Proceeding of Integrative Science Education Seminar **Vol. 3, 2023, pp. 107-113**

Available online at

PISCES

Proceeding of Integrative Science Education Seminar

Journal homepage : https://prosiding.iainponorogo.ac.id/index.php/pisces

Article

Development of MI SOSYS: Eco-Friendly Miniature Solar System as a Bridge for Students to Learn Solar System Materials

Akrim Ulfa Diana[1*], Cahya Lutfiati[2], Chelsea Aisyah Amelia[3], Aziza Karenina[4]

[1,2,3,4]Tadris IPA A, Faculty of Tarbiyah and Teacher Training, IAIN Ponorogo

*akrimulfad@gmail.com

Article Info

3rd AVES
Annual Virtual Conference of Education and Science 2023

Keywords

Props
Science Learning
Solar System

ABSTRACT

Miniature *solar system* props are used to make it easier for teachers to convey material about the Solar System made from materials that are easily found in everyday life by utilizing used goods (*eco-friendly)* and affordable prices. Learners are directly involved in the use of props such as being able to sort the planets in the Milky Way Galaxy, explain the Rotation-Revolution of the Earth and the Moon, and can even explain the occurrence of Solar and Lunar Eclipses. This research uses the modified *Research and Development* (R & D) method from Borg and Gall, namely 1. Research, 2. Information gathering, 3. Planning, 4. Initial product development, 5. Validation. The results of the validation were analyzed descriptively qualitatively, resulting in the material expert test and learning effectiveness showing a percentage of 100%, the curriculum expert test showing a percentage of 90%, and the product design expert test showing a percentage of 80%. From the research conducted, it was found that the highest validation results were material aspects and learning effectiveness, while the lowest validation results were product design aspects. Based on the results of this validation, it is feasible to proceed to the next stage, namely the initial product revision.

INTRODUCTION

The learning of Natural Sciences (IPA) has been regulated in the Regulation of the Minister of Education and Culture, which integrates the content of biology, physics, and chemistry. Natural Science or science is a subject that studies objects on earth and objects in the sky. According to Trianto's opinion in (Mardiyah, 2016) explains that science is a big theory that discusses natural phenomena through observation and experimentation methods, and raises scientific attitudes in the form of high curiosity, openness, and honesty. Meanwhile, Susanto's opinion in (Sevti Annisa, 2021) that science is a form of human effort through observation and reasoning to understand the surrounding nature which aims to

produce a conclusion. All subjects certainly have goals or directions to be achieved. To achieve this goal, we must know the extent of the success of students' learning. According to Kunandar's opinion (in Siti Maimunah, 2021) Teachers are the biggest factor in influencing student learning outcomes, with superior teacher resources, learning objectives are easier to achieve, in accordance with the ideals of the Indonesian nation, namely educating the nation's life. Teachers must also create a conducive atmosphere in teaching and learning activities. One of the roles of the teacher in the process of teaching and learning activities is to create a pleasant learning environment by providing innovations or creative ideas, so that the focus of students' attention becomes more focused on participating in the teaching and learning process Wahyuni (in Siti Maimunah, 2021).

A pleasant learning atmosphere makes students enthusiastic in participating in learning. Moreover, junior high school students with a high level of curiosity about something. Subject teachers, besides having to be good at communicating, must also be required to be creative in developing learning models using various learning media. To support these learning objectives can be by utilizing learning aids. Schramm (in Satria, 2018) states that teaching aids are a technique for delivering learning through a tool or media by prioritizing the effectiveness and efficiency of learning. Teaching aids can certainly support the communication process in learning. Blake & Haralsen (in Rohani, 1997) that teaching tools are a tool as a means of communication in the teaching and learning process which can be in the form of hardware or software, to achieve teaching processes and results effectively and efficiently, as a way to achieve teaching goals. Mediation in teaching materials must be adapted to the material and conditions of continuous learning.

In junior high school science subjects, the Earth and Solar System is studied at the end of semester 2 of class VII which includes four subchapters. There are four sections in the discussion of Earth and Solar System material which includes the sky and planets, Earth's movement, eclipses of the Moon and Sun, and the positive impact of the Sun on Earth. Learners are expected to develop their understanding of the relative position of the Earth, the Earth and the Sun in the Solar System through learning outcomes. Learners who have difficulty in understanding the concepts of scientific concepts taught. Many learners complain that they feel overwhelmed by the information provided in the lesson. Learners still face difficulties in understanding all material about the Earth and Solar System. Sari, et al (2019) conducted a study which concluded that students faced obstacles when observing celestial objects. In addition, students also face difficulties in understanding phenomena related to the Solar System such as the apparent annual movement of the Sun. In addition, students still have difficulty in distinguishing between eclipses of the Earth and eclipses of the Sun and understanding the difference between the rotation and revolution of the Earth. To overcome this, steps need to be taken to improve knowledge of natural science (IPA) about the Earth and Solar System. If using learning aids such as the Solar System or the like, students become less interested especially if they can only observe without being able to move.

