International Journal of Multicultural and Multireligious Understanding

http://ijmmu.com
editor@ijmmu.com
ISSN 2364-5369
Volume 13, Issue 2
February, 2026
Pages: 251-264

Analysis of Students' Difficulties in Solving Statistics Problems Based on the SOLO Taxonomy Classification and Students' Attitudes Toward Mathematics

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http://dx.doi.org/10.18415/ijmmu.v13i2.7314

Abstract

This study aims to analyze students' difficulties in solving statistics problems and their attitudes toward mathematics among senior high school students in Purworejo Regency. It also aims to identify the types of difficulties students experience based on the SOLO taxonomy classification and students' attitudes toward mathematics, as well as to measure the relationship between students' attitudes toward mathematics and the level of difficulties they encounter. This study employs a mixed-methods approach with a exsplanatory squential research design. The study subjects consist of 391 senior high school students in Purworejo Regency, selected from 13 schools categorized as high, medium, and low levels using a stratified proportional random sampling technique. The research instruments include six statistics test questions, an attitude questionnaire with 30 statements, and an interview guide validated by experts. Data were collected through tests, questionnaires, and interviews. The findings indicate that the highest difficulty lies in the aspect of drawing conclusions, with a percentage of 80.59%, while the lowest difficulty is in conceptual understanding, at 48.67%. Based on the SOLO taxonomy classification, the highest level of difficulty is at the extended abstract level, reaching 75.68%, while the lowest is at the unistructural level, at 37.63%. Students' attitudes toward mathematics fall into the low category, with an average score of 66.36. The average attitude score for students in high-category schools is 75.77, in medium-category schools is 72.41, and in low-category schools is 50.92. There is a negative correlation between students' difficulties in solving statistics problems based on the SOLO taxonomy classification and their attitudes toward mathematics, with a correlation value of -0.113. This indicates that the more negative students' attitudes toward mathematics are, the greater their difficulties in solving statistics problems.

Keywords: *Students' Difficulties; Statistics; Attitudes Toward Mathematics; SOLO Taxonomy*

Introduction

Human resource development is a key indicator of a nation's progress, as it encompasses improvements in education, skills, health, and productivity, which collectively support economic growth and sustainable welfare (United Nations Development Program, 2019). Educational quality plays a central role in shaping individual character and societal development; therefore, the Indonesian government has undertaken various initiatives to improve access, quality, teacher competence, learning facilities, and educational management (Silitonga et al., 2016). These efforts align with the Law of the Republic of

Indonesia Number 20 of 2003 on the National Education System, which guarantees the right to quality education for all citizens and regulates national standards for competencies, curriculum content, learning processes, and assessment.

Mathematics is a strategic subject in achieving national education goals, as it fosters critical, analytical, and logical thinking skills (Adhiska, 2020). However, there remains a gap between the expected learning outcomes and students' actual achievements. Many students perceive mathematics as difficult and fail to recognize its relevance in daily life. This challenge is reflected in international assessment results, such as TIMSS 2015, where Indonesia ranked 44th out of 49 participating countries with a score of 397, and PISA 2019, where Indonesia ranked 73rd out of 79 countries with a score of 379. These findings indicate that students' mastery of mathematical concepts remains low.

Statistics is one of the mathematical topics that students frequently struggle with. Difficulties in this area often stem from weak conceptual understanding, limited data-processing skills, and inadequate ability to interpret information (Priatna, 2017). National Examination results over several years also show that students' performance in statistics is relatively low and tends to decline, signaling the need for a deeper analysis of contributing factors.

To comprehensively understand students' learning difficulties, analysis should go beyond evaluating correct or incorrect answers. The SOLO Taxonomy (Structure of the Observed Learning Outcome), developed by Collis and Biggs, offers a systematic framework for assessing the quality of students' understanding through five levels of cognitive development—prestructural, unistructural, multistructural, relational, and extended abstract (Collis & Biggs, 1982; Brown, 2004). This framework allows for a more detailed examination of students' thinking structures and helps identify specific areas requiring improvement (Halimah, 2020).

In addition to cognitive aspects, students' attitudes toward mathematics significantly influence their learning outcomes. Attitudes are formed through beliefs, emotions, and behavioral tendencies toward the subject (Capuno, 2019; Yani, 2016). Research shows that positive attitudes enhance conceptual understanding and reduce learning difficulties (Gumilar, 2023), whereas negative attitudes contribute to challenges in solving mathematical problems (Amallia, 2018). This relationship is further supported by studies showing that the more positive students' attitudes toward mathematics, the lower their level of difficulty in solving mathematical problems, including statistics and algebra (Sari, 2021; Putri Rahayu, 2023).

Based on these theoretical and empirical insights, it is important to investigate students' difficulties in solving statistical problems using the SOLO Taxonomy classification, as well as examine the relationship between these difficulties and students' attitudes toward mathematics. Such research is essential to provide a deeper understanding of the nature, levels, and influencing factors of students' challenges and to support the development of more effective mathematics learning strategies.

