An analysis of students' difficulties and problem-solving strategies in trigonometry instruction

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DOI: https://doi.org/10.31980/pme.v4i1.2647

Submission Track:
Received: 08-12-2024 | Final Revision: 12-01-2025 | Available Online: 28-02-2025

How to Cite:
Ismayanti, S., & Jatisunda, M. G. (2025). An analysis of students' difficulties and problem-solving strategies in trigonometry instruction. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu (PME)*, *4*(1), 75-90.

Abstract
Problem solving is a fundamental skill in learning mathematics, especially trigonometry. However, students often encounter difficulties in understanding trigonometric concepts and applying appropriate problem-solving strategies. The purpose of this study is to analyze students' problem-solving abilities in solving trigonometric problems and to identify factors that contribute to their difficulties. A qualitative descriptive method was used, with data collected through observational tests, interviews, and analysis of students' written work. The research involved 29 students who had previously studied trigonometry. The findings indicate that while most students were able to identify the problems correctly, many struggled to formulate the problems and select appropriate solution strategies. In addition, only a small number of students demonstrated the ability to explain or verify their solutions. These difficulties were primarily attributed to limited conceptual understanding, ineffective learning strategies, and a lack of reflective thinking about their own work. Therefore, an interactive, problem-based learning approach is recommended to improve students' conceptual understanding and problem-solving skills in trigonometry.
Keywords: Analysis of students' difficulties; Problem-solving ability; Problem-solving strategies; Trigonometry instruction

Abstrak
Kemampuan pemecahan masalah merupakan kompetensi esensial dalam pembelajaran matematika materi trigonometri. Namun, siswa sering mengalami kesulitan dalam memahami konsep dan menerapkan strategi penyelesaian masalah. Penelitian ini bertujuan untuk menganalisis kemampuan pemecahan masalah siswa dalam menyelesaikan soal trigonometri serta mengidentifikasi faktor-faktor yang mempengaruhi kesulitan siswa. Metode penelitian yang digunakan adalah deskriptif kualitatif dengan teknik pengumpulan data berupa tes observasi, wawancara, dan analisis hasil kerja siswa. Subjek penelitian terdiri dari 29 siswa yang telah mempelajari trigonometri. Hasil penelitian menunjukkan sebagian besar siswa mampu mengidentifikasi soal dengan baik, tetapi mengalami kesulitan dalam merumuskan permasalahan dan menerapkan strategi yang tepat. Selain itu, sedikit siswa yang mampu menjelaskan dan memeriksa ulang hasil penyelesaian. Kesulitan ini disebabkan oleh kurangnya pemahaman konsep, strategi pembelajaran yang kurang efektif, serta rendahnya refleksi terhadap hasil pekerjaan

mereka. Oleh karena itu, diperlukan pendekatan pembelajaran yang lebih interaktif dan berbasis pemecahan masalah untuk meningkatkan pemahaman siswa terhadap trigonometri.
Kata Kunci: Analisis kesulitan; Kemampuan pemecahan masalah; Pembelajaran trigonometri; Strategi penyelesaian

Introduction

Many students entering higher education still need to strengthen their understanding of basic mathematics, including trigonometry (Sithole et al., 2017; Yiğit Koyunkaya, 2016). It is an important and very difficult part of high school math that combines algebraic, geometric, and graphical thinking (Kamber & Takaci, 2018). Mastering trigonometry is important for students to master calculus and other advanced mathematics (Hanifah et al., 2020), but also to solve complex mathematical tasks (Weber, 2008). In addition, the diversity of cognitive content and semantic complexity in trigonometry contributes to the development of student's ability to understand concepts, apply procedures, and integrate various aspects of mathematics more deeply (Thompson, 2015).

Problems in trigonometry require students to read, comprehend, transform, process, and encode information, which is a complex process and potentially increases the likelihood of errors in determining the correct solution (Dewanto et al., 2017; Obeng et al., 2024; Orhun, 2004). This difficulty is further compounded by the challenge of understanding the basic concepts of trigonometry from an early introduction, especially the definition of trigonometric functions in right triangles (Blackett & Tall, 1991). A weak understanding of fundamental concepts such as angles, angle measurement, right triangles, and the unit circle is often the root of problems in learning trigonometry.(Weber, 2005). As a result, only higher-ability students can conceptually understand trigonometry, while those with lower abilities often find it too abstract (Gur, 2009).

In fact, a deep understanding of trigonometry is very important because it supports the learning of advanced mathematics, such as calculus and analytical geometry, but also (Mustangin & Setiawan, 2021) Playing an important role in building problem-solving skills (Arilaksmi et al., 2021). Trigonometry is an essential branch of mathematics (Laja, 2022) That has a wide range of applications in real life, such as in engineering, construction, and navigation (Imbaquingo Guerrero et al., 2024). Students can also more easily understand the relationship between the angles and sides of a triangle through the trigonometric approach (Mohammad Nurwahid, 2023), and analyse patterns in geometric shapes by studying trigonometric functions, identities, and equations (Setiawan, 2021). Therefore, mastering trigonometry is not only an important foundation for students' academic success, but also prepares them for future conceptual and practical challenges.

