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THE MINIATURE OF SOLAR SYSTEM MEDIA IN IMPROVING SCIENCE UNDERSTANDING AND LEARNING OUTCOMES IN ELEMENTARY SCHOOLS

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ABSTRAK
Science learning in elementary schools often faces difficulties in teaching abstract concepts, such as the solar system, which are difficult for students to understand. Interactive and visual learning media, such as miniature solar system media, can solve this problem. This study aims to test the effectiveness of miniature solar system media in improving the understanding and learning outcomes of 5th-grade elementary school students. This study used a quasi-experimental design with two groups, experimental (using miniature media) and control (traditional learning methods), consisting of 25 students. Data were collected through a learning outcome test containing 25 questions about basic competencies. Data analysis was carried out using normality tests, homogeneity tests, regression tests, and hypothesis tests. The study showed that the miniature solar system media significantly improved students' science learning outcomes, with a t-test value of 7.334, and H1 was accepted. This study concludes that miniature media effectively enhances the understanding of abstract science concepts and can be implemented in science learning in elementary schools. The practical implications are the importance of teacher training to utilize this media optimally and the expansion of technology in science learning in elementary schools.

Keywords: Miniature media, solar system, science learning, learning outcomes.

INTRODUCTION

Natural Science education at the elementary school level is essential in forming the foundation of scientific knowledge and critical thinking skills for students. (Endiape et al., 2023). Science learning aims to provide an understanding of scientific concepts and foster curiosity and analytical thinking skills from an early age (Maryani, Irsalinda, Jaya, Sukma, & Raman, 2025)One of the topics that is quite complex for elementary school students is the solar system. This involves abstract concepts about celestial bodies, the distance between planets, and the movement and interaction between elements of the universe. Although this material is essential in the science curriculum, teaching about the solar system often challenges students' understanding. (Putra, Erman, & Susiyawati, 2022; Stevi & Haryanto, 2020).

The development of educational technology offers various innovative solutions to overcome these problems (Mohammed & Kumassah, 2024). One method that has recently received attention is using visual media as a tool in the learning process. Miniature solar system media, which can illustrate these concepts concretely and interactively, are an exciting choice for use in the classroom (Addido, Burrows, & Slater, 2022). This media helps students more

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easily understand abstract ideas and increases their involvement in learning, making it more enjoyable and in-depth. Using miniature solar system media in science learning is essential to improve the quality of students' understanding and learning outcomes in elementary school (Mufit, Festiyed, Fauzan, & Lufri, 2023). However, although many studies have shown the potential of using media to enhance learning outcomes, few studies specifically explore the effectiveness of using miniature solar system media in the context of science learning at the elementary school level. This is a strong reason to conduct further research to explore the effectiveness of the media in improving students' understanding and learning outcomes (Sekarsari & Rusnilawati, 2023).

The main problem in learning science in elementary schools is students' difficulty understanding abstract concepts in the material, such as the solar system. Concepts that include celestial bodies and their interactions can often not be understood well only through verbal explanations or pictures in textbooks. Students tend to find it difficult to imagine the distance between planets or the movement of celestial bodies that they cannot observe directly in everyday life. This can lead to low levels of understanding and learning outcomes for students in science materials, especially on the solar system. (Adi, Ragil, Atmojo, & Ardiansyah, 2024). Another obstacle is the limited use of effective media in science learning in the classroom. Many schools, especially in areas with limited educational resources, still rely on traditional learning media that cannot provide students with in-depth and interactive learning experiences. Therefore, developing and testing new learning media to meet visualization needs and improve students' understanding of the material is essential. (Basco, 2020).

This research must consider the challenges educators and students face in science learning, especially related to the solar system material (Herwinarso, Pratidhina, Adam, Kuswanto, & Rahmat, 2023). A survey conducted by the Sumenep Regency Education Office in 2023 showed that more than 60% of elementary school science teachers reported difficulties effectively teaching material about the solar system. As many as 45% of teachers also reported that many students had trouble understanding the relationships between planets and the movement of celestial bodies due to the lack of adequate media to illustrate these concepts concretely (Hardiansyah & Zainuddin, 2022). In addition, data obtained from the results of the final semester exams in several elementary schools in Sumenep Regency showed that only 35% of students achieved satisfactory scores in the science exam covering the solar system material. This indicates a significant gap in students' understanding of science material, which in turn has the potential to affect their overall academic achievement. Therefore, this

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study explores the effectiveness of using miniature solar system media in improving students' understanding and science learning outcomes at the elementary school level, especially in areas that experience similar obstacles (Hardiansyah, Armadi, Ar, & Wardi, 2024).

