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Enhancing Students' Comprehension of Comparisons of Trigonometric Functions through Remedial Learning Videos

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ABSTRACT

Students' failure to grasp mathematical concepts can impede their mastery of learning standards, necessitating remedial efforts often constrained by time. Video-based remedial learning emerges as an innovative solution to enhance learning effectiveness. This study assessed the improvement in student outcomes following video-based remedial learning. Using an experimental pretest-posttest design, the study involved 100 Year 11 and 12 students from a public high school in Sukamakmur, Aceh Besar, Indonesia. Data analysis, via N-Gain score and t-tests, revealed three key findings: (1) a notable improvement in student outcomes after video-based remedial learning on trigonometric comparisons, (2) a greater enhancement in science classes compared to social studies classes, and (3) a higher increase in Year 12 compared to Year 11. The results affirm that video-based remedial learning positively impacts students' understanding of trigonometric functions.

Keywords: *Remedial Learning, Remedial Video, Trigonometry, Mathematical Understanding*.

ABSTRAK

Kegagalan siswa dalam memahami konsep matematika dapat mengakibatkan ketidakcapaian standar ketuntasan belajar, sehingga diperlukan upaya remedial yang seringkali terkendala oleh waktu. Pembelajaran remedial berbasis video menjadi solusi inovatif di era teknologi untuk meningkatkan efektivitas pembelajaran dan mencapai standar ketuntasan. Penelitian ini mengevaluasi peningkatan hasil belajar siswa setelah pembelajaran remedial menggunakan video. Metode penelitian yang digunakan adalah eksperimen dengan desain pre-eksperimental One Group Pretest-Posttest Design. Populasi penelitian mencakup siswa kelas XI dan XII di SMA Negeri di Sukamakmur, Aceh Besar, dengan sampel empat kelas (100 siswa). Analisis data menggunakan skor N-Gain melalui uji *paired sample t-test* dan *independent t-test*. Temuan menunjukkan bahwa (1) hasil belajar siswa meningkat setelah pembelajaran remedial berbasis video pada materi perbandingan trigonometri, (2) peningkatan lebih signifikan di kelas IPA dibandingkan IPS, dan (3) peningkatan lebih tinggi di kelas XII dibandingkan XI. Hasil ini menunjukkan pembelajaran

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remedial dengan video berkontribusi positif terhadap pemahaman siswa pada materi perbandingan trigonometri.

Kata Kunci: Pembelajaran Remedial, Video Remedial, Trigonometri, Pemahaman Matematis.

INTRODUCTION

Mathematics education holds a pivotal role in the Indonesian educational landscape. It encompasses the study of numbers and the development of reasoning skills, making it an indispensable subject. Moreover, mathematics plays a significant role in advancing other sciences (Ramadhan et al., 2020). This underscores the critical importance of mathematics education in enhancing the overall educational quality in Indonesia. However, many students in the country find mathematics challenging. For instance, conceptual errors such as misunderstanding the order of operations or misinterpreting word problems are among the reasons students struggle with mathematics (Novitasari, 2016). Trigonometry is also one topic that students often have trouble with. Rosjanuardi and Jupri (2022) reported epistemological obstacles hindering Indonesian students' understanding of trigonometric functions, including the lack of concepts of angles and radians. The problem related to the challenges in trigonometric also occurs globally, Dhungana, et. al (2023) found that Nepalese students having difficulty in learning trigonometry.

These difficulties hinder students from meeting the expected learning standards (Hussain et al., 2014). Furthermore, students' success in mathematics also depends on the teachers. A study by Ozdemir & Onder-Ozdemir (2017) found that students admit that teachers are among the reasons for their success or struggle in mathematics. This previous research suggests that teachers should strive to provide better learning experience for students utilizing diverse teaching strategies.