Literature Review

Students' Difficulties

Learning difficulties are broadly defined as disturbances in one or more basic psychological processes related to understanding and using language, both spoken and written. According to the United States Office of Education (Public Law, 1977, p. 94-142) and the National Advisory Committee on Handicapped Children (1967), these disturbances may manifest as challenges in listening, thinking, speaking, reading, writing, spelling, or performing mathematical calculations. Multiple scholars describe learning difficulties as neurologically based conditions that disrupt one's ability to store, process, or produce information (Roopnarine, 2011), affecting various skills including reading, writing, spelling, speaking, and mathematical computation (Hallahan, 2009).

In mathematics learning, student difficulties are also linked to the types of mathematical objects involved. Bell (1978) distinguishes between direct objects facts, skills, concepts, and principles and indirect objects such as logical reasoning, problem-solving ability, positive attitudes toward mathematics, perseverance, and accuracy.Difficulties often arise when students struggle to recognize keywords, interpret text, or apply skills accurately (Abdurrahman, 2009). Writing difficulties, which involve organizing ideas and applying correct grammar and vocabulary, may also hinder students' performance on mathematical tasks (Westwood, 2004).

Learning difficulties are not caused by visual, auditory, emotional, or environmental factors, but by challenges related to cognitive and linguistic processes (Snow, 1998). Many students struggle to solve teacher-assigned tasks due to such difficulties (Westwood, 2004). Specific difficulties in mathematics, known as mathematical learning disabilities, are commonly associated with neurological dysfunctions and include dyscalculia defined as a disturbance in learning mathematical concepts and computation due to central nervous system dysfunction (Lerner, 2006; Santrock, 2003).

Characteristics of mathematics difficulties include information-processing problems, language-related challenges, and mathematics anxiety (Lerner, 2006). Students' errors often reflect their process of adapting to their learning environment (Brown, 2004). Errors may occur in written work, practical tasks, or oral responses and may result from carelessness or procedural slips (Haylock, 2007).

Indicators of learning difficulties include low academic achievement, inconsistent performance, delayed task completion, unusual behaviors, or unexpected changes in performance (Ahmadi, 2013). Students typically struggle to understand problems, lack appropriate strategies, and fail to translate verbal statements into mathematical form (Saputra, 2020). Other difficulties include inaccurate computation, confusion about algorithmic steps, misunderstanding place value, limited working memory, ineffective strategies, and difficulty comprehending text-based problems (Westwood, 2004).

Bell (1978) further categorizes mathematical learning objects and highlights five areas of potential difficulty: understanding facts, applying procedural skills, understanding concepts, mastering principles, and using investigative and problem-solving abilities. Students may struggle to identify symbols and illustrations (Rahmadian Mahendra, 2019), perform procedural steps accurately (Alang, 2017), use appropriate definitions (Ismail, 2019), relate concepts into coherent principles (Suryani, 2020), or analyze mathematical situations effectively (Wardani, 2020). Additional challenges include strategy selection, slow processing, calculation errors, and limited fact recall (Byrnes, 2008).

Student difficulties can also be analyzed through types of errors. Newman's Error Categories (NEC) classify errors into: Reading errors failure to interpret symbols or keywords (Susanto, 2017). Comprehension errors inability to understand the meaning of the problem due to insufficient prerequisite knowledge or limited concentration. Transformation errors difficulty determining the correct operations or translating problems into mathematical models (Rigusti, 2020). Processing skill errors inaccuracy in performing procedures despite knowing the needed operations, often due to lack of attention to detail (Urbaytun, 2020; Wahyuni, 2020). Encoding errors failure to express the correct solution in an acceptable written form (Mulyadi, 2019). Newman's Error Categories are commonly applied because they align with stages of problem solving, making them effective for identifying students' challenges. In many studies, learning difficulties in mathematics are categorized into challenges in understanding problems, translating them into mathematical form, performing mathematical processes, and drawing conclusions.

Attitudes Toward Mathematics

Attitudes are closely tied to an object of focus, as attitudes cannot exist without an object toward which they are directed (Gerungan dalam Sriyanti, 2021). An object whether concrete or abstract elicits an individual's response, behavior, or judgment, making it a key element in the formation of attitudes. In learning contexts, psychological aspects such as emotions, motivation, and perceptions strongly influence student engagement and achievement (Sari A. S., 2018). Students' self-image and personality characteristics—including cognitive ability, learning styles, and preferences also shape how they process information and respond to instruction. A supportive learning environment helps foster positive attitudes and holistic student development.

Lack of mathematical understanding may lead to frustration, loss of confidence, and avoidance behavior, which contribute to negative attitudes toward mathematics (Sari D. P., 2020). Negative attitudes are often expressed through fear, dislike, or complete avoidance of mathematical tasks, ultimately hindering student motivation and learning. Therefore, educators must apply appropriate strategies, provide support, and create inclusive learning environments to help students develop more positive attitudes toward mathematics.