However, the fact is that students have difficulty in understanding the concepts, the use of principles, and the skills in learning trigonometry (Sinambela & Rombe, 2021). The understanding of the concept of trigonometric comparison in high school students is still low, influenced by the way teachers teach, the way students learn, and the lack of interest in learning mathematics (Suendarti & Liberna, 2021a). As a result, it has a negative impact on students' problem-solving skills, trigonometry difficulties (Fauziah & Puspitasari, 2022), especially for students with low self-esteem and non-visual learning styles (Lestari et al., 2022). The lack of interactive learning media and real-world examples makes it difficult for students to understand the relevance of trigonometry concepts in everyday life (Suendarti & Liberna, 2021b). It is difficult to indicate the need for further analysis of the factors that influence students' understanding of trigonometry.

One of the most important competencies that students must have in the 21st century is problem-solving ability (Widana, 2021). In addition, it is one of the main objectives of the curriculum, which demands conceptual understanding and analytical thinking skills (Liu et al., 2025; Öztürk et al., 2020), and address complex challenges (Siswanto & Meiliasari, 2024), and equip students to handle challenging situations in the real world (Syamsinar et al., 2023). The success of students' problem solving is not only determined by prior knowledge and understanding of concepts, but also by metacognitive knowledge that allows students to manage and direct their thinking processes effectively (Jatisunda & Nahdi, 2020). In addition to cognitive aspects, the effectiveness of learning also affects students' success in problem solving, which pays attention to the sequence of learning by considering the complexity of the material and the student's cognitive readiness (Costley et al., 2024).

Research shows that success in problem solving not only depends on logical thinking skills, but is also influenced by other factors, such as reading comprehension (Dabarera et al., 2014) interest in mathematics and attitude to mathematics (Pimta et al., 2009), and epistemological beliefs(Erdamar & Alpan, 2013). Furthermore, difficulties in problem solving are often rooted in the weak mental representations that students have (Liu et al., 2025). Therefore, a learning approach is needed that not only focuses on concept mastery but also strengthens critical thinking skills, reflective abilities, and metacognitive strategies to more thoroughly support problem-solving competence.

In this context, this study aims to analyse the barriers faced by students in solving trigonometry problems through test data, observations, and interviews. A qualitative approach is used to explore in depth the students' mindset and the strategies they use in dealing with trigonometry problems. This analysis not only aims to identify specific conceptual and procedural difficulties, but also to understand how students represent, interpret, and solve problems based on their understanding. The results of this study are expected to make an important contribution to designing more effective and contextualised learning interventions, so that students' problem-solving skills in trigonometry can be improved in a structured and sustainable manner.

Method

The type of research used is descriptive qualitative research. Qualitative descriptive research aims to provide an in-depth description of students' ability to solve mathematical problems in trigonometry material. The data in this study were obtained through observation tests, interviews, and analysis of student work. The researcher does not only focus on the final result but also on the students' thinking process in solving trigonometry problems, so as to provide a comprehensive picture of their problem-solving ability. The subjects of this study were students of class XI SMAN 1 Rajagaluh who had studied the trigonometry material. The selection of this subject is based on the consideration that students at this level have obtained the concept of trigonometric comparison. The number of research subjects consisted of 29 students who were selected based on diverse ability levels, including students with high, medium, and low abilities. This variation aims to obtain a comprehensive picture of students' problem-solving abilities, both in terms of the strategies used, the difficulties faced, and their thinking patterns.

The research instruments used in this study consisted of two types, namely observation tests and interviews. The observation test was used to identify students' problem-solving skills in trigonometry. The questions in this test were designed based on the indicators of mathematical problem solving according to the National Council of Teachers of Mathematics (NCTM). The test questions are arranged with varying levels of difficulty, covering basic concepts to questions that require in-depth analysis. The test was also designed to bring out students' mindsets in solving problems. The interview guideline was used to explore more in-depth information about the strategies used by students, the difficulties experienced, and their concept understanding. The interview was conducted in a semi-structured manner, with the focus of the interview covering the steps students take when solving problems, factors that influence difficulties in understanding trigonometry concepts, and students' perceptions of trigonometry learning.

The procedure for conducting this research consists of three main stages, namely preparation, implementation of data collection, and data analysis. The preparation stage includes determining research subjects, compiling research instruments, testing instruments, and asking permission from the school to conduct research. The data collection implementation stage begins with giving observation test questions to students to measure problem-solving skills on trigonometry material. Conducting semi-structured interviews with students to explore deeper information related to difficulties, problem-solving strategies, and understanding of student concepts, which were selected purposively based on the results of the observation test. Furthermore, the analysis stage with data analysis using NVivo software to facilitate the organisation, coding, and analysis of data. The data analysis process is carried out through several stages, including: data preparation, data coding, thematic analysis, data visualisation, and conclusion drawing.

Result

After collecting data through observation, the observation results were compiled and analyzed to identify patterns and themes that emerged in relation to students' abilities in learning trigonometric comparison materials. Segments of student behavior relevant to the research objectives, such as students' ability to identify problems, the way they analyze problems, and the application and evaluation of problem-solving results, were highlighted. This analysis focused on student behavior in solving opportunity problems.

