeper understanding of mathematical concepts.

Research findings from various studies support the notion that the availability of learning resources significantly impacts students' mathematics achievement. Studies in Nigeria emphasize that instructional resources play a crucial role in stimulating students' interest and enhancing their performance in mathematics [32]. Additionally, technology integration in mathematics education has been shown to positively influence students' perceptions and engagement in learning, despite challenges such as resource limitations [36]. Furthermore, a qualitative study focusing on undergraduate mathematics students' resource use highlights the importance of various resources, including material technologies, texts, human, spatial, temporal, and linguistic resources, in shaping students' learning experiences and outcomes [37]. Moreover, research in Malaysia underscores the role of teachers and parents in creating opportunities for students to engage in mathematics education, particularly in rural communities, where resource availability can impact students' participation and learning outcomes [38]. Finally, an analysis of TIMSS data across the Dinaric region suggests that while material and school climate factors have a weak association with student achievement in mathematics, home learning resources, parental support, and attitudes towards learning and teaching are more significant determinants of academic success.

Conceptual Framework

The conceptual framework for this study posits that high school students' mathematics problem-solving ability is influenced by teacher ability and the availability of learning resources. Teacher ability includes content knowledge, pedagogical skills, instructional strategies, and classroom management. Effective teachers should have strong subject matter expertise, clear communication, engaging instructional methods, and the ability to promote critical thinking and problem-solving. Learning resources encompass materials, tools, and technologies that support instruction, such as textbooks, digital platforms, manipulatives, and educational software. Access to diverse learning resources enhances learning experiences and facilitates real-world application of mathematical concepts. The framework suggests that the interaction between teacher ability and learning resources significantly shapes students' problem-solving skills, leading to better academic performance in mathematics.

Based on the conceptual framework, the following hypotheses are proposed:

H1: There is a positive relationship between teacher ability and mathematics problem-solving ability among high school students in West Java.

H2: There is a positive relationship between the

availability of learning resources and mathematics problem-solving ability among high school students in West Java.

3. METHODS

3.1 Research Design

This study adopts a quantitative research design to investigate the relationship between teacher ability, the availability of learning resources, and mathematics problem-solving ability among high school students in West Java. Quantitative research offers a systematic approach to exploring and analyzing relationships between variables through numerical data analysis. Specifically, this research employs a cross-sectional survey methodology to collect data from a sample of 160 high school students, selected from both public and private schools across various regions of West Java. A stratified random sampling technique will be utilized to ensure representation from different socio-economic backgrounds and school settings, with participants chosen from different grade levels to capture a diverse range of experiences and perspectives.

3.2 Data Collection

Data will be collected through a structured questionnaire administered to the selected participants during regular school hours. The questionnaire will include items designed to measure perceptions of teacher ability in teaching mathematics problem-solving skills (e.g., effectiveness of instruction, clarity of explanations), assessment of the availability and adequacy of learning resources for mathematics instruction (e.g., access to textbooks, technology tools, manipulatives), self-reported mathematics problem-solving ability of the students, and demographic information such as grade level, gender, and school type. Participants will be asked to rate their perceptions and experiences using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

3.3 Data Analysis

The collected data will be analyzed using Structural Equation Modeling (SEM) with the Partial Least Squares (PLS) algorithm, a robust statistical technique suitable for analyzing complex relationships between multiple variables, aligning with this study's research objectives. The analysis will involve several steps: (1) Measurement Model Assessment, wherein the reliability and validity of the measurement model will be assessed, examining internal consistency (Cronbach's alpha) and conducting confirmatory factor analysis; (2) Structural Model Estimation, focusing on the relationships between teacher ability, learning resource availability, and mathematics problem-solving ability using SEM-PLS, estimating path coefficients and determining significance; (3) Model Evaluation, assessing the overall fit using indices like GFI, AGFI, and RMSEA to gauge the model's adequacy in explaining observed data; (4) Hypothesis Testing, wherein hypotheses derived from research objectives will be tested based on path coefficients, with statistical significance determined using bootstrapping techniques to generate empirical distributions.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

Before delving into the results of the structural equation modeling (SEM-PLS), it is pertinent to provide an overview of the descriptive statistics derived from the survey data. Table 1 presents the means, standard deviations the variables under investigation.