Based on the background of the problems that have been explained, this research will focus on several main questions that are the focus of attention and objectives for further study: How effective is the use of miniature solar system media in improving the understanding of science concepts, especially in the topic of the solar system, in elementary school students? Can miniature solar system media use improve student learning outcomes in science learning in elementary schools? How does using miniature solar system media affect students' motivation and involvement in science learning in the classroom? This study aims to assess the effectiveness of using miniature solar system media in improving students' understanding and learning outcomes in science learning in elementary schools. Specifically, this study aims to assess whether miniature solar system media can help students understand abstract concepts in solar system material more easily and effectively. Measuring the increase in student learning outcomes after implementing miniature solar system media in science learning and analyzing the impact of miniature media on student motivation and involvement in science learning.

Several previous studies have examined the influence of learning media on students' understanding and learning outcomes at various levels of education. For example, research conducted by (Inayah & Zubaidah, 2020) Found that the use of visual media in science learning can improve students' understanding of scientific concepts that are difficult to understand abstractly. In this study, media such as images, diagrams, and 3D models increased students' interest and understanding of science material. Research by Setiani, Sanjaya, and Jatmiko also shows that using technology-based learning media, such as animation and interactive simulations, can improve student learning outcomes in elementary schools. The results of this study indicate that students who are taught using technology-based learning media show significant improvements in exam results and conceptual understanding compared to students who use traditional methods. However, research that specifically examines the use of miniature solar system media in the context of science learning in elementary schools is still limited. This study attempts to fill this gap by focusing on the effectiveness of miniature media as a science learning aid at the elementary school level.

This study offers a new contribution by focusing on using miniature solar system media to aid science learning. Using miniatures as learning media provides direct visualization that can stimulate students' curiosity and involvement in understanding difficult-to-understand

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material. This study is also relevant to the need to adapt technology and innovation in education, especially in areas still facing challenges in providing effective learning media. Thus, this study can potentially improve the quality of science learning in elementary schools and contribute to developing more interactive and enjoyable learning strategies for students.

METODOLOGY

This study uses a quantitative approach with a quasi-experimental research design to assess the effectiveness of miniature solar system media in improving elementary school students' understanding and science learning outcomes. The choice of a quasi-experimental design is based on the need to measure changes that occur in the experimental and control groups without the need for complete randomization, which is often not possible in more practical educational settings, such as elementary schools. This design also allows researchers to compare groups using miniature media and control groups using traditional learning methods. The population of this study was all 5th-grade students at SDN Pangarangan 1, Sumenep. The research sample consisted of 50 randomly selected students (random sampling). It was divided into two groups: the experimental group that would use miniature solar system media and the control group that would be taught using conventional methods. The sample division was carried out randomly to ensure that the two groups did not have significant differences that could affect the study results.

The main instrument used in this study was a learning outcome test consisting of 25 objective questions that measure students' understanding of the solar system material. This test was designed by considering the basic competencies that grade 5 students must master according to the applicable curriculum. The questions in this test cover various aspects of knowledge, understanding, and application related to the topic of the solar system, such as the names of the planets, the order of the planets, the distances between planets, and astronomical phenomena that are relevant to the learning objectives to improve students' understanding of the solar system, as well as to encourage them to develop critical thinking skills.

Validity and reliability tests will ensure that the instrument used can measure what should be measured (validity) and consistently provide results (reliability). Validity tests are conducted using content validity and construct validity methods, while reliability tests are performed using the Cronbach's Alpha method to measure the internal consistency of the test instrument. After the instrument has been tested for validity and reliability, data analysis will be carried out with a series of statistical tests. First, the normality test checks whether the data obtained is normally distributed, which is the basic assumption in parametric statistical tests.

The homogeneity test checks whether the variance between the experimental and control groups is homogeneous. The normality test can be conducted using the Shapiro-Wilk test, while the homogeneity test can be performed with the Levene test. If the data is usually distributed and homogeneous, the hypothesis test will be conducted using the t-test for independent samples to test the difference in average learning outcomes between the experimental and control groups.

The t-test was chosen because it allows the comparison of means between two separate groups and usually assumes distributed and homogeneous data. Conversely, if the data is not normally distributed or not homogeneous, then a non-parametric test such as the Mann-Whitney test will be used to test the difference between the two groups. The selection of this test is based on the nature of the existing data, where non-parametric tests are more appropriate when the assumption of normality or homogeneity is not met. The hypotheses of this study are as follows:

H0 (Null Hypothesis): There is no significant difference between the learning outcomes of students who use the miniature solar system media and students who use traditional learning methods.