The coding process was conducted using an open coding technique in which each segment of student behavior was labeled based on the meaning contained in each action taken by the student during the problem-solving process. For example, students who showed good ability to identify problems and find alternative solutions were coded as "can identify", while students who had difficulty understanding the problem and were not active in finding solutions were coded as "cannot identify". From the results of coding the responses of all students, 12 codings were obtained, which were grouped into 5 themes related to problem-solving skills. The codings are as follows: 1) Identifying the problem (able to identify the problem; unable to identify the problem). 2) Formulating the problem (able to formulate the problem; inappropriate problem formulation; not formulating the problem). 3) Apply the strategy (appropriate strategy; inappropriate strategy; no strategy (respond directly). 4) Explain the result (able to explain the result; unable to explain the result). 5) checking the result (checking the result well; not checking the result). Each node is explained in detail based on the visualization results using NVivo.

1. Identifying the Problem

In this code/node, students are expected to read and understand the information in the given problem. This is the first step in the problem-solving process, where students should be able to identify relevant information and define the context of the problem. This code includes students' actions in capturing the important points in the problem, such as the values given or the conditions of the problem to be solved. If students struggle at this stage, they may miss important information that could affect their problem-solving. Therefore, the ability to correctly identify the problem is critical to correctly completing the next step. From the "Identifying the Problem" node, there are two new nodes, "Can Identify the Problem" and "Cannot Identify the Problem".

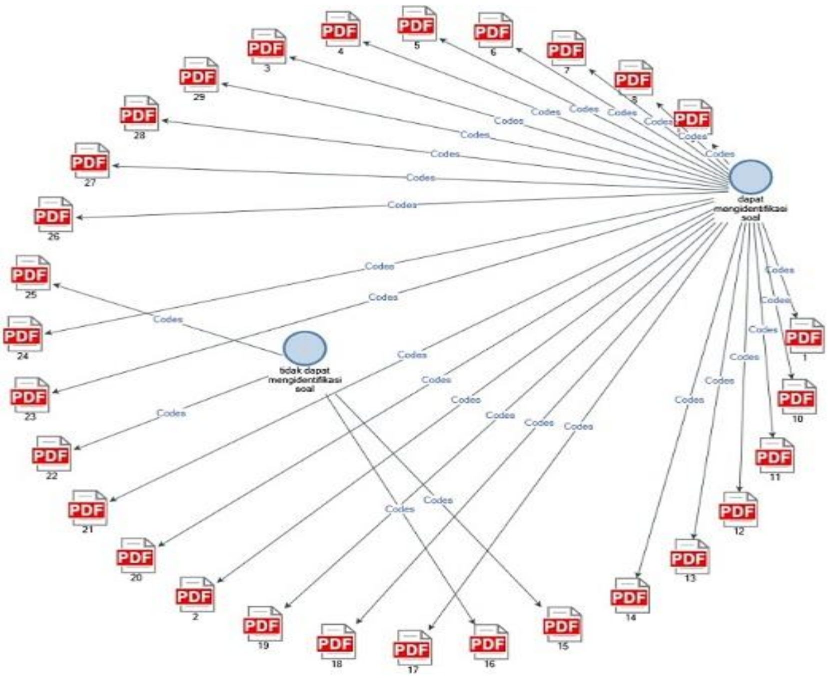

Figure 1. Indicators of identifying a problem

Figure 1 shows the results of coding students' responses based on indicators of their ability to identify questions. Out of a total of 29 students analyzed, 25 students (86.2%) showed a good ability to identify relevant information from the given problem. This indicates that most students understood the context of the problem and were able to recognize important elements needed to begin problem solving. However, 4 students (13.8%) failed to identify the problem correctly, indicating an initial barrier in understanding the problem thoroughly. This finding shows that although the majority of students had an adequate initial understanding, there were still a small number of students who needed special intervention to strengthen their initial skills in problem analysis, which is a crucial stage in the overall problem-solving process.

2. Formulating Problems

This node represents an important stage in the problem-solving process where students are expected to be able to formulate problems in a clear, structured, and mathematically relevant way. At this stage, students must determine exactly what is being asked in the problem and reorganize the identified information into an operational question or problem statement. This ability includes determining the relationship between elements in the problem, recognizing relevant variables, and constructing appropriate mathematical models. Failure to formulate the problem correctly can lead to confusion in choosing the right solution strategy and potentially lead to errors in later stages. Therefore, the ability to formulate problems serves as a critical bridge between understanding the problem and planning an effective solution strategy.