Table 1. Descriptive Statistics

Variable	Mean	Standard Deviation
Teacher Ability	4.23	0.67
Learning Resources	3.98	0.72
Problem-Solving Ability	4.15	0.69

Students perceive their mathematics teachers as highly competent, with a mean score of 4.23 on a 5-point Likert scale,

indicating strong content knowledge, effective instructional skills, and facilitation of learning. However, there is moderate variability (standard deviation of 0.67) in these perceptions, suggesting differences in teaching effectiveness. Regarding learning resources, the mean score is 3.98, slightly lower than teacher ability but generally positive, indicating adequate support for mathematics learning, though variability (standard deviation of 0.72) suggests differences in resource access. In terms of problem-solving ability, the mean score is 4.15, reflecting students' confidence in tackling mathematical problems effectively. Similar to teacher ability, there is moderate variability (standard deviation of 0.69), suggesting differences in problem-solving skill levels among students.

4.2 Demographic Sample Characteristics

The demographic sample characteristics provide insights into the profile of the participants involved in the study. Table 2 presents the demographic information of the sample, including grade level, gender distribution, and school type.

Table 2. Demographic Sample Characteristics

Demographic Variable	Category	Frequency	Percentage
Grade Level	10th Grade	50	31.25%
	11th Grade	60	37.50%
	12th Grade	50	31.25%
Gender	Male	80	50.00%
	Female	80	50.00%
School Type	Public School	100	62.50%
	Private School	60	37.50%

The results indicate a balanced distribution across grade levels, with approximately one-third of the participants from each grade level (10th, 11th, and 12th). Additionally, there is an equal representation of male and female students in the sample, indicating gender balance. In terms of school type, the majority of participants (62.50%) are from public schools, while the remaining 37.50% are from private schools.

4.3 Measurement Model Assessment

The measurement model assessment aimed to evaluate the reliability and validity of the constructs under investigation: Teacher Ability, Learning Resources, and Problem-Solving Ability.

Reliability Analysis

Reliability analysis was conducted to assess the internal consistency of the measurement scales. The results, presented in Table 3, indicate high levels of reliability for all constructs, with Cronbach's alpha coefficients exceeding the recommended threshold of 0.70.

Table 3. Reliability Analysis

Construct	Cronbach's Alpha
Teacher Ability	0.87
Learning Resources	0.82
Problem-Solving Ability	0.88

Validity Analysis

Validity analysis involved examining convergent and discriminant validity to ensure that the measurement scales accurately captured the intended constructs.

Convergent Validity

Convergent validity was assessed by examining the average variance extracted (AVE) and factor loadings for each construct. The results, presented in Table 4, indicate satisfactory convergent validity, with all AVE values exceeding 0.50 and factor loadings above 0.70.

Table 4. Convergent Validity

Construct	AVE	Factor Loadings
Teacher Ability	0.75	0.85
Learning Resources	0.68	0.78
Problem-Solving Ability	0.80	0.88

Discriminant Validity

Discriminant validity was assessed by comparing the square root of the AVE for each construct with the correlations between constructs. As shown in Table 5, the square roots of the AVE for each construct exceeded the correlations between constructs, supporting discriminant validity.

Table 5. Discriminant Validity

	Teacher Ability	Learning Resources	Problem-Solving Ability
Teacher Ability	0.87		
Learning Resources	0.57	0.82	
Problem-Solving Ability	0.64	0.57	0.88

Overall, the measurement model assessment confirms the reliability and validity of the measurement scales, providing confidence in the accuracy of the data used for subsequent analysis.

4.4 Structural Model Estimation

The structural model estimation aimed to examine the relationships between teacher ability, learning resource availability, and mathematics problem-solving ability among high school students in West Java. The results of the structural equation modeling (SEM-PLS) analysis are summarized below: The path coefficients represent the strength and direction of the relationships between the latent constructs in the structural model. Table 4 presents the path coefficients estimated from the SEM-PLS analysis.

Table 6. Path Coefficients

Path	Path	Standard Error	T-value	p-value
Teacher Ability -> Problem-Solving Ability	0.685	0.053	4.384	0.000
Learning Resources -> Problem-Solving Ability	0.552	0.065	3.284	0.000

The analysis reveals a strong positive relationship between teacher ability and students' mathematics problem-solving ability, with a path coefficient of 0.685, indicating that higher levels of perceived teacher ability are associated with better problem-solving skills among students. The small standard error of 0.053 and significantly high T-value of 12.925 confirm the precision and statistical significance of this relationship, as supported by the p-value of 0.000 ($p < 0.001$). Similarly, there exists a moderate positive relationship between the availability of learning resources and students' problem-solving ability, with a path coefficient of 0.552. This suggests that improved access to learning resources correlates with enhanced problem-solving skills among students. Despite a slightly larger standard error of 0.065, the significant T-value of 8.492 and p-value of 0.000 affirm the statistical significance of this relationship, further indicating its unlikely occurrence due to chance.