Based on these definitions, attitudes toward mathematics consist of cognitive components (beliefs and knowledge about mathematics), affective components (emotional responses toward mathematics), and conative components (behavioral tendencies in learning mathematics). Mathematics itself functions as an object of attitude, as it involves symbolic language, logical thinking, problem-solving, and communication skills. Student attitudes toward mathematics are therefore influenced by their understanding of mathematical processes, emotional responses to learning, and behavioral tendencies in interacting with mathematical tasks and teachers.

Components of Students' Attitudes Toward Mathematics

Attitudes consist of three interrelated components: cognitive, affective, and conative (Besse Intan Permatasari, 2020). The cognitive component involves beliefs and knowledge; the affective component involves emotional reactions; and the conative component reflects behavioral tendencies (Azwar, 2013). These components manifest as cognitive responses (knowledge), behavioral responses (participation or actions), and affective responses (emotional expressions) toward an object (Ramlan Rida B., 2023). Improving student attitudes toward mathematics is essential because attitudes are known to significantly influence mathematics achievement (Kusaeri, 2019). Overall, attitudes represent students' cognitive, emotional, and behavioral expressions directed toward mathematics.

Measuring Students' Attitudes Toward Mathematics

Students' attitudes can be positive or negative and are commonly measured using questionnaires or inventories (Kusaeri & C., 2017). Several instruments have been developed to assess attitudes toward mathematics. One instrument measures two indicators: enjoyment of mathematics and perceived value of mathematics. Another categorizes attitudes into confidence, importance of mathematics, and engagement in learning (Sanchal, 2017). The ATMI (Attitude Toward Mathematics Inventory) by Tapia & Marsh (2004) uses 19 items measuring engagement and attitude/behavior domains (Wangdi, 2022). These instruments typically use Likert scales to capture students' degrees of agreement.

In the present study context, attitudes refer to students' perceptions and feelings toward mathematics, particularly in relation to difficulties faced in solving statistical problems. These attitudes encompass interest, confidence, motivation, and acceptance of mathematics as a relevant discipline. Positive attitudes support persistence and understanding, whereas negative attitudes hinder learning. The indicators used measure students' tendencies to face challenges, overcome difficulties, and remain open to instructional strategies, making attitudes a key factor influencing their ability to solve statistics problems, which are subsequently analyzed using the SOLO taxonomy.

SOLO Taxonomy

The Structure of the Observed Learning Outcome (SOLO) taxonomy is a learning framework used to define learning objectives, design assessments aligned with those objectives, and evaluate the quality of student responses. Developed by Biggs & Collis (1970–1980), SOLO is defined as “the structure of the actual response that she gives to specific learning tasks” (Biggs & Collis, 1982, p. 22). Traditional assessments tend to emphasize recall and summarization, which often fail to differentiate deeper levels of understanding among learners (Sanjaya, 2018). Therefore, the SOLO taxonomy provides a hierarchical structure for classifying student understanding and observable learning outcomes (Prasetyo, 2020; Setiawan, 2019).

SOLO describes five progressive levels of understanding: Prestructural (0), Unistructural (1), Multistructural (2), Relational (3), and Extended Abstract (4) (Biggs & Collis, 1982). Higher levels represent deeper cognitive processing, enabling learners to form connections, analyze relationships, and generalize concepts. At the relational level, students integrate multiple ideas to compare, analyze, and synthesize concepts. At the extended abstract level, learners generalize knowledge to new situations and demonstrate abstract, creative, and critical thinking (Fathonah, 2021; Halimah, 2020).

The SOLO taxonomy offers several advantages in assessing student learning. It differentiates levels of complexity, facilitates detailed error analysis, emphasizes the quality rather than mere correctness of responses, and supports the development of higher-order thinking (Wulansari, 2020). SOLO thus allows educators to interpret students’ cognitive development and plan instructional strategies suited to their level of understanding (Sari, 2019).

Characteristics of SOLO Levels

The SOLO taxonomy describes qualitative differences in student responses: Prestructural: Students demonstrate no relevant understanding, provide unrelated information, repeat questions, or fail to grasp the task (Hayuhantika, 2016). Due to the difficulty of assessing cognitive complexity at this level, it is often excluded from analytical scoring. Unistructural: Students use one relevant piece of information and can apply simple, isolated ideas, but do not understand their broader significance (Marisa, 2020). Multistructural: Students use several relevant pieces of information but fail to integrate them; ideas remain separate and unconnected (Faisal, 2019). Relational: Students integrate multiple ideas into a coherent whole, identify relationships, apply principles, and use prior knowledge to explain or contextualize concepts (Rochmah, 2023). Extended Abstract: Students generalize principles, construct hypotheses, engage in conceptual transfer, and extend understanding to new contexts (Potter, 2012; Caniglia, 2018).

SOLO-Based Question Criteria

SOLO can also guide the construction of mathematical word problems. Since students at the prestructural level cannot handle such tasks, item development typically begins at the unistructural level. Biggs’ criteria specify: Unistructural: Two pieces of information appear in the question, but solving requires only one. Multistructural: Two or more pieces of information can be used directly to obtain the answer. Relational: All information is present but must be connected or transformed through principles or concepts to generate new data before solving. Extended Abstract: All information is available, but the problem requires abstract generalization or hypothesis-building to generate new information. These criteria allow SOLO to function as a practical evaluation tool for measuring student thinking levels and analyzing difficulties in solving mathematical problems (Saputro, 2024).