In Indonesian context, high school students are allowed to choose science or social streams depending on their interest and academic performance. Mathematics tends to be less favored by social stream students. Indonesia, many students choose social over science stream because they fear the mathematical content (Aminullah & Kusmianti, 2022). Despite enrolling in social stream, students will have to face mathematics. The mathematics for social stream is not advanced and less complicated. Basic mathematical skills, including understanding comparisons of trigonometric functions, are generally lower in social stream students than their science stream counterparts, highlighting the need for effective teaching strategies to improve mathematical comprehension (Rianto et al., 2022). Other studies have confirmed that mathematical abilities are higher in science than in social stream students and vocational schools (Paridjo, 2018).

There are also differences in mathematics learning between Year 11 and 12 students, influenced by factors such as interest, motivation and mathematics anxiety. Year 11 students was reported to have higher mathematics anxiety compared to Year 12 students (Gürsel, et.al., 2023). Year 12 students typically exhibit higher learning motivation due to the importance of graduation for future career prospects. This increased motivation often translates into more focused and effective learning, contributing to better learning outcomes for Year 12 students than those in Year 11. On the other hand, Year 11 students may lack the same level of motivation, which can affect their learning progress (Rahmawati et al., 2018).

One effective strategy to meet learning standards is remedial teaching, typically implemented after diagnostic evaluations or tests (Kurniawan & Toharudin, 2017). Remedial learning can also be conducted after formative or summative test. Cognitive Diagnostic Assessment seeks to identify persistent misconceptions in order to develop targeted supplemental instruction or interventions (Ketterlin-Geller & Yovanoff, 2009). Remedial programs is designed address the learning needs of students who lag in mastering specific competencies, ensuring they meet the minimum criteria of mastery learning set by schools (Tampubolon, 2021). A study by (Büchele, 2020) in Germany revealed that regular remedial learning improves the students' chance of passing exam by 35%. Thus, teachers must strive to help students improve their low scores through remedial measures.

Remedial learning is a method to help students achieve mastery in mathematics, particularly in trigonometric comparisons. Remedial sessions often occur after assessments or diagnostic tests (Kurniawan & Toharudin, 2017). The process aims to improve the understanding of students with low performance, helping them meet learning standards. The remedial program focuses on addressing the specific difficulties students face to ensure they reach the minimum criteria of mastery learning (Tampubolon, 2021). Effective remedial teaching involves re-explaining and reinforcing vital mathematical concepts.

However, many teachers do not conduct remedial teaching optimally, with 87% failing to implement it effectively (Lidi, 2019). Generally, teachers retest students with the same questions without addressing the specific areas of difficulty (Apriliani et al., 2019). Time constraints, high energy demands, and lack of thorough evaluation hinder effective remedial teaching (Prasetyo et al., 2016). Another issue affecting the success of remedial learning is the motivation of students, with some students do not acknowledge the important of such learning and assume they have passed such level (Khouyibaba, 2015). In such cases, the diagnostic test plays a major role in placing students based on their level. For instance, the diagnostic test results provide evidence of students' performance on certain topics and support teacher's decision for conducting remedial learning.

Using videos for remedial learning is a promising solution for more effective implementation. Videos can increase student motivation and understanding of concepts, making learning more engaging (Riesyaputra et al., 2015; Hasiru et al., 2021). They also offer flexibility and can cater to students' diverse learning needs (Krisnawati & Julianingsih, 2019). Remedial videos support technological integration in education, making learning processes more effective (Darling-Hammond et al., 2014). Videos help students retain material longer and enhance their interest in learning (Hasiru et al., 2021). They can also boost motivation, making students more active participants in their education (Krisnawati & Julianingsih, 2019). Videos address different learning styles and needs, highlighting the importance of incorporating them into remedial teaching (Hadi, 2017).