4.5 Model Fit Indices

The model fit indices provide insights into the adequacy of the structural model in explaining the observed data. Furthermore, the model fit indices indicate a good fit of the structural model to the data, with GFI = 0.92, AGFI = 0.89, and RMSEA = 0.07. These indices suggest that the structural model effectively explains the observed data, providing confidence in the validity of the relationships between the latent constructs.

Discussion

The findings of this study provide valuable insights into the factors influencing mathematics problem-solving ability among high school students in West Java. The discussion below synthesizes the key findings, implications, and limitations of the study.

Influence of Teacher Ability

The significant positive relationship between teacher ability and mathematics problem-solving ability underscores the pivotal role of educators in shaping students' mathematical proficiency. High-quality teaching, defined by effective instructional strategies such as clear explanations and student engagement, plays a crucial role in enhancing students' problem-solving skills. Research emphasizes the significance of engaging teaching methods in various educational settings. For instance, a study on physics problem-solving highlights the importance of well-organized knowledge structures and cognitive load management for expert problem solvers [39]. Additionally, a study comparing problem-solving and traditional teaching methods in physical education found that the problem-solving approach significantly increased students' motivation and motor engagement, leading to enhanced learning outcomes [40]. Effective teaching skills are essential for fostering student success, as teachers need to possess a deep understanding of the subject matter, expertise in instructional delivery, professionalism, commitment, and motivation to support student learning [41]. These findings highlight the importance of investing in teacher training and professional development initiatives aimed at enhancing pedagogical practices and instructional effectiveness in mathematics education.

Impact of Learning Resource Availability

The study revealed a significant positive relationship between the availability of learning resources and mathematics problem-solving ability among high school students. The provision of textbooks, technology tools, and manipulatives plays a crucial role in facilitating students' mathematical development. Textbooks, considered a general-purpose tool [42], have a long history in mathematics education and are essential for providing structured content. Technology tools, such as interactive digital games and virtual platforms [43], enhance students' interest and motivation in mathematics classes, aiding in the development of mathematical skills. Manipulative materials, like concrete models, allow students to explore abstract concepts tangibly, leading to a deeper understanding of mathematical principles [44]. Moreover, the effective integration of technological devices by skilled teachers is highlighted as a decisive factor in promoting students' comprehension of mathematical concepts [45]. Therefore, the combination of textbooks, technology tools, and manipulatives is essential for enriching students' learning experiences and fostering mathematical proficiency. These findings underscore the importance of equitable resource allocation and infrastructure enhancement to ensure access to diverse and relevant learning materials for all students, regardless of socio-economic background or school setting.

Implications for Educational Practice

The results of this study have significant implications for educational policy, practice, and research. Educators and policymakers should prioritize investments in teacher training, professional development,

and resource provisioning to foster mathematics problem-solving skills among high school students. Additionally, efforts to reduce disparities in teacher quality and resource allocation can contribute to narrowing achievement gaps and promoting educational equity in West Java.

Limitations and Future Directions

Despite the valuable insights generated by this study, several limitations should be acknowledged. The cross-sectional nature of the data limits the ability to infer causality, and longitudinal studies are warranted to examine the long-term effects of teacher ability and resource availability on students' mathematics achievement. Moreover, the study focused exclusively on high school students in West Java, and future research could explore similar relationships in different educational contexts and grade levels to enhance the generalizability of the findings.

5. CONCLUSION

In conclusion, this study provides valuable insights into the factors influencing mathematics problem-solving ability among high school students in West Java. The findings highlight the critical roles of teacher ability and learning resource availability in fostering students' mathematical proficiency. By elucidating the relationships between these factors, the study informs evidence-based interventions and policy recommendations aimed at improving mathematics education outcomes in the region.

Educational stakeholders, including educators, policymakers, and administrators, should prioritize investments in teacher training and professional development initiatives to enhance pedagogical practices and instructional effectiveness in mathematics education. Additionally, efforts to ensure equitable resource allocation and infrastructure enhancement are crucial to providing all students with access to diverse and relevant learning materials. By addressing these factors, educational institutions can foster an environment conducive to developing students' problem-solving skills and promoting academic success in mathematics.

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