SOLO-Based Assessment Instruments

SOLO-based assessments can be designed using superitems, which are sets of related items sharing the same context or stimulus. Each item corresponds to a different SOLO level—unistructural, multistructural, relational, and extended abstract—while the prestructural level may be omitted. Superitems allow teachers to examine student responses in a structured way and capture the depth of their understanding for each level (Wells, 2015). Indicators for SOLO-based assessment include: Unistructural:

Use of a single relevant idea; procedural application of isolated facts or concepts. Multistructural: Use of multiple ideas without integration; disconnected facts. Relational: Ability to connect, compare, analyze, and synthesize information meaningfully. Extended Abstract: Ability to generalize, hypothesize, critique, theorize, and apply principles to new situations. Through SOLO-based superitems, teachers can measure cognitive development across levels, provide precise feedback, and design instruction that aligns with students' conceptual progression.

Method

This study adopted a mixed-methods approach, integrating quantitative and qualitative procedures to obtain a comprehensive understanding of students' difficulties in solving statistics problems and their attitudes toward mathematics. The research design followed an explanatory sequential model, in which quantitative data were collected and analyzed first, followed by qualitative data collection to clarify and elaborate the initial findings (Creswell, 2012). Research Setting. The study was conducted in Purworejo Regency, Central Java, Indonesia. The region consists of senior high schools distributed across urban and semi-urban areas, with varying accreditation levels (A, B, and C). This diverse educational landscape provides an appropriate context for the use of stratified sampling and allows the research findings to reflect differences across school quality categories.

The research procedures consisted of several stages. First, two research instruments were developed: a student difficulty test and a mathematics attitude questionnaire. Second, validity and reliability testing was conducted to ensure the accuracy and consistency of the instruments. Third, quantitative data were gathered through the administration of the test and questionnaire. Based on these results, several students were selected for interviews to obtain qualitative explanations. Finally, both datasets were interpreted integratively to determine the extent to which qualitative findings supported and strengthened the quantitative results.

The population consisted of 2,766 Grade XI students across schools with accreditation A, B, and C. A stratified random sampling technique was used to ensure proportional representation. Based on the Krejcie and Morgan sample size table, the minimum required sample was 338 students. Proportional allocation resulted in sample targets of 326 students from accreditation A schools, 12 students from accreditation B schools, and 2 students from accreditation C schools. To meet this requirement, sample selection was conducted across 13 schools representing all accreditation strata. Classes from each selected school were then randomly chosen, yielding a total of 391 participants.

Results and Discussion

Results

Students' Difficulties in Solving Statistics Problems Based on the SOLO Taxonomy Classification

The findings revealed that students' difficulties in solving statistics problems reached 53.14%, indicating a high level of difficulty. When analyzed across school strata, students from high-strata schools exhibited a lower level of difficulty (41.34%), with the main difficulties occurring at the mathematical processing stage. Students from mid-strata schools experienced a difficulty level of 49.22%, predominantly at the conclusion stage. In contrast, students from low-strata schools demonstrated the highest difficulty level (68.86%), with difficulties mainly arising during the transformation stage. These results suggest that differences in school conditions and academic environments contributed to variations in students' cognitive performance, supporting previous studies that emphasize the influence of contextual and instructional factors on mathematical difficulties (Wijaya et al., 2014; Yuliyani & Fitriyani, 2023).

Analysis based on the SOLO Taxonomy showed that the greatest proportion of difficulties occurred at the extended abstract level (75.68%), classified as very high. This indicates that students encountered significant challenges when required to generalize, integrate, or construct broader conceptual understandings. Such abilities are critical for higher-order statistical reasoning. This finding is consistent with prior research reporting that students often struggle with tasks involving abstraction and multi-step reasoning processes (Arslan & Yildiz, 2021; Irawati et al., 2022).

Students' attitudes toward mathematics were generally categorized as low, with an average score of 66.36, and varied according to school strata. Students from high-strata schools showed more positive attitudes (75.77) compared with those from mid-strata (72.41) and low-strata schools (50.92). Moreover, the cognitive, affective, and behavioral components of attitude were also low, with percentages of 47.64%, 31.18%, and 34.09%, respectively. These results reinforce earlier findings that negative attitudes toward mathematics can adversely affect students' problem-solving performance and engagement (Hyde et al., 2019; Zan & Di Martino, 2007).

Correlation analysis indicated a negative but weak relationship (r = –0.113) between students' statistical difficulties, classified using the SOLO Taxonomy, and their attitudes toward mathematics. Although the correlation was weak, the result suggests that students with more positive attitudes tended to experience fewer difficulties. This supports the notion that affective factors such as motivation and self-confidence contribute to mathematical performance (Ma & Kishor, 1997; Di Martino & Zan, 2010). Nevertheless, the weak correlation implies that students' difficulties in statistics were influenced by multiple factors beyond attitudes alone, including instructional design, prior knowledge, and cognitive readiness.