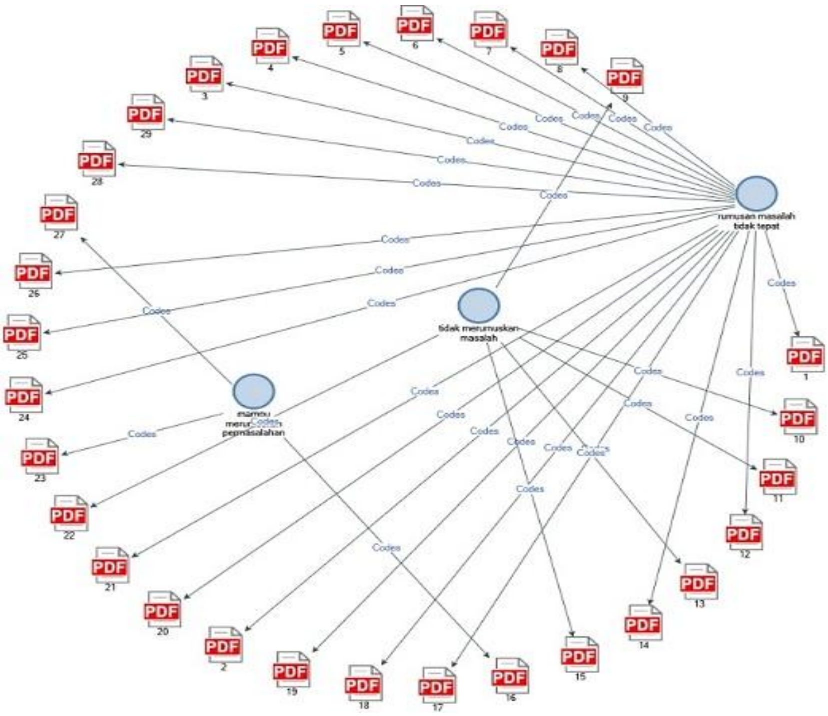

Figure 2. Indicators of Formulating Problems

Figure 2 shows the results of coding the students' responses based on the indicators of problem formulation, which are grouped into three categories, namely: (1) able to formulate the problem correctly, (2) inappropriate problem formulation, and (3) not formulating the problem. Out of a total of 29 students analyzed, only 3 students (10.3%) showed the ability to formulate the problem correctly and in accordance with the context of the problem. A total of 20 students (69.0%) belonged to the category of inappropriate problem formulation, which indicated errors in interpreting information or establishing relationships between problem elements. Meanwhile, 6 students (20.7%) did not formulate the problem at all, reflecting serious obstacles in the early stages of problem solving. These findings suggest that the majority of students have difficulty organizing and conceptualizing information into mathematically solvable problems. This emphasizes the need for educational interventions that focus on strengthening structural and representational thinking skills in order to understand and formulate problems systematically.

3. Applying Strategies.

This node represents a crucial stage in the problem-solving process, where students select and apply appropriate strategies to solve the problem they have formulated. At this stage, students are expected to identify relevant methods, such as the use of trigonometric formulas, diagramming, or other visual representation techniques, to represent and solve the problem systematically. Choosing the right strategy plays a central role in determining the success of problem-solving. Although students may be able to identify important information and formulate the problem well, using the wrong or inappropriate strategy can lead to failure to reach the correct solution. Therefore, the ability to select, adapt, and implement problem-solving strategies appropriately becomes an important indicator in assessing the depth of students' conceptual understanding and procedural skills in solving trigonometry problems.

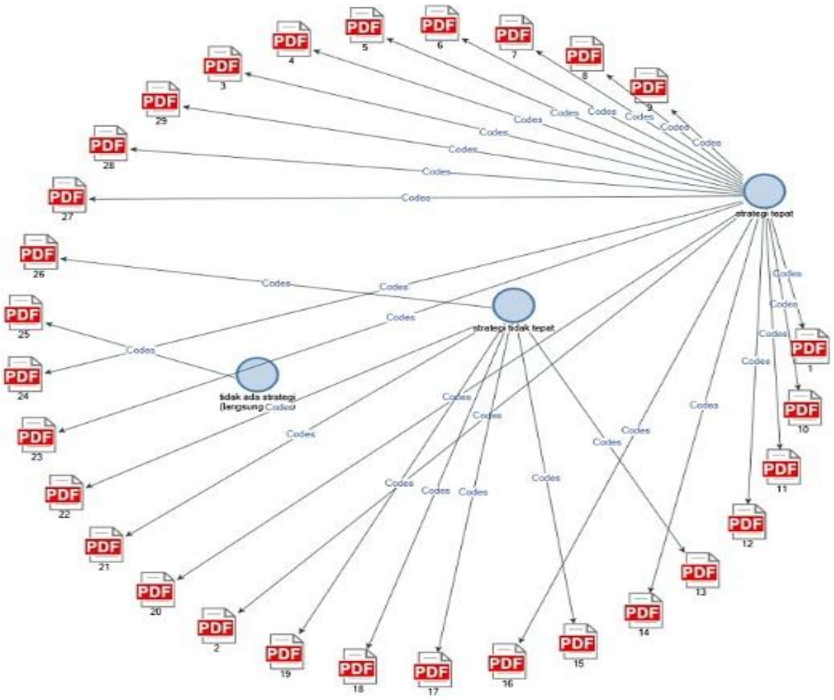

Figure 3. Indicator of Applying Strategies

Figure 3 shows the results of coding the students' responses based on the indicators of strategy application, which are divided into three main categories, namely: (1) appropriate strategy, (2) inappropriate strategy, and (3) no strategy (direct response). Out of a total of 29 students analyzed, 20 students (69.0%) successfully applied the correct strategy in solving the problem, showing a good understanding of appropriate procedures and methods, such as the use of trigonometric formulas or diagrammatic representations. Meanwhile, 8 students (27.6%) used inappropriate strategies, reflecting errors in the choice of methods or a mismatch between the strategies used and the demands of the problem. In addition, 1 student (3.4%) directly answered without showing any application of the strategy, indicating a weakness in the systematic approach to problem solving. These results confirm the importance of fostering the ability to select and apply appropriate problem-solving strategies as part of strengthening critical and reflective thinking skills in mathematics learning.

