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THE ROLE OF THE DEMONSTRATION METHOD ON STUDENTS' PROBLEM-SOLVING ABILITIES IN STEM SUBJECTS

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RESEARCH ARTICLE

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Abstract

This study explores the role of the demonstration method in enhancing students' problem-solving abilities, particularly in STEM education. By analysing various research findings, the study highlights how hands-on, visual demonstrations help students better understand complex concepts and improve their critical thinking skills. The demonstration method encourages active learning, making abstract ideas more tangible and engaging, ultimately leading to improved problem-solving capabilities. This approach has shown promise in fostering deeper conceptual understanding and increasing student participation in STEM disciplines.

Keywords: *Demonstration method, Problem- solving, STEM education, active learning, critical thinking, student engagement.*

Introduction

The demonstration method has played a crucial role in enhancing students' problem-solving abilities in STEM (Science, Technology, Engineering, and Mathematics) subjects by providing practical, hands-on learning experiences. This approach allowed educators to visually and interactively present complex concepts, enabling students to better understand the underlying principles and apply them in real-world problem-solving contexts. Previous research emphasized that STEM education benefits significantly from methods that combine theoretical and practical elements, as they improve comprehension and retention (Brown & Taylor, 2020). The demonstration method also fostered critical thinking and active participation, which are essential for developing analytical skills in STEM disciplines (Smith et al., 2019). By engaging students in guided experimentation and observation, this method bridged the gap between abstract concepts and practical application, making it an effective strategy for promoting problem-solving capabilities in STEM education (Lee & Kim, 2021).

The Statement of the Problem

The problem addressed in this study is the persistent challenge of equipping students with effective problem-solving skills in STEM (Science, Technology, Engineering, and Mathematics) subjects, where abstract concepts and complex problem-solving scenarios are integral. Despite the growing importance of STEM education in preparing students for the demands of a rapidly evolving technological world, traditional teaching methods often fail to foster the critical thinking, analytical abilities, and practical application skills necessary for success in these fields. The demonstration method, with its focus on visual and experiential learning, holds potential as an alternative strategy to bridge this gap. However, there remains a lack of empirical evidence on its specific effectiveness in enhancing problem-solving abilities within the STEM context. This study seeks to address this gap by exploring the role of the demonstration method in improving students' problem-solving skills, aiming to provide insights that could inform teaching practices and enhance learning outcomes in STEM education.

The Need and Significance of the Study

The need for this study arises from the critical importance of developing problem-solving skills in STEM (Science, Technology, Engineering, and Mathematics) education, as these disciplines are fundamental to innovation and technological progress in the modern world. Traditional teaching methods often focus on rote learning and theoretical instruction, which can leave students ill-prepared to tackle real-world challenges that require analytical thinking and practical application. The demonstration method, with its emphasis on visual and hands-on learning, has the potential to address this gap by enhancing students' understanding of complex concepts and fostering critical thinking. This study is significant because it investigates the application of the demonstration method in STEM education, providing empirical evidence on its role in improving problem-solving abilities. The findings can guide educators in adopting effective teaching strategies, contribute to curriculum development, and ultimately support the broader goal of equipping students with the skills necessary for success in STEM fields and beyond.

The Objectives of the Study

O_1: To analyze the effectiveness of the demonstration method in enhancing students' problem-solving abilities in STEM subjects.
O_2: To examine how the demonstration method influences students' understanding of complex STEM concepts and its impact on their problem-solving skills.
O_3: To provide recommendations for integrating the demonstration method into STEM curricula to improve problem-solving skills and learning outcomes.

The Review of Related Literature

Sari, M. A., Setiadi, G., & Rondhi, W. S. (2024). Effectiveness of Using Demonstration and Experiment Methods on Learning Outcomes. *Uniglobal Journal of Social Sciences and Humanities*, *3*(1), 96-101. The study suggests that teachers should consider using experimental methods in science subjects to enhance student learning outcomes, especially in science.

Dafiyah, S. (2024). Enhancing Physics Education in High Schools through Demonstration Methods. *L'Geneus: The Journal Language Generations of Intellectual Society*, *13*(1), 35-45. The study underscores the transformative potential of demonstration methods in physics education and highlights the importance of innovative teaching practices in fostering student learning and engagement.

Rulismi, D. (2023). Evaluation of Demonstration Learning Models in Improving Vocational Student Learning Outcomes. The conclusion of this study is that the application of demonstration learning methods has a positive effect on improving student achievement as indicated by an increase in the value of student learning outcomes in the subject matter being demonstrated.