Overall, the findings underscore the importance of enhancing students' conceptual understanding, particularly at higher SOLO levels, while simultaneously fostering positive attitudes toward mathematics. Instructional strategies that emphasize conceptual reasoning, appropriate scaffolding, and affective support are recommended to reduce students' difficulties in statistics and improve learning outcomes.

Description of Students' Attitudes Toward Mathematics

In addition to test-based measurements of students' difficulties, this study employed an attitude questionnaire consisting of 30 items (19 positive and 11 negative statements) rated on a five-point Likert scale. The instrument measured three attitude components—cognitive, affective, and conative—toward mathematics, mathematics learning, and mathematics teachers. The questionnaire was administered to 391 senior high school students.

Descriptive analysis revealed clear variations in students' attitudes across school strata. Students from high-strata schools obtained the highest mean attitude score (75.77), followed by those from mid-strata schools (62.41) and low-strata schools (50.92), with an overall mean score of 66.36. These differences were also reflected in the standard deviation values, which ranged from 6.15 to 8.26, while the theoretical score range was 30–150.

Analysis based on attitude components showed that students across all school strata achieved the highest scores in the cognitive component, followed by the conative and affective components. In high-strata schools, the cognitive component reached 61.22%, whereas the affective and conative components were considerably lower. A similar pattern was observed in both mid- and low-strata schools. This indicates that students' beliefs, perceptions, and evaluations of mathematics—the cognitive aspect of attitude—remained relatively weak across all strata.

The distribution of attitude categories further supported these findings. Among the 391 students, the majority were classified within the moderate and low attitude categories. High-strata schools showed the largest proportions in these two categories. Although a very high attitude category appeared among students from high-strata schools, it was not found in either the mid- or low-strata groups. Notably, no students across the three school strata were classified in the very low attitude category.

Overall, the results indicate that while a small proportion of students demonstrated positive attitudes toward mathematics, most students exhibited attitudes that were not yet optimal. These limitations were more pronounced among students from mid- and low-strata schools, suggesting the need for instructional strategies that not only address cognitive challenges but also strengthen students' affective and conative engagement in mathematics learning.

Description of the Correlation Between Students' Problem-Solving Difficulties and Their Attitudes Toward Mathematics

1. Correlation Analysis

A Pearson correlation test was conducted to examine the relationship between students' difficulties in solving problems and their attitudes toward mathematics using JASP software. Prior to conducting the correlation analysis, assumption testing was performed.

The normality assumption was tested using the Shapiro–Wilk test. The results showed a Shapiro–Wilk value of 0.926 with a p-value of 0.80. Since the p-value exceeded 0.05, the data were considered normally distributed, indicating that the normality assumption was satisfied and that Pearson correlation analysis was appropriate.

The Pearson correlation analysis yielded a correlation coefficient of –0.328, indicating a negative relationship between students' difficulties in solving problems and their attitudes toward mathematics. This result suggests that students who experienced higher levels of difficulty tended to demonstrate less positive attitudes toward mathematics.

2. Simple Regression Analysis

The residual normality test was conducted using JASP software. The Q–Q plot of standardized residuals showed that the data points followed the diagonal line, indicating that the residuals were normally distributed.

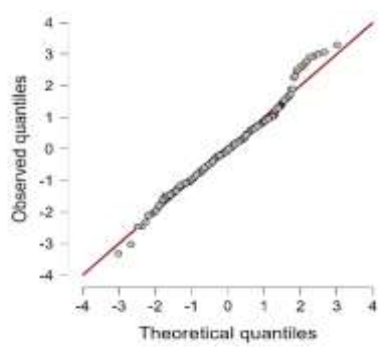

Figure 1. Q–Q Plot of Standardized Residuals

Linearity between students' attitudes toward mathematics and their difficulties was examined using partial regression plots. The distribution of data points followed the regression line, indicating that the linearity assumption was satisfied.

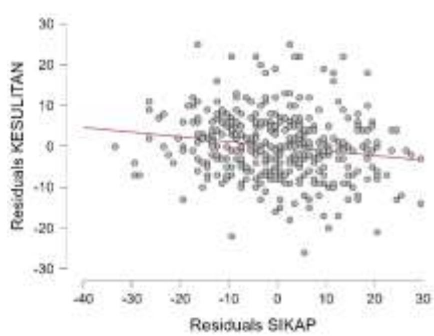

Figure 2. Partial Regression Plot

Heteroscedasticity was examined using a residuals versus predicted values plot. The residuals were randomly distributed above and below the zero line, indicating that heteroscedasticity was not present.