4. Explaining Results

This node describes the stage where students are expected to not only solve the problem, but also clearly explain the steps they have taken in the process of solving the problem. At this stage, students are expected to be able to communicate in detail the application of the formula or concept used, as well as the reasoning behind the choice of strategy they took to reach the final answer. The ability to explain the results well shows that students not only understand the procedures or algorithms used but also understand the conceptual basis underlying the process. Thus, this stage is very important to identify the level of students' conceptual understanding of the material taught, as well as help teachers evaluate how deeply students understand the solutions obtained. In addition, the ability to clearly communicate the steps of the solution can also strengthen students' critical and reflective thinking skills in solving mathematical problems.

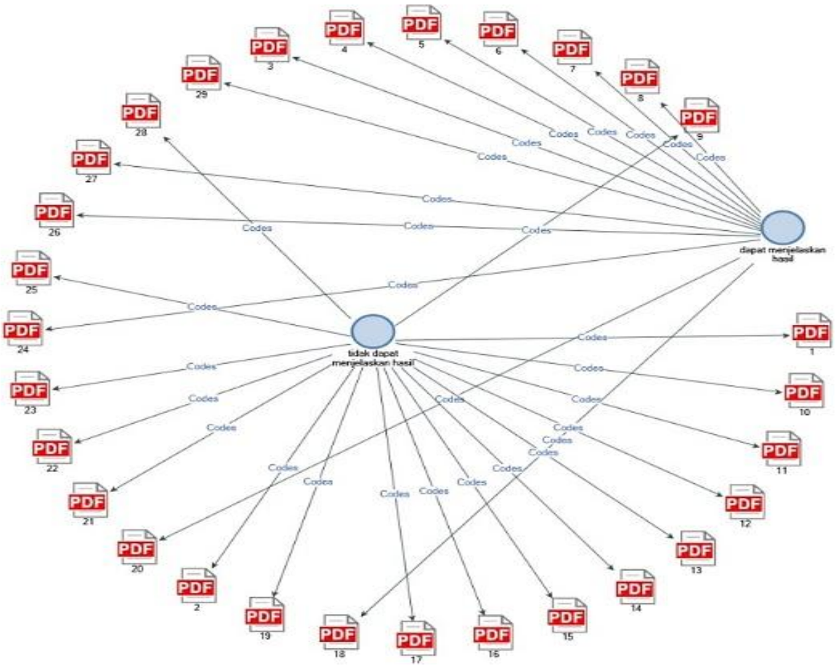

Figure 4. An indicator of explaining results

Figure 4 shows the results of coding the students' responses based on the indicator of explaining the results, which are divided into two main categories, namely: (1) able to explain the result, and (2) unable to explain the result. Out of a total of 29 students analyzed, 12 students (41.4%) were able to explain the results of problem solving well, showing their ability to communicate the steps taken and their understanding of the concepts used. In contrast, 17 students (58.6%) failed to explain the results adequately, indicating a lack of conceptual understanding or difficulty in communicating the problem-solving process in a clear and structured manner. These findings highlight the importance of developing students' mathematical communication skills, particularly in terms of explaining the solution process and the conceptual underpinnings of problem solving, to ensure a deeper understanding of the material.

5. Rechecking Results

This node refers to the final evaluation stage in the problem-solving process, where students are expected to recheck the results they have obtained to ensure that the solution provided truly meets the requirements of the problem. At this stage, students must re-evaluate the steps taken to ensure that each procedure followed is logical, consistent, and relevant to the context of the given problem. This process includes verifying that the final result matches the initial conditions listed in the problem, as well as verifying that all calculations and assumptions used in the solution have been applied correctly. This ability to double-check results not only improves the accuracy of the solution but also allows students to identify potential errors due to omissions or incorrect calculations. This stage is crucial for developing students' reflection and questioning skills, and helps to reduce errors that may occur in the mathematical problem-solving process.