H1 (Alternative Hypothesis): There is a significant difference between the learning outcomes of students who use the miniature solar system media and students who use traditional learning methods.

This hypothesis test is essential to determine whether miniature solar system media significantly impact students' understanding and learning outcomes in science material compared to conventional methods that are commonly used. If H1 is accepted, it can be concluded that the miniature solar system media are efficacious in improving students' science learning outcomes. Conversely, if H0 is accepted, the press will not significantly impact.

RESULT AND DISCUSSION

In this section, the research results obtained will be analyzed and interpreted to identify the extent to which the effectiveness of using miniature solar system media in improving elementary school students' understanding and science learning outcomes. Based on the data collected, the analysis was carried out by referring to the research objectives, namely to measure the increase in understanding of the concept of the solar system and the differences in learning outcomes between the group using miniature media and the control group using traditional learning methods. In addition, this analysis will also consider other factors that can affect the results, such as student motivation and their involvement in the learning process.

As a first step, a statistical test was carried out to ensure that the data obtained were valid and met the assumptions needed for hypothesis testing.

Table 1. Reliability test data results

Alpha Cronbach	N of Item
.833	25

One of the most common methods used to measure the internal consistency of an instrument is Cronbach's Alpha coefficient. This value reflects how strong the relationship between items is in a scale or test that aims to measure the same construct. Based on the data in Table 1, Cronbach's Alpha value of 0.833 was obtained from 25 items in the instrument used, and a reliability value of ≥ 0.8 was categorized as good. Thus, it can be concluded that the instrument used in this study has high internal consistency and is suitable for measuring students' science learning outcomes on the solar system. A value of 0.833 indicates that most of the items in the instrument are closely related and together stably measure the intended variables. This provides confidence that the test results from students reflect the actual conditions and can be relied on for further analysis, such as hypothesis testing or comparative analysis between the experimental and control groups. This high reliability can be associated with several important factors, including the suitability between the question indicators and the fundamental competencies targeted in the fifth-grade science curriculum. Clarity of question construction regarding language, context, and difficulty level allows students to understand and respond consistently. Balance between question items, where there is no dominance of specific indicators that disrupt the homogeneity of the construct being measured. Academically, these results provide a strong basis for asserting that the test instrument has acceptable measurement quality in the context of educational research, especially at the elementary school level. In addition, the validity of learning outcomes measured through this instrument will have a higher weight because it is supported by adequate internal consistency.

Table 2. Normality Test Results

		Shapiro-Wilk		
		Statistics	Df	Sig.
Pre-test	Experiment	.932	25	.522
	Control	.877	25	.518
Post-test	Experiment	.944	25	.634
	Control	.912	25	.534

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Based on Table 2, the Shapiro-Wilk statistical value for the pre-test of the experimental group is 0.932 with a significance value (Sig) of 0.522, which is greater than 0.05. This indicates that the pre-test data of the experimental group is usually distributed. Likewise, the control group, which has a statistical value of 0.877 and a significance value of 0.518, is also greater than 0.05, which means that the pre-test data of the control group is also normally distributed. In the post-test, the results of the Shapiro-Wilk test show that the experimental group data has a statistical value of 0.944 with a significance value of 0.634, which is much greater than 0.05, so the post-test data of the experimental group is also normally distributed. Likewise, the control group in the post-test has a statistical value of 0.912 and a significance value of 0.534, indicating a normal data distribution in this group. Overall, the normality test results suggest that the pre-test and post-test data for both experimental and control groups are normally distributed, with a significance value greater than 0.05. This allows the use of further parametric statistical tests, such as the t-test, to test the difference in means between the experimental and control groups because one of the main assumptions of the t-test is the normality of the data.

Table 3. Homogeneity Test Result

		Levene Statistics	f1	df2	Sig.
Results	Based on the Mean	144		52	.831
	Based on the Median	094		52	.822
	Based on Median and with adjusted df	094		48	.822
	Based on the trimmed mean	188		52	.812