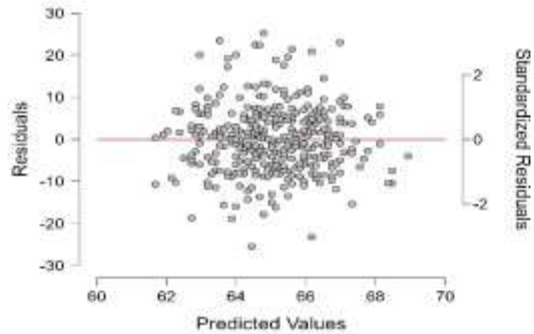

Figure 3. Residuals vs. Predicted Values Plot

After all assumptions were met, a simple regression analysis was conducted. The results showed a constant value of 65.540 and a regression coefficient of –0.395, resulting in the regression equation: Difficulty = 65.540 – 0.395 (Attitude) The standardized coefficient (β = –0.328) indicates a negative relationship between students' attitudes and their difficulties. The effect was statistically significant ($p = 0.001 < 0.05$; $t = –4.49$), with an R^2 value of 0.129, indicating that students' attitudes toward mathematics explained 12.9% of the variance in their difficulties.

3. One-Way ANOVA Test

A one-way ANOVA was conducted to examine differences in the mean scores of students' attitudes toward mathematics and problem-solving difficulties across school strata. Prior to the ANOVA, the assumptions of normality and homogeneity of variance were tested.

Normality was assessed using the Shapiro–Wilk test with the assistance of JASP software. The results are presented in Table 1. All p-values were greater than 0.05, indicating that the data were normally distributed across school strata.

Table 1. Results of the Shapiro–Wilk Normality Test for Attitude and Difficulty Variables

School Strata	***P-Value***	
	Attitude	Difficulty
High	0,075	0,057
Low	0,085	0,143
Medium	0,370	0,421

Homogeneity of variance was examined using Levene's Test. The results showed that the p-value for students' attitudes toward mathematics was 0.062, and for students' difficulties was 0.162. Since both values exceeded 0.05, the variances were considered homogeneous.

After the assumptions were satisfied, a one-way ANOVA was conducted. The results for students' attitudes toward mathematics are presented in Table 2, while the results for students' difficulties are shown in Table 3.

Table 2. One-Way ANOVA Results for Students' Attitudes Toward Mathematics

Cases	***Sum of Squares***	***df***	***Mean Square***	***F***	***p***
Categories	40648.737	3	13549.579	433.031	< .001
Residuals	12109.258	387	31.290		

Table 3. One-Way ANOVA Results for Students' Difficulties

Cases	*Sum of Squares*	*df*	*Mean Square*	*F*	*p*
Categories	68927.809	4	17231.952	919.733	< .001
Residuals	7232.027	386	18.736		

The ANOVA results indicated that both variables showed statistically significant differences across school strata ($p < 0.001$). This finding confirms that students' attitudes toward mathematics and their problem-solving difficulties differed significantly among the strata.

4. *Post Hoc Test*

Following the significant ANOVA results, Tukey's HSD post hoc test was conducted to identify specific group differences. The post hoc comparison results for students' difficulties are presented in Table 4.

Table 4. Tukey Post Hoc Test Results for Students' Difficulties

Post Hoc Comparisons			
		Mean Difference	p_{tukey}
Moderate	Low	16.005	< .001
	Very Low	32.552	< .001
	High	-15.402	< .001
Low	Sangat Rendah	16.547	< .001
	High	-31.406	< .001
Very Low	High	-47.953	< .001

All pairwise comparisons were statistically significant ($p < 0.001$). The mean difficulty scores followed the order: High > Moderate > Low > Very Low, with significant differences observed between all groups.

The post hoc comparison results for students' attitudes toward mathematics are presented in Table 5

Table 5. Tukey Post Hoc Test Results for Students' Attitudes Toward Mathematics

Post Hoc Comparisons			
		Mean Difference	p_{tukey}
Moderate	Low	18.001	< .001
	Very Low	37.880	< .001
	Very High	-26.299	< .001
	High	-12.616	< .001
Low	Very Low	19.879	< .001
	Very High	-44.301	< .001
	High	-30.618	< .001
Very Low	Very High	-64.179	< .001
	High	-50.497	< .001
Very High	High	13.683	< .001

Significant differences were found among all attitude categories ($p < 0.001$). The mean attitude scores increased consistently from Very Low to Very High, indicating a clear gradation across categories.

Discussion

The results indicate that students experienced varying levels of difficulty in solving statistical problems, which were effectively categorized using the SOLO taxonomy. Most students were positioned at the Unistructural and Multistructural levels, suggesting that their understanding remains fragmented and limited to isolated components of the tasks. This aligns with Biggs and Collis (2014), who state that learners at these stages generally fail to integrate multiple ideas into coherent reasoning.

Only a few students reached the Relational level, demonstrating the ability to connect concepts and apply them systematically. This finding reinforces earlier studies which report that students often struggle to develop robust statistical reasoning due to misconceptions and weak foundational understanding (Garfield & Ben-Zvi, 2008; Chance, 2002).

Students' attitudes toward mathematics were also found to influence their performance. Learners with positive attitudes such as confidence, persistence, and interest tended to achieve higher SOLO levels. Conversely, those expressing anxiety or negative feelings generally performed at lower levels. These results support the conclusions of Ma and Kishor (1997), who established a positive relationship between attitude and mathematical achievement, as well as Hannula's (2015) emphasis on the central role of emotions in mathematical engagement.