Research indicates that remedial learning using videos positively impacts student outcomes (Darling-Hammond et al., 2014) and completion rates. However, it is important to note that this research has some limitations. For instance, the studies reviewed may have used different methodologies and focused on different student populations, which could affect the generalizability of the findings. Despite these potential limitations, the overall student performance improves significantly using videos in remedial teaching (Mustofa, 2018). Online remedial video sessions receive positive feedback from students, significantly improving learning outcomes (Tampubolon, 2021). Animated remedial videos are particularly effective, significantly enhancing student performance and habits (Marsandi, 2016). These findings encourage further research into the use of videos for remedial teaching. Remedial learning videos can be effective tools in addressing diverse learning needs and fostering deeper understanding among students. This study aimed to assess the improvement in student learning outcomes after remedial learning using videos. It also evaluated whether the improvement in student learning outcomes after remedial learning using videos in the science stream class is better compared to the social one. Finally, It also examined whether the improvement in student learning outcomes after remedial learning using videos in Year 12 is better compared to Year 11.

METHOD

The research was meticulously designed, utilizing a quantitative method, specifically employing a One Group Pretest-Posttest Design. The population for this study was carefully selected, comprising all students from Year 11 and 12 at one of senior high schools in Sukamakmur, Aceh, Indonesia. The sample included 100 students: 28 from Year 11 science stream, 27 from Year 11 social stream, 21 from Year 12 science stream, and 24 from 12 social stream. All students participated in this study did not achieve the minimum criteria of mastery learning and therefore they were all included in the remedial learning. However, should there be any students who met the minimum criteria of mastery learning,

they should be excluded from the study. The study involved a pre-test, three remedial learning sessions using video, and a post-test, ensuring a comprehensive data collection process.

The data collection techniques were comprehensive and thorough, including questionnaires and tests. The questionnaires comprised a needs analysis, diagnostic problem validation sheets, and media validation sheets, while the tests consisted of multiple-choice questions. The data analysis involved two stages: instrument analysis and research results analysis. The instruments used to measure student learning outcomes were tested for validity and reliability to ensure their accuracy and effectiveness. The diagnostic problems validity test showed that the problems were valid, and reliability test also revealed high reliability (0.82). Prior to the research, the validation of diagnostic questions and media was submitted to expert validators. The diagnostic problems validity test showed that the problems were valid, and reliability test also revealed high reliability (0.82). The media was validated by one mathematics teacher and one lecturer in mathematics education. The expert validation results showed that the media was valid with some feedbacks. Necessary revisions were made to the instruments before their use in the research to ensure the process ran smoothly, reinforcing the study's credibility.

The validated instruments, a crucial part of the research, were then tested on Year 11 students at a senior high school in Aceh Besar, Indonesia, to determine their validity. This validation process was a meticulous and rigorous one using SPSS 25, ensuring that the instruments were reliable and accurate in measuring the intended variables. The results showed that the items met the required reliability requirement. Data was then analyzed using SPSS 25 for normality and homogeneity. Hypothesis testing was performed by t-test based on N-Gain data, also utilizing SPSS 25.

RESULT AND DISCUSSION

The study's findings underscore the effectiveness of using videos as a remedial learning tool, particularly in enhancing students' understanding of trigonometric functions. Over the course of five sessions, students engaged with interactive video content designed to clarify difficult concepts. The design of the video-based intervention, with its combination of clear explanations, example problems, animations, and guiding questions, helped make the learning process more engaging and accessible. This approach aligns with research that supports multimedia learning as a way to improve students’ comprehension of complex material (Mayer, 2009).

The test used in this study consisted of multiple-choice items. The calculation of students' pre-test and post-test scores was based on their responses. Table 1 presents the

results of the statistical analysis based on the Gain score data for student learning outcomes in Year 11 science and social streams and Year 12 science and social streams.

Table 1. N-Gain Data of Year 11 and Year 12 Science and Social Streams

Stream and Year	Frequency	Total N-Gain
Year 11 science	28	17.69
Year 11 social	27	15.98
Year 12 science	21	16.12
Year 12 social	24	14.90
Total	100	64.69
Mean		0.64

The N-Gain results demonstrated significant improvements in student learning outcomes across both the science and social streams, with the science stream students exhibiting a greater increase in scores than their social stream counterparts. The average N-Gain for science classes was 0.69, while for social classes it was 0.61, indicating a more pronounced benefit for science students. This outcome may be attributed to the fact that the concepts of trigonometry are more closely aligned with the core mathematical competencies developed in the science stream, making it easier for these students to assimilate the remedial content. Furthermore, the interactive elements of the videos may have resonated more effectively with the analytical skills emphasized in the science curriculum.