Based on Table 3, the Levene test results show that the Levene Statistic value for testing based on the average (Based on Mean) is 0.144 with a significance value (Sig) of 0.831, greater than 0.05. This indicates that the variance between the experimental and control groups in the pre-test and post-test is not significantly different. Hence, the data is homogeneous based on the average. Likewise, the Levene test based on the MedianMedian (Based on the Median) gives a value of 0.094 with a Sig of 0.822, which is also greater than 0.05, indicating that the variance between groups at the MedianMedian is homogeneous. Testing with MedianMedian and adjusted df produces a value of 0.094 with a Sig value of 0.822, which shows consistent results, namely that the homogeneity of variance is maintained. Finally, Levene's test based on the trimmed mean obtained a value of 0.188 with a Sig value of 0.812, indicating that the variance between the experimental and control groups is not significantly different, so homogeneity is maintained. Overall, the results of Levene's test on various tests (based on the mean, Median, and trimmed mean) indicate that the variance between the experimental and control groups in the pre-test and post-test is homogeneous. Thus, the assumption of homogeneity of variance has been met, allowing further parametric statistical tests, such as the t-test, to test the difference in means between the experimental and control groups.

Table 4. Test Regression Coefficients [a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	32,404	4.212		7,334	000
NGain_Eks	61,332	7.65	.809	7,555	000

The regression analysis results in Table 4 show essential information related to the influence of the independent variable on the dependent variable and how much each variable contributes to the tested regression model. In this model, the unstandardized and standardized coefficients provide in-depth insight into the influence of each variable on the research results. The unstandardized coefficient value for the constant (Constant) is 32.404 with a Standard Error of 4.212, which produces a t value of 7.334 and a Sig. of 0.000. This shows that the constant in this regression model is very significant, with a p-value of less than 0.05, which means that the constant plays a significant role in explaining the variability of learning outcomes observed in this study. This constant indicates the initial or baseline prediction value before other variables enter the model. Next, the unstandardized coefficient for NGain_Eks (which can refer to the change in the experimental value or the gain obtained from the experimental group) is 61.332 with a Standard Error of 7.65, which produces a standardized coefficient (Beta) of 0.809. The t-value for NGain_Eks is 7.555, and the Sig. The value is 0.000, which also shows very high statistical significance. A Beta of 0.809 indicates that changes in NGain_Eks significantly affect changes in the dependent variable (e.g., learning outcomes), contributing to 80.9% of the variability explained in the model.

Overall, these results indicate that NGain_Eks significantly improves student learning outcomes, and the very low Sig. values for both coefficients suggest that the resulting regression model is valid and provides a strong explanation of the phenomenon being tested. The contribution of NGain_Eks is quite significant, indicating that using media or methods applied in the experimental group significantly positively impacts student learning outcomes. Because the Sig. The value for NGain_Eks is 0.000, which is less than 0.05, then H0 is rejected, and H1 is accepted. This means that the use of miniature solar system media significantly improves students' science learning outcomes in elementary schools. Thus, miniature solar system media effectively improve students' science learning outcomes, as reflected in the values obtained in the experimental group compared to the control group.

Discussion

The results of this study indicate that the use of miniature solar system media significantly improves elementary school students' understanding of concepts and science learning outcomes. This is indicated by the high N-Gain score in the experimental group compared to the control group, and the t-test results confirm a significant difference between the two. In addition, the regression analysis also strengthens this finding by showing that the N-Gain score has a decisive contribution ($\beta = 0.809$, $p < 0.001$) to students' post-test results. This high regression coefficient indicates that the increase in students' understanding is greatly influenced by using more concrete and visual learning media. The interpretation of these results can be linked to the theory of constructivism, which states that learning will be more effective when students construct their understanding through direct experience. The miniature solar system media allows students to observe and interact directly with models that illustrate abstract astronomical concepts, such as the distance between planets, celestial bodies' movement, and the planets' order in the solar system. (Prima, Putri, & Rustaman, 2018). This experience provides a real context for students, making it easier for them to understand and remember the information. These results are in line with the findings of previous studies, such as those conducted by (Winarni & Purwandari, 2019), which showed that using visual media in science learning can improve students' understanding because visual media allows students to see and observe the objects being taught directly. However, although these results show a significant increase in students' learning, it should be noted that although NGain_Eks had a substantial impact on the experimental group, this influence did not necessarily occur evenly in all students. Several factors, such as teacher skills in integrating media into teaching or differences in individual student characteristics, can influence how miniature media can improve student learning outcomes.