The use of learning aids that can be moved and observed can use 3D learning media. According to Saadiyah (2022), 3D learning media in the Solar System has the advantage of being able to make students interact directly with objects that are difficult to present in class such as celestial bodies. In the learning process teaching aids have a very important role to help the effective learning process. Given the importance of teaching aids to improve school quality, teachers are required to master the skills of selecting, developing, and using teaching aids according to the concept or material to be discussed (Sepriyanty, 2018). To increase student understanding related to Solar System material, a learning aid in the form of a miniature solar system was developed by utilizing used items in the surrounding environment. How is the development of MI SOSYS Development: Miniature Solar System Based on Eco-Friendly as a Bridge to Student Learning on Solar System Material?

METHODS

The research was conducted using the Research and *Development* (R&D) method of the modified Borg and Gall research and development procedure, namely 1. Research, is one of the stages of the Borg and Gall research and development procedure carried out by observing how students learn material about the Solar System, 2. Information gathering, carried out by seeking information about the extent to which students' understanding of Solar System material using learning methods that have been applied by educators, 3. Planning, is the stage where planning how students can maximally receive Solar System material, 4. Initial product development, is a stage of activity after planning activities so that students can receive Solar System material. The initial product development stage is carried out by making products that can help students learn Solar System material optimally. The initial product made in helping students learn Solar System material is a miniature *Solar* System props. 5. Validation, 6. Initial product revision, 7. Product trial (small group), 8. Product revision, 9. Usage trial, 10. Dissemination (mass production). However, this research only reached the 5th stage, namely validation. Test the validity and effectiveness of teaching aids through the results of data analysis from material validation trial experts, effectiveness of use, curriculum suitability and learning design. The results of expert validity in the form of a questionnaire in the form of a percentage with additional constructive suggestions. In analyzing the feasibility of miniature solar system props based on the validation of material experts, experts on the effectiveness of the use of props, curriculum experts and design experts used a formula as follows:

$$\text{Percentage result} = \frac{\text{Expert validation score}}{\sum \text{Score}} \text{ X } 100\%$$

The results of the expert validation percentage produce a conclusion in accordance with the validity criteria according to Sugiyono (2014) in Table 1. whether MI SOSYS teaching aids can be used for science learning effectively and efficiently.

Table 1. Validity Criteria

Criteria	Validity level
$80\% < x \leq 100\%$	Very high validity
$60\% \leq x \leq 80\%$	High validity
$40\% \leq x < 60\%$	Medium validity
$20\% \leq x < 40\%$	Low validity
$0\% \leq x < 20\%$	Very low validity/invalid

After obtaining the results of the analysis through validity tests from material experts, effectiveness of use, curriculum suitability and learning design, data processing is carried out using a qualitative descriptive analysis method so as to produce a conclusion.

RESULTS AND DISCUSSION

The results of the research based on the validity test of MI SOSYS teaching aids on each expert, namely material experts, learning effectiveness experts, curriculum experts, and product design experts show the results as in Table 2 below.

Table 2. Validity Test Results

Aspects	Results
Material	100%
Learning Effectiveness	100%
Curriculum Suitability	90%
Product Design	80%

The results of the material expert test show a percentage of 100% including in the very high validity category (very good to use), just like the material expert, the learning effectiveness expert shows a percentage of 100% including a very high validity category, the curriculum expert shows a percentage of 90% including in the high validity category, while the product design expert shows a percentage of 80% including in the high validity category (good to use).

The validity test experts also provided suggestions for the MI SOSYS teaching aids made. According to Mrs. Anif Fathuri, teacher of SMP Negeri 2 Paron Ngawi as a validator related to the aspect of learning effectiveness, if the miniature solar system props are used for demonstration, the size can be enlarged and can be attached to the blackboard, so that it can be seen from the students' bench. Furthermore, according to Mrs. Tri Lukitaningsih, a teacher at SMP Negeri 2 Paron Ngawi as a validator, the product design for the shape of the planet is made more attractive by making various colors and patterns that resemble the characteristics of the planet. Based on Table 2, the highest validity test results are in the material aspect and learning effectiveness, while the lowest is in the product design aspect.

Material is knowledge, attitudes, knowledge that must be learned by students to achieve predetermined competency standards. The material must be delivered and presented as interestingly as possible, in order to motivate and increase the learning spirit of students. So the provision of teaching aids is very important, but the selection of teaching aids must be in accordance with the material to be taught. The material includes very high validity because the use of teaching aids in the field of science studies is based on the need to explain many abstract learning topics. For example, such as human digestion material, the heart system, electricity, the solar system, and so on. Therefore, the use of teaching aids in the material is considered very suitable to help learners understand the material more easily. This can help students in an effort to improve their learning achievement in the field of science studies (Widyatmoko & Pamelasari, 2012). Making teaching aids must certainly meet the criteria, such as the suitability of learning materials. Teaching aids that are not in accordance with the criteria can cause failure in the learning process, because not all topics or learning materials in science can be made props, and when demonstrated it makes it difficult for students to understand the material (Mariyatul Dkk, 2020). It can be seen that the MI SOSYS props are in accordance with the solar system material. MI SOSYS props can explain the process of rotation of the earth and the moon, the revolution of the planets and the moon, and the process of lunar and solar eclipses. Material with a very high percentage of validity has a good impact on students, namely in one teacher demonstration, students are able to know the order of the planets starting from the closest to the sun, are able to know the planetary revolution and know the formation of solar eclipses and lunar eclipses. By using MI SOSYS teaching aids, students will more easily understand and remember material about the solar system.