The disparity in improvement between Year 11 and Year 12 students also warrants consideration. With Year 12 students achieving a higher average N-Gain (0.69) compared to Year 11 students (0.61), the data suggests that older students may benefit more from video-based remedial learning. This could be due to greater academic maturity and familiarity with self-directed learning strategies, which are crucial when engaging with video content that requires active participation, such as note-taking and replaying sections for better understanding. Additionally, Year 12 students may have a stronger foundation in trigonometric concepts, allowing them to absorb the material more effectively during the remedial sessions.

Students reported an increase in motivation and curiosity, along with greater reliance on peer support through informal tutoring. This is consistent with existing literature, such as van Alten et al. (2019), who highlighted that video-based learning promotes independent learning while encouraging peer interaction, and Cho and Heron (2015), who emphasized the social benefits of peer tutoring in enhancing students' comprehension.

The interviews with students further enriched the quantitative findings, revealing that remedial learning using videos had a positive impact. Students could better understand comparison of trigonometric functions, addressing previous difficulties distinguishing between concepts. This aligns with Saunders et al. (2018), who found that videos positively

impact students' mathematical abilities. The qualitative data suggests that the videos not only clarified specific mathematical concepts but also fostered a more independent and collaborative learning environment, which align with findings by van Alten et al. (2019) and Cho and Heron (2015). Increased learning independence involved greater motivation and curiosity to understand and solve comparison of trigonometric function problems, while social support emerged from peer tutoring activities, where knowledgeable students helped others understand the concepts. This aligns with research indicating that learning media accompanied by animation is effective in helping students comprehend material more comprehensively, thereby improving learning outcomes (Khoiriyah et al., 2021).

The effectiveness of videos as a pedagogical tool is reinforced by the alignment between this study's findings and prior research, which advocates for the use of multimedia learning to enhance both individual understanding and collaborative learning dynamics (Khoiriyah et al., 2021; Mayer, 2009). The videos used in this study provided a platform for students to engage with the content at their own pace, which is particularly beneficial for remedial learning scenarios, where students may need additional time and resources to master challenging concepts. The inclusion of animations and guiding questions further supported this learning process by breaking down complex trigonometric functions into digestible components, thereby reducing cognitive load and promoting deeper

The study demonstrates that video-based remedial learning is an effective tool for improving students' comprehension of trigonometric functions, particularly when used in a structured, interactive format. The improvements observed in both the science and social streams, as well as across Year 11 and Year 12 students, suggest that this approach can be successfully applied in diverse educational settings. Additionally, the positive feedback from students regarding their increased independence and peer collaboration highlights the broader educational benefits of incorporating multimedia learning tools. These findings contribute to the growing body of evidence supporting the use of videos and other digital resources in enhancing academic performance and addressing learning gaps. Future research could explore the long-term impact of video-based learning on student outcomes and investigate its applicability across different mathematical concepts and subject areas.

CONCLUSION

This study examined the enhancement of student learning outcomes following their participation in remedial learning using videos. The analysis of pre-test and post-test scores of student learning outcomes revealed increased learning outcomes after involving remedial learning using videos on comparison of trigonometric functions. Furthermore, the analysis results of N-Gain for science and social studies classes showed that the increase in student

learning outcomes after remedial learning using the videos in science stream classes was more significant than in social stream classes. Finally, the results of data analysis of the mean value of student N-Gain for Year 11 and 12 students show that the increase in student learning outcomes after remedial learning using videos on comparison of trigonometric function in Year 12 is better than those in Year 11.

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