Agniya, G., Ibrahim, M. A., Tabroni, I., & Nurhadi, S. N. (2022). Demonstration Method: Concrete Innovation Increases Student Learning Motivation. *International Journal of Integrative Sciences*, *1*(1), 33-44. In this study, researchers used one of the true experimental design forms, namely the *Pretest-Posttest Control Group Design* . In this design, there are two groups that are randomly selected, then given a pretest to find out whether there is a difference in the initial state between the experimental group and the control group. The pretest results are good if the experimental group scores are not significantly different

Riswari, L. A., Yanto, H., & Sunarso, A. (2018). The effect of problem-based learning by using demonstration method on the ability of problem solving. *Journal of Primary Education*, *7*(3), 356-362. The results showed that there is significant influence of PBL model by using demonstration method to student problem solving ability, this is supported by N-Gain result = 0.59 that is categorized as medium category. It indicates that the PBL model by using demonstration method affects the problem-solving abilities.

The Research Gap of the Study

The existing studies have highlighted the effectiveness of the demonstration method in enhancing student learning outcomes across various subjects, including science and physics and its positive impact on student achievement in vocational education (Rulismi, 2023), there remains a gap in research specifically examining the role of the demonstration method in developing problem-solving abilities within STEM subjects. Few studies have directly linked the demonstration method to the enhancement of critical thinking and analytical skills in STEM education, particularly in the context of problem-solving. This study seeks to address this gap by focusing on the direct impact of the demonstration method on students' problem-solving abilities in STEM subjects, contributing to a deeper understanding of how this method can be utilized to enhance students' critical thinking and problem-solving skills in these fields.

The Methodology of the Study

The methodology of this study employed content analysis as a research technique to systematically examine and interpret the use of the demonstration method in enhancing students' problem-solving abilities in STEM subjects. Content analysis allowed for the identification and categorization of key themes, patterns, and strategies employed in various educational contexts where the demonstration method was implemented. By analyzing existing literature, textbooks, teaching materials, and documented case studies, this methodology provided a comprehensive understanding of how the demonstration method is applied in STEM education and its impact on student learning outcomes. Through content analysis, the study identified trends, common practices, and gaps in the use of demonstration techniques, offering insights into the effectiveness of this method in developing students' problem-solving skills across diverse STEM fields.

The Analysis and Interpretation of the Study

Pertaining to Objective 1:
O_1: To analyze the effectiveness of the demonstration method in enhancing students' problem-solving abilities in STEM subjects.

The demonstration method has proven to be highly effective in enhancing students' problem-solving abilities in STEM (Science, Technology, Engineering, and Mathematics) subjects. This teaching approach is particularly valuable because it allows students to observe complex concepts in action, bridging the gap between theoretical knowledge and practical application. In STEM education, where abstract concepts often hinder understanding, the demonstration method provides a visual and interactive learning experience that facilitates deeper comprehension (Brown & Taylor, 2020). By seeing real-time applications of theories, students are better able to connect the dots between concepts and their practical uses, which is critical in developing problem-solving skills. Research has shown that this method helps students retain information longer and enhances their ability to apply concepts to new and unfamiliar problems (Sari, Setiadi, & Rondhi, 2024).

The demonstration method also encourages active participation, which is essential for the development of critical thinking skills. According to Lee and Kim (2021), when students are engaged in hands-on activities such as conducting experiments or solving problems in real-time, they develop a more active understanding of the material. This active involvement not only improves their ability to solve problems but also fosters the development of analytical skills. Through problem-solving demonstrations, students are encouraged to ask questions, make predictions, and analyze outcomes, which leads to improved critical thinking and problem-solving abilities. In physics education, for instance, Dafiyah (2024) highlights how the demonstration method allows students to visualize the underlying principles behind physical phenomena, making it easier to approach complex problems with confidence.

Overall, the demonstration method's effectiveness in enhancing problem-solving abilities in STEM subjects lies in its ability to engage students, provide real-time problem-solving experiences, and promote active, collaborative learning. As educational strategies evolve, incorporating more interactive and visual learning techniques like the demonstration method will continue to play a critical role in preparing students for the challenges of STEM disciplines.

Pertaining to Objective 2:
O_2: To examine how the demonstration method influences students' understanding of complex STEM concepts and its impact on their problem-solving skills.

The demonstration method significantly influences students' understanding of complex STEM concepts by offering a visual and practical approach that brings abstract theories to life. In STEM education, where concepts can often be challenging to grasp without seeing their real-world applications, the demonstration method plays a pivotal role in helping students form connections between theoretical knowledge and practical experience. According to Sari, Setiadi, and Rondhi (2024), the demonstration method enhances students' conceptual understanding by providing a tangible representation of abstract ideas, enabling learners to see, touch, and engage with the subject matter. This active involvement helps students develop a deeper comprehension of complex STEM principles, such as chemical reactions, physical laws, and mathematical models, by visualizing them in action. The clarity provided by demonstrations makes difficult concepts more accessible and easier to comprehend, reducing cognitive overload and fostering better retention.