Learning effectiveness is a quality standard of education and as a measure of the achievement of learning objectives (Afifatu, 2015). Learning effectiveness includes very high validity because of the importance of using teaching aids so that the learning success obtained by students depends on their treatment in learning, either teacher treatment or student activities while learning (Blumenfeld, 2011). Effective teaching aids will increase enthusiasm

and motivation in learning students (Yamomaha, 2020), the use of MI SOSYS teaching aids will increase student understanding in understanding the solar system, besides that the use of teaching aids also helps increase student activeness in class (Swan, K, 2003). Learning effectiveness with a very high percentage of validity has a good impact on students with the use of MI SOSYS teaching aids in the solar system learning process will get better results than not using teaching aids. The use of MI SOSYS teaching aids in solar system learning is considered very effective in helping teachers explain the material in a very short time, not wordy and easily understood by students. In addition to having a positive impact on students' understanding of solar system material with the effectiveness of learning can strengthen the good relationship between educators and students (Carnell E & Lodge C, 2002).

Curriculum suitability is harmony in the selection of teaching aids. The teaching aids applied are in accordance with the curriculum at school. In addition to being in accordance with the material, the teaching aids used in the learning process must follow the applied curriculum. Curriculum suitability includes very high validity because the criteria for good science learning in accordance with the Education Unit Level Curriculum are not only sourced from books, but learning must be balanced with practical tools and connected to the surrounding environment. Students will be encouraged to develop scientific skills and attitudes in learning that are useful for living in the community. Through teaching aids as learning media, naming science concepts, principles and materials will produce effective learning. Science learning, which was initially perceived as difficult by students, will be easier to understand when using interesting teaching aids (Widyatmoko & Pamelasari, 2012). Teaching aids that are in accordance with learning objectives can improve the quality of student learning, the use of teaching aids stimulates students' enthusiasm in participating in learning, so that students who are initially passive become active. The suitability of the curriculum with a very high percentage of validity has a very good impact on students to encourage critical thinking, improve students' skills, and cause more attention from students so as to create effective learning.

Product design is the design, appearance, shape, color of a product. Product design includes high validity because the advantages of this MI SOSYS teaching aid use simple materials that are easily obtained in the surrounding environment. The utilization of used goods teaches students to protect and conserve the environment. Making MI SOSYS props is very easy and does not require expensive costs. In addition to low-cost production, teaching aids are easy to present in the classroom, can be used as individual and group observation activities, do not need an internet network and require little preparation time (Salamah et al., 2023). MI SOSYS props are designed according to the layout of the planets in space, so that students are easier to observe space objects. In addition, the color selection of the planets in MI SOSYS is in accordance with the original, so that students seem to see the original object. Product design with a high percentage of validity has an impact on students, when the teacher enters the classroom carrying a teaching aid, students will certainly be enthusiastic and ask questions, what the tool is, how it is used, why the teacher brings it, and so on. Props that have an attractive design, good appearance accompanied by a variety of diverse colors make students more enthusiastic in participating in learning.

CONCLUSIONS

The results of the research on the development of Miniature Solar System learning aids showed very high validity test results in the material aspect and learning effectiveness with a percentage of 100%, while the curriculum suitability aspect with a percentage of 90% and the product design aspect with a percentage of 80% included in the high validity test. Based on the research, the MI SOSYS teaching aids can already be called feasible to be demonstrated

as science learning aids on the material of the solar system class VII SMP / MTs. The advantages of Miniature Solar System teaching aids compared to other science teaching aids are that, once the teacher demonstrates, students can learn the sequence of planets starting from the closest to the sun to the farthest, being able to know the characteristics of each planet in the solar system, planetary revolutions and knowing the formation of solar eclipses and lunar eclipses, so that the learning implementation process can run effectively and efficiently without wasting time. In addition, the raw materials for making Miniature Solar System props also utilize eco-friendly used goods in the surrounding environment, such as making planets from used sterofoam, and cardboard as a system, this is an effort to instill the character of environmental love to students. In addition to the advantages, the MI-SOSYS props also have several disadvantages such as the shape of the planet is less attractive, the product is too small to be demonstrated. As an improvement, the MI-SOSYS props will be formed larger and add more patterns or colors to the planets so that when viewed it is not boring, it would be even better if the planets arranged can rotate around the sun according to their respective orbits.

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