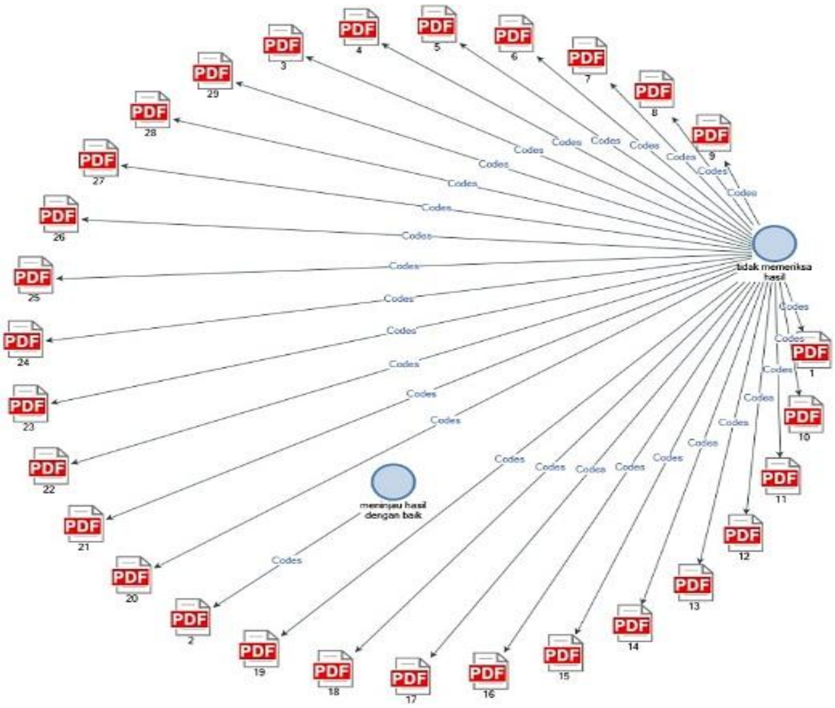

Figure 5. Indicator for double-checking results

Figure 5 shows the results of coding students' responses based on the indicator of checking the results, which is divided into two main categories: (1) checking the results well and (2) not checking the results. Out of a total of 29 students analyzed, only 1 student (3.4%) managed to check the results of problem solving well, indicating that the student carefully evaluated the steps and results achieved. In contrast, 28 students (96.6%) did not check their results after solving the problem, indicating either a lack of attention to the final evaluation or an inability to identify potential errors in the given solution. This finding reflects the importance of training students to develop the habit of checking their results to ensure that each step and the final result are appropriate to the context and demands of the problem, and to reduce errors that may occur due to omissions or inaccurate calculations.

In this study, the interviews were analyzed using NVivo software, which allows researchers to organize and categorize qualitative data systematically. One of the visualization methods used to analyze and present the data was word clouds. Word clouds provide an effective visual representation of the frequency of occurrence of words in students' responses, allowing researchers to identify key themes emerging from the interviews quickly. Word clouds present the most frequently mentioned words in an attractive visual form, where the size of each word reflects its frequency of occurrence in the data. Larger words indicate higher frequency, while smaller words appear with lower frequency. This visualization made it easier for the researcher to identify patterns in the students' responses and to gain insight into the topics or issues most frequently discussed by the students in the interviews. The use of word clouds as a visualization tool in this qualitative analysis supported a deeper understanding of the data and assisted in drawing relevant conclusions.

Figure 6. Word cloud of interview results

The results of the word cloud visualization show several key words that stand out and are often expressed by students in interviews. The words 'learning' and 'comparison' appear with the largest size, indicating that these two concepts are central to students' learning experiences. The word 'trigonometry' also appears prominently, reflecting students' perception that this topic has a high level of importance in the context of learning mathematics. In addition, the occurrence of words such as 'the material', 'itself' and 'the teacher' suggests that students are concerned not only with the content of the material, but also with the way it is delivered and the role of the teacher in supporting their understanding. This suggests that the pedagogical interaction between teachers and students is an important factor in shaping concept understanding. Meanwhile, the word "problem", which also appears with a high frequency, indicates the obstacles or challenges that students face in applying trigonometric concepts in the context of problem solving.

Discussion

The results of this study showed a number of significant patterns and themes related to students' abilities in learning trigonometric comparison materials. Through the analysis of observations and interviews, it was found that students showed variations in their ability to identify, formulate, and solve problems, as well as explain results and double-check their answers. The majority of students (86.2%) were able to identify problems well, reflecting a strong understanding of the material taught. However, 13.8% of students who could not identify the problems indicated challenges that need to be addressed. Follow-up interviews need to be conducted to understand the causes of these difficulties, such as motivation and support received. The analysis also showed that only 3 out of 29 students were able to formulate the problem correctly, while 20 students had difficulty. This indicates confusion in understanding the core of the problem, so teaching should emphasise critical thinking skills and strategies in formulating problems.

In terms of applying problem-solving strategies, 20 students successfully applied appropriate strategies, while 8 students used inappropriate strategies, and 1 student did not use a strategy at all. This shows that although most students understand the basic concepts, there are still challenges in selecting and applying appropriate strategies. Strengthening the learning method that focuses on strategy application can be a solution. A total of 12 students were able to explain the results well, while 17 students had difficulties. This shows that explaining results is not just the final step, but also reflects a deep understanding of the process that has been carried out. Teaching that encourages students to communicate about their steps and the reasoning behind each step can help improve their understanding.

The results also showed that only 1 student double-checked the results, while 28 students did not evaluate their work. This indicates that students are less aware of the importance of rechecking their work. Learning interventions that emphasise self-evaluation and reflection can assist students in improving the accuracy and quality of their learning outcomes. The findings provide valuable insights for the development of more effective teaching strategies. Some recommendations that can be considered include the development of more focused interventions for struggling students, including guidance sessions and the use of alternative teaching methods. In addition, encouraging the use of props, group discussions, and relevant projects can help students better practically understand trigonometry concepts. Integrating activities that encourage students to double-check their results and understand the importance of reflection in the learning process is also an important step.

Overall, this study shows that there are significant challenges in some aspects of students' problem-solving ability, particularly in formulating problems and checking results. By understanding the patterns and themes that emerge from these analyses, teachers can design appropriate interventions to support students in improving their abilities in learning trigonometry. Collaborative efforts between students, teachers, and learning resources will be crucial to achieving better outcomes in mathematics education.