This study significantly contributes to science learning theory, especially in terms of applying visual-based learning media that can enrich students' learning experiences. In line with the constructivism theory proposed by (Myer et al., 2024), this study shows that direct experience-based learning can help students understand complex concepts. The miniature solar system media allows students to construct their knowledge through direct observation, which provides a deeper and more comprehensive understanding of the material being taught. These findings have important implications in educational practice, especially for developing science teaching methods in elementary schools. (Inayah & Zubaidah, 2020). The results show that miniature media are effective in improving students' understanding, and this media can be used more widely in elementary school science classes. Teachers can utilize miniature solar system models to help students understand the relationships between planets, the movement of celestial bodies, and other natural phenomena that they cannot observe directly. (Arslan, Eroglu, & Tatli, 2022). Implementing this media can also increase student engagement in learning because students listen to explanations and interact with media that provide a clearer picture of the studied concepts. (Firdaus, Zubaidah, & Munzil, 2024)

This study also suggests the importance of training teachers to use miniature media optimally in science learning. Teachers skilled in using the miniature press will be able to increase learning effectiveness so that student learning outcomes can be maximized. On the other hand, schools in areas with limited resources need to ensure adequate access to quality learning media, including miniature presses that can be used to support students' understanding of science materials.

Although this study provides significant results, several limitations need to be considered. First, this study's sample was limited to 50 students, divided into two groups (experimental and control). Although this sample is sufficient to provide an overview of the effects of using miniature media, a larger sample size would provide more representative results and increase the generalizability of the study findings. Research with a larger sample size could cover more variations in student characteristics, thus providing more comprehensive results regarding the effectiveness of miniature media in a broader context. The second limitation is the relatively short duration of the study. This study was only conducted over a few weeks, which may not be enough to measure the long-term impact of miniature media on student learning outcomes. The positive effects seen in the short term may be different if measured over a longer period. Therefore, further research with a longer duration is needed to evaluate the extent to which miniature media can maintain their effectiveness in improving student learning outcomes over a longer period. In addition, although the miniature solar system media provided significant results in the experimental group, it is undeniable that the success of using this media depends on the teacher's skills in integrating the media into learning. Teachers who are less skilled or less familiar with this medium may be unable to maximize the potential of miniature media, which can affect student learning outcomes. Therefore, training for teachers in using new learning media is essential so that the objectives of this study can be achieved more effectively.

This study paves the way for further research on using visual-based learning media in science education. Some suggestions for future research include expanding the research sample to include more schools in various regions, both with adequate and limited access to resources. It is essential to find out whether the effectiveness of the miniature solar system media can be applied more widely in different contexts. Second, further research should involve long-term testing to evaluate the impact of using miniature media in science learning on student learning outcomes over a longer period. Long-term measurements will provide a more accurate picture of how sustainable the improvements achieved by students are after using this media. Third, future research can also explore using various other types of learning media, such as interactive digital technology and simulations, which can support science learning in elementary schools. Modern technology can provide students with a more interesting and immersive experience, improving their understanding of more complex science concepts.

The findings of this study also have social and ethical implications that need to be considered, especially in the context of the use of digital technology in education. On the one hand, miniature solar system media can be a very effective tool to improve students' understanding. However, access to this media is still limited in some areas, especially in schools with inadequate facilities. This raises questions about the gap in access to education, where students who live in areas with limited resources may not get the same opportunity to utilize sophisticated educational technology, such as miniature media. In addition, there are ethical aspects related to the use of technology in education. The use of technology-based learning media requires attention to teacher training to integrate this technology effectively into learning. Without adequate training, there is a risk that this technology will not be used optimally, which can ultimately reduce teaching effectiveness. From a social perspective, technology in education has the potential to change the way we view the learning process, where visual and interactive learning media can increase student engagement and motivation. However, there needs to be a policy that ensures equal access to this technology so as not to exacerbate society's educational gap.

CONCLUSION

Based on the research results, using miniature solar system media significantly improves elementary school students' understanding and learning outcomes in science. The results of the regression test show that NGain_Eks (changes in student learning outcomes) have a considerable influence with a significant coefficient value ($p < 0.05$), which indicates that miniature media is effective in facilitating students' understanding of complex concepts in the solar system. Thus, miniature solar system media have proven to be a very effective tool in science learning, especially in helping students understand abstract astronomical phenomena through concrete visualization. These findings support the constructivist theory that emphasizes the importance of direct experience in learning. Miniature media allows students to interact directly with models that depict the objects and phenomena they are studying, enhancing their understanding. Therefore, using miniature solar system media can be a valuable learning method for teaching science at the elementary school level. This study shows that the miniature solar system media is effective in science learning. Therefore, further research needs to develop other types of learning media that can more deeply support the teaching of scientific concepts. Interactive digital technology, animation, or computer-based simulations can be interesting alternatives that further facilitate students' understanding of more complex concepts. In this case, technology can be increasingly introduced as an integral part of learning in elementary schools.

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