Overall, the findings highlight the need for instructional strategies that strengthen conceptual understanding and promote positive attitudes toward mathematics. Learning activities should guide students from surface-level learning toward relational reasoning, consistent with the SOLO framework. Improving students' affective readiness may further enhance their ability to engage with and solve statistical problems.

Conclusion

This study concludes that students' difficulties in solving statistics problems are high (53.14%), with the highest difficulty observed in low-accreditation schools (68.86%) and the dominant difficulty type varying across strata. SOLO taxonomy analysis shows the extended abstract level as the most challenging (75.68%). Students' attitudes toward mathematics are generally low (mean 66.36), with significant differences across school accreditation levels. The correlation between SOLO-based difficulties and mathematics attitudes is -0.113, indicating a very weak negative relationship, suggesting that more positive attitudes are associated with slightly lower levels of difficulty.

References

Abdurrahman, M. (2009). *Pendidikan Bagi Anak Berkesulitan Belajar.* Jakarta: Rineka Cipta.

Adhiska, D., Fathurrohman, M., & Khaerunnisa, E. (2020). Analisis Pemahaman Konsep Matematis Peserta Didik pada Materi Aljabar. *Wilangan: Jurnal Inovasi dan Riset Pendidikan*, 64-75.

Ahmadi, A., & Supriyono. (2013). *Psikologi Belajar*. Jakarta: Rineka Cipta.

Alang, H. (2017). Urgensi Diagnosis dalam Mengatasi Kesulitan Belajar. *Al-Irsyad Al-Nafs*, 1-14.

Amallia, N. (2018). Analisis Kesulitan Belajar Matematika pada siswa Kelas III Sekolah Dasar. *Attadib: Journal of Elementary Education*, , 123-133.

Bell, F. H. (1978). *Teaching and Learning Mathematics in Scondary School. Cetakan Kedua.* Dubuque, Lowa: Win C. Brown Company Plublisher.

Besse I., & Nur I. (2020). Sikap Siswa Sekolah Dasar terhadap Pelajaran Matematika. *de Fermat: Jurnal Pendidikan Matematika*, 34–41.

Brown, H. D. (2004). *Language Assessment: Principles and Classroom Practices.* United States of America: Person Education.

Byrnes, J. P. (2008). *Cognitive Development and Learning in Structional Context (3rd ed).* New York: Pearson Education.

Capuno, R. N., Necesario, R., & Etcuban, J. (2019). Attitudes, Study Habits, and Academic Performance of Junior High School Students in Mathematics. *International Electronic Journal of Mathematics Education*, 547-561.

Collis.K.F, B. (1982). *Evaluating The Quality of Learning the SOLO.* New York: Academic Press.

Gumilar, Fitriani, & Siahaan. (2023). Analisis Pemahaman Konsep Matematika Siswa Kelas VII Berdasarkan Taksonomi SOLO (Structure of Observed Learning Outcomes) Pada Materi Perbandingan. *Jurnal Inovasi Pembelajaran Matematika*, 1-10.

Gumilar, G., Lyesmaya, D., & Uswatun, D. A. (2023). Pengaruh Sikap Belajar Matematika Siswa terhadap Kemampuan Pemahaman Konsep Matematis Siswa. *Jurnal Pendidikan Guru Sekolah Dasar*, 251-258.

Halimah, L. (2020). Analisis Kemampuan Pemecahan Masalah Matematika berdasarkan Taksonomi SOLO. *Jurnal Inovasi Pendidikan dan Pembelajaran Sekolah Dasar*, 123-130.

Hallahan, D., Kauffman, J. M., & Pullen, P. C. (2009). *Exceptional Learners An Introduction to Special Education.* New York: Pearson.

Haylock, D., & Thagata, F. (2007). *Key Concepts in Teaching Primary.* London: Sage Publications.

Kusaeri. (2019). Penilaian sikap dalam pembelajaran matematika. *Jurnal Pendidikan Matematika*, 61–70.

Kusaeri, & Cahyan, E. D. (2017). Sikap, Harapan, dan Persepsi Siswa pada Matematika serta Implikasinya terhadap Kemampuan Regulasi Diri. *Jurnal Pendidikan Matematika dan IPA*, 123–130.

Lemer, P. D. (2006). *The role of culture in education: A framework for understanding diversity.* Routledge.

Mulyadi. (2019). Faktor-faktor kesulitan belajar siswa MIN Janti. *Jurnal Pendidikan*, 123-130.

OECD. (2019). *Programme for International Student Assesment (PISA) Result From PISA 2018. Indonesia-Country Note-PISA 2018 Results.* Paris: OECD Publishing.

Prasetyo, Z. & Lestari, D. (2020). Implementasi Taksonomi SOLO dalam Pembelajaran Biologi untuk Meningkatkan Kemampuan Analisis Siswa. *Jurnal Biologi Pendidikan*, 120–130.