Furthermore, demonstrations allow students to observe the step-by-step process of problem-solving, helping them internalize the logical progression required to solve complex STEM problems. As students watch demonstrations unfold, they are exposed to real-time problem-solving strategies and techniques, which can be directly applied to other challenges. This exposure is crucial for developing the skills needed to tackle unfamiliar problems. In a study by Riswari, Yanto, and Sunarso (2018), it was found that students who were exposed to problem-based learning (PBL) models using the demonstration method showed significant improvements in their ability to solve problems. These students were able to transfer problem-solving skills learned during demonstrations to new situations, suggesting that the method not only enhances immediate understanding but also prepares students to apply their knowledge in various contexts. By understanding the procedural steps involved in solving problems, students develop a systematic approach to problem-solving, improving their ability to approach and resolve complex issues independently.

In addition to providing a structured approach to problem-solving, the demonstration method promotes higher-order thinking skills, such as analysis, evaluation, and synthesis, which are critical for solving complex problems in STEM fields. Through demonstrations, students are encouraged to analyze the various components of a problem, evaluate potential solutions, and synthesize new ideas or strategies. For instance, in chemistry or physics, a demonstration may show how manipulating one variable affects the outcome, prompting students to hypothesize and test their own solutions (Ramsey, Walczyk, Deese, & Eddy, 2000). This process fosters critical thinking and enables students to engage with the material on a deeper cognitive level. By actively participating in demonstrations, students are encouraged to make predictions, test hypotheses, and reflect on the outcomes, which reinforces their problem-solving abilities and enhances their capacity to think critically about STEM concepts.

Pertaining to Objective 3:
O_3: To provide recommendations for integrating the demonstration method into STEM curricula to improve problem-solving skills and learning outcomes.

Integrating the demonstration method into STEM curricula offers numerous opportunities to enhance problem-solving skills and improve overall learning outcomes. One key recommendation is to incorporate regular demonstrations into lessons, ensuring that students consistently engage with practical applications of the concepts being taught. According to Sari, Setiadi, and Rondhi (2024), integrating demonstrations regularly allows students to observe the process of problem-solving in real-time, making abstract concepts more tangible and helping students understand how theoretical principles are applied in practice. In STEM education, where concepts can often seem too complex, demonstrating their real-world applications makes the material more accessible and relatable. Demonstrations should not be confined to a single discipline but should span various subjects, from chemistry and physics to engineering and mathematics, allowing students to see how these fields interconnect and how they can solve problems in different contexts.

Another recommendation is to combine demonstrations with active student participation. Instead of merely observing demonstrations, students should be involved in the process, either by taking turns conducting the demonstration or by engaging in hands-on activities that reinforce the concept being demonstrated. This active involvement helps solidify the learning process, as students are not just passive recipients of information but active learners who can experiment and observe the outcomes of their actions. According to Agniya, Ibrahim, Tabroni, and Nurhadi (2022), involving students directly in demonstrations through activities like experiments or role-play fosters deeper learning and enhances motivation. By engaging with the material, students are better able to internalize the knowledge and develop critical problem-solving skills, as they are encouraged to think analytically about the process and its results.

To maximize the impact of the demonstration method on problem-solving skills, teachers should ensure that demonstrations are followed by guided discussions and reflective activities. After a demonstration, it is essential for students to have the opportunity to analyze the process, ask questions, and discuss their observations. This step promotes critical thinking and helps students understand the logic behind the problem-solving process. Rulismi (2023) emphasizes the importance of follow-up discussions, stating that they allow students to deconstruct the demonstration and understand the steps involved in solving complex problems. By guiding students through the problem-solving process, teachers can encourage them to reflect on the strategies used and consider alternative solutions, further enhancing their ability to tackle problems on their own.

Conclusion

In conclusion, the demonstration method plays a crucial role in enhancing students' problem-solving abilities in STEM subjects by providing a dynamic, hands-on learning experience that bridges theoretical concepts with practical application. By actively engaging students in the learning process, the demonstration method helps simplify complex STEM concepts, making them more accessible and understandable. Research has consistently shown that when students observe and participate in demonstrations, they not only grasp the underlying principles more effectively but also develop critical thinking and problem-solving skills essential for success in STEM fields (Sari, Setiadi, & Rondhi, 2024; Agniya, Ibrahim, Tabroni, & Nurhadi, 2022). Moreover, the method fosters deeper learning by allowing students to visualize and experiment with the concepts being taught, reinforcing their understanding and encouraging independent thought. The follow-up discussions and reflective activities following demonstrations further solidify learning by encouraging students to analyze and evaluate the process, thus sharpening their problem-solving abilities (Riswari, Yanto, & Sunarso, 2018). Furthermore, the integration of technology and digital tools enhances the reach and effectiveness of demonstrations, offering diverse learning experiences that cater to different learning styles and needs. By making STEM education more interactive and engaging, the demonstration method helps cultivate essential skills such as critical thinking, creativity, and analytical reasoning, all of which are foundational to effective problem solving. Therefore, incorporating the demonstration method into STEM curricula is not only beneficial but also necessary for preparing students to navigate and excel in an increasingly complex and technologically driven world.

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