Conclusion

This study reveals that students' problem-solving abilities in trigonometric ratios vary significantly. Although the majority of students were able to identify the given problems accurately, many encountered difficulties in formulating the problems, selecting and applying appropriate strategies, explaining their solutions, and reviewing their answers. These findings indicate the presence of obstacles in students' deeper mathematical thinking processes, likely stemming from limited conceptual understanding, insufficient classroom interaction, and a lack of reflective habits in solving problems. Based on these findings, it is essential to implement instructional strategies that emphasize conceptual understanding, metacognitive development, and active student engagement. Teachers are encouraged to adopt participatory and contextual approaches, such as problem-based learning and group discussions, to foster a more comprehensive understanding of trigonometric concepts. Additionally, providing students with varied problem-solving exercises and project-based assignments can enhance their critical thinking skills and their ability to formulate and evaluate solution strategies. To cultivate reflective thinking, teachers can also facilitate activities such as reflective journaling and discussions on students' problem-solving processes, enabling them to reconstruct their reasoning more consciously. Furthermore, offering additional support for students who face difficulties, as well as incorporating visual aids and interactive digital technologies to enhance the visualization of trigonometric concepts, may help strengthen their conceptual understanding more concretely. Implementing these strategies is expected to improve students' problem-solving skills in trigonometry significantly, both in terms of conceptual comprehension and the effectiveness of their problem-solving strategies.

Conflict of Interest

The authors declare that no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely addressed by the authors.

Reference

Arilaksmi, N. P. G., Susiswo, S., & Sulandra, I. M. (2021). Kemampuan Berpikir Kreatif Mahasiswa Pendidikan Matematika dalam Memecahkan Masalah Open-Ended Trigonometri. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *9*(2), 46. https://doi.org/10.25273/jipm.v9i2.8331

Blackett, N., & Tall, D. O. (1991). Gender and the versatile learning of trigonometry using computer software. *Proceedings of the 15th Conference of the International Group for the Psychology of Mathematics Education*, *1*, 144–151.

Costley, J., Gorbunova, A., Courtney, M., Chen, O., & Lange, C. (2024). Problem-solving support and instructional sequence: impact on cognitive load and student performance. *European Journal of Psychology of Education*, *39*(3), 1817–1840. https://doi.org/10.1007/s10212-023-00757-7

Dabarera, C., Renandya, W. A., & Zhang, L. J. (2014). The impact of metacognitive scaffolding and monitoring on reading comprehension. *System*, *42*, 462–473. https://doi.org/10.1016/j.system.2013.12.020

Dewanto, M. D., Budiyono, B., & Pratiwi, H. (2017). Students' error analysis in solving the math word problems of high order thinking skills (HOTS) type on trigonometry application. *1st Annual International Conference on Mathematics, Science, and Education (ICoMSE 2017)*, 126–131. https://doi.org/10.2991/icomse-17.2018.34

Erdamar, G., & Alpan, G. (2013). Examining the epistemological beliefs and problem solving skills of preservice teachers during teaching practice. *Teaching in Higher Education*, *18*(2), 129–143. https://doi.org/10.1080/13562517.2012.694101

Fauziah, R., & Puspitasari, N. (2022). Kesulitan Belajar Matematika Siswa SMA pada Pokok Bahasan Persamaan Trigonometri di Kampung Pasanggrahan. *Plusminus: Jurnal Pendidikan Matematika*, *2*(2). https://doi.org/10.31980/plusminus.v2i2.1876

Gur, H. (2009). Trigonometry Learning. *New Horizons in Education*, *57*(1), 67–80.

Hanifah, N. F., Hidayat, W., & Aripin, U. (2020). Gender Perspective And Newman's Theory In Error Analysis Of Students'answers In Ratio And Proportion. *Kalamatika: Jurnal Pendidikan Matematika*, *5*(2), 103–118. https://doi.org/10.22236/KALAMATIKA.vol5no2.2020pp103-118

Imbaquingo Guerrero, J. A., Bastidas González, K. A., Gutiérrez Bastidas, J. O., & Alvarado Rosado, S. M. (2024). Aplicación de trigonometría en la resolución de problemas de la vida cotidiana para estudiantes de bachillerato. *Reincisol.*, *3*(5), 1593–1607. https://doi.org/10.59282/reincisol.V3(5)1593-1607

Jatisunda, M. G., & Nahdi, D. S. (2020). Kemampuan Pemecahan Masalah Matematis melalui Pembelajaran Berbasis Masalah dengan Scaffolding. *Jurnal Elemen*, *6*(2), 228–243. https://doi.org/10.29408/jel.v6i2.2042

Kamber, D., & Takaci, D. (2018). On problematic aspects in learning trigonometry. *International Journal of Mathematical Education in Science and Technology*, *49*(2), 161–175. https://doi.org/10.1080/0020739X.2017.1357846

Laja, Y. P. W. (2022). Analisis Kesulitan Mahasiswa Pendidikan Matematika dalam Menyelesaikan Soal Limit Trigonometri. *Mosharafa: Jurnal Pendidikan Matematika*, *11*(1), 37–48. https://doi.org/10.31980/mosharafa.v11i1.1129