Priatna, & Iyam M. N. (2017). Analisis Kesulitan Dalam Materi Statistika Ditinjau Dari Kemampuan Penalaran Dan Komunikasi Statistis. *Jurnal PRISMA Universitas Suryakancana*, 173-179.

Program, U. N. (2019). Human Development Report 2019: beyond income, beyond averages, beyond today. *In United Nations Development Program.*

Putri Rahayu S., & Desi, S. (2023). Analisis kesulitan siswa menyelesaikan soal aljabar berdasarkan klasifikasi taksonomi SOLO. *PYTHAGORAS: Jurnal Program Studi Pendidikan Matematika*, 164-175.

Rahmadian, M. N., Mulyono, & Isnarto. (2019). Kemampuan representasi matematis dalam model pembelajaran Somatic, Auditory, Visualization, Intellectually (SAVI). *PRISMA, Prosiding Seminar Nasional Matematika*, 287-292.

Ramlan Rida B., & Syamsuri. (2023). Hubungan antara sikap siswa SMA terhadap matematika dengan prestasi belajarnya berdasarkan indikator Attitudes Toward Mathematics Inventory (ATMI). *WILANGAN: Jurnal Inovasi dan Riset Pendidikan Matematika*, 15–22.

Rigusti, W., Pujiastuti, & Heni. (2020). Anslisis Kemampuan Pemecahan Masalah Ditinjau dari Motivasi Belajar Matematika Siswa . *Jurnal Pendidikan Matematika*, 1-10.

Roopnarine, L. J., & Johnson, J. (2011). *Pendidikan Anak Usia Dini dalam Berbagai Pendekatan.* Jakarta: Kencana.

Azwar. (2013). *Sikap Manusia: Teori dan Pengukurannya.* Yogyakarta: Pustaka Pelajar.

Sanchal, A., & Sharma, S. (2017). Students' Attitudes Towards Learning Mathematics: Impact of Teaching in a Sporting Context. Teachers and Curriculum. 89-99.

Sanjaya, H., & Supriyono, W. (2018). Penerapan Taksonomi SOLO dalam Pembelajaran Matematika untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jurnal Pendidikan Matematika*, 215–225.

Santrock, Jhon W. (2003). *Adolescence (Edisi Keenam).* Jakarta: Erlangga.

Saputra, A. (2020). Pendidikan dan Teknologi: Tantangan dan Kesempatan. *Indonesian Journal of Islamic Educational Management*, 21-33.

Sari, A. K., Ismanto, H. S., & Setiawan, A. (2021). Hubungan antara minat belajar dengan kesulitan belajar siswa kelas XI di SMA N 8 Semarang. *Widyasari Press*, 29-35.

Sari, D. P., Sutarto, S., & Fathurrochman, I. (2020). Teacher Strategies in Online Learning to Increase Students' Interest in Learning during COVID-19 Pandemic. *Jurnal Konseling dan Pendidikan*, 129–137.

Setiawan, A., & Dewi, N. (2019). Analisis Penerapan Taksonomi SOLO terhadap Pemahaman Konsep Fisika Siswa SMA. *Jurnal Pendidikan Fisika Indonesia*, 45–53.

Silitonga, P., Harahap, M. B., & Silitonaga, P. (2016). Pengaruh Model Pembelajaran Inquiry Training dan Kreativitas terhadap Keterampilan Proses Sains Effect of Inquiry Training Learning Model. 5(1).

Snow, C. E., Burns, M. S. & Griffin, P. (1998). *Preventing reading difficulties in young children.* National Academy Press.

Sriyanti, A., Wahyuni, s., & Kurniawati, N. (2021). Pengembangan E-Modul berbantuan software Sigil dengan pendekatan kontekstual pada materi program linear peserta didik kelas XI. *Jurnal Pendidikan Matematika*, 123–135.

Suryani, N. (2020). Analisis kesulitan belajar siswa pada mata pelajaran matematika. *Pedagogia*, 201-210. .

Susanto, A. (2017). *Teori Belajar & Pembelajaran.* Jakarta: Prenada Media.

Urbaytun, S. (2020). Kesulitan Belajar pada Siswa Sekolah Dasar Negeri 42 Pontianak. *Bimbingan Konseling*, 15-22.

Wahyuni, S. (2020). Analisis Kesulitan Belajar Siswa dan Upaya Mengatasinya (Studi Kasus Di MA Syarif Hidayatullah Pontianak). *Bimbingan dan Konseling*, 87-95.

Wangdi, Thinley, & Shimary. (2022). Qualities of effective EFL English Teachers as Perceived by Thai University Students: A photovoice study. *Issues in Educational Research*, 805–824.

Wardani, S. (2020). Jenis-Jenis Kesulitan Belajar dan faktor Penyebabnya: Sebuah penelitian di SMK Muhammadiyah Kota Tegal . *Psychoidea*, 101-110.

Westwood, P. (2004). *Learning and Learning Difficulties. A Handbook for Teacher.* Acer Press: Victoria.