Lestari, W. D., Gunadi, F., & Yahkya, Z. S. (2022). Kesulitan belajar matematika siswa pada materi trigonometri berdasarkan self-esteem dan gaya belajar. *Pedagogy: Jurnal Pendidikan Matematika*, *7*(2), 32–45. https://doi.org/10.30605/pedagogy.v7i2.1934

Liu, X., Bulut, O., Cui, Y., & Gao, Y. (2025). Uncovering adults' problem-solving patterns from process data with hidden Markov model and network analysis. *Journal of Computer Assisted Learning*, *41*(1), e13089. https://doi.org/10.1111/jcal.13089

Mohammad Nurwahid. (2023). Media Pembelajaran Panganmewah dan Jargon untuk Meningkatkan Pemahaman Konsep dan Motivasi Belajar Siswa pada Materi Perbandingan Trigonometri. *Plusminus: Jurnal Pendidikan Matematika*, *3*(2). https://doi.org/10.31980/plusminus.v3i2.2935

Mustangin, M., & Setiawan, Y. E. (2021). Pemahaman Konsep Mahasiswa Semester Satu pada Mata Kuliah Trigonometri. *Jurnal Elemen*, *7*(1), 98–116. https://doi.org/10.29408/jel.v7i1.2773

Obeng, B. A., Banson, G. M., Owusu, E., & Owusu, R. (2024). Analysis of senior high school students' errors in solving trigonometry. *Cogent Education*, *11*(1), 2385119. https://doi.org/10.1080/2331186X.2024.2385119

Orhun, N. (2004). Students' mistakes and misconceptions on teaching of trigonometry. *Journal of Curriculum Studies*, *32*(6), 797–820.

Öztürk, M., Akkan, Y., & Kaplan, A. (2020). Reading comprehension, Mathematics self-efficacy perception, and Mathematics attitude as correlates of students' non-routine Mathematics problem-solving skills in Turkey. *International Journal of Mathematical Education in Science and Technology*, *51*(7), 1042–1058. https://doi.org/10.1080/0020739X.2019.1648893

Pimta, S., Tayraukham, S., & Nuangchalerm, P. (2009). Factors Influencing Mathematic Problem-Solving Ability of Sixth Grade Students. *Online Submission*, *5*(4), 381–385.

Setiawan, Y. E. (2021). Analisis Kesalahan Mahasiswa Semester Pertama dalam Menentukan Nilai Fungsi Trigonometri Sudut Istimewa. *SJME (Supremum Journal of Mathematics Education)*, *5*(1). https://doi.org/10.35706/sjme.v5i1.4531

Sinambela, M., & Rombe, A. (2021). Analisis Kesulitan Mahasiswa Semester I Pendidikan Matematika STKIP Abdi Wacana Wamena Memahami Materi Trigonometri. *JURNAL EDUSCIENCE*, *8*(1), 62–69. https://doi.org/10.36987/jes.v8i1.2121

Siswanto, E., & Meiliasari, M. (2024). Kemampuan Pemecahan Masalah pada Pembelajaran Matematika: Systematic Literature Review. *Jurnal Riset Pembelajaran Matematika Sekolah*, *8*(1), 45–59. https://doi.org/10.21009/jrpms.081.06

Sithole, A., Chiyaka, E. T., McCarthy, P., Mupinga, D. M., Bucklein, B. K., & Kibirige, J. (2017). Student attraction, persistence and retention in STEM programs: Successes and continuing challenges. *Higher Education Studies*, *7*(1), 46–59. https://doi.org/10.5539/hes.v7n1p46

Suendarti, M., & Liberna, H. (2021a). Analisis Pemahaman Konsep Perbandingan Trigonometri Pada Siswa SMA. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *5*(2), 326. https://doi.org/10.33603/jnpm.v5i2.4917

Suendarti, M., & Liberna, H. (2021b). Analisis Pemahaman Konsep Perbandingan Trigonometri Pada Siswa SMA. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *5*(2), 326. https://doi.org/10.33603/jnpm.v5i2.4917

Syamsinar, S., K, G., Asmawati, A., & Ahmad, A. K. (2023). Model pembelajaran problem based learning (pbl) terhadap kemampuan pemecahan masalah matematika siswa. *Al-Irsyad Journal of Mathematics Education*, 2(2), 91–102. https://doi.org/10.58917/ijme.v2i2.71

Thompson, P. W. (2015). Researching Mathematical Meanings for Teaching 1, 2. In *Handbook of international research in mathematics education* (pp. 435–461). Routledge. https://doi.org/10.4324/9780203448946-22

Weber, K. (2005). Students' understanding of trigonometric functions. *Mathematics Education Research Journal*, 17(3), 91–112. https://doi.org/10.1007/BF03217423

Weber, K. (2008). Connecting research to teaching: teaching trigonometric functions: lessons learned from research. *The Mathematics Teacher*, *102*(2), 144–150. https://doi.org/10.5951/MT.102.2.0144

Widana, I. W. (2021). Realistic Mathematics Education (RME) untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa di Indonesia. *Jurnal Elemen*, *7*(2), 450–462. https://doi.org/10.29408/jel.v7i2.3744

Yiğit Koyunkaya, M. (2016). Mathematics education graduate students' understanding of trigonometric ratios. *International Journal of Mathematical Education in Science and Technology*, 47(7), 1028–1047. https://doi.org/10.1080/0020739X.2016.1155774

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