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Effectiveness of Dry Lab Based Augmented Reality to Overcome the Misconceptions of Students on Solar System and Eclipse Learning Topics

Hamdi Akhsan[1]*, Muhamad Yusup[1], Melly Ariska[1], Tsabita Husna[1], Dwita Kartika Sari[1]

[1]Department of Physics Education, Sriwijaya University, Ogan Ilir, Indonesia.

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Corresponding Author:
Hamdi Akhsan
hamdiakhsan@fkip.unsri.ac.id

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Abstract: In science learning there are many important concepts that must be understood. The solar system is a complex and abstract material because it cannot be seen directly by human senses resulting in students experiencing misconceptions. Interactive learning media is needed to help students understand concepts. One of the learning media that can be applied is augmented reality based on dry lab simulation. This study aims to determine the effectiveness of using Dry Lab simulation to overcome misconceptions of earth and solar system material in junior high school. This research uses experimental research methods with Pre-experimental research models. The overall research results, the average effectiveness was 45.16%, which showed less effective results. Partially for the two sub-concepts of planets and solar and lunar eclipses, the average effectiveness is 65.5%, which shows that the dry lab simulation is effective in changing students' misconceptions.

Keywords: Augmented Reality; Dry Lab; Misconception; Science; Solar System

Introduction

Science is a knowledge that studies nature in everyday life (Juliani et al., 2021). Science as a process of inquiry includes ways of thinking, attitudes and systematic activity steps to obtain science products, such as observation, measurement, formulating, testing hypotheses, collecting data, experimenting and prediction (Purbosari, 2016). Most learners perceive science as a difficult subject and many experience significant problems in transforming science-related concepts into a concrete understanding of the subject (Baran et al., 2018).

Concepts are the basis for higher science to formulate principles (Harjono et al., 2015) and not just memorised but must understand (Susilawati et al., 2022). Therefore, concepts are very important in thinking (Serttaş & Türkoğlu, 2020). The concept of learning is the most basic and earliest thing taught by teachers. The concept of learning is one of the determinants of the final result of the learning process. The level of success of students in mastering learning depends on the extent to which students master the learning concept. One of the success factors of learning is the use of learning aids or media that are in accordance with the content of the learning material. According to (Febriyana et al., 2021) the percentage of students' concept understanding at MTs Al-Falah class VII is low. The results of research using the two tier diagnostic test are 50% of students with low concept understanding.

Based on the previous research above, it means that during the learning process, students are not always optimal in absorbing information, especially in science subjects which contain many scientific concepts (Adiansyah Syahrul et al., 2015) and contains abstract concepts (Hasnawati et al., 2022). One of the reasons students are not optimal in absorbing information in learning is because of misconceptions (Hunaidah et al., 2022). Misconceptions are conceptual understandings of knowledge constructs that do not match or differ from

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the concepts given by scientists (Ariska et al., 2022) (Alhinduan et al., 2016). Students will have difficulty learning if learning does not pay attention to misconceptions which will affect student achievement (Juita et al., 2023). Misconceptions can occur to anyone at any level of education. If the concepts embedded in students at an early level such as elementary or junior high school are wrong (misconceptions). Then the misconceptions that occur will continue to the next level of education. (Korur, 2015).

One of the science materials that often occur misconceptions is Solar System material such as the concept of tides, the concept of earth rotation, the concept of earth revolution, the concept of the sun as a star, and other concepts. (Rachmawati & Susanto, 2017). The solar system is a complex learning (Ariff et al., 2021) and abstract (Furkan Bayar, 2019) because students have not been able to experience the real conditions of the objects in the solar system. (Saputro & Setyawan, 2020) (Ervana et al., 2022) due to the limitations of human senses. Therefore, learning requires media that can help students understand concepts or knowledge comprehensively (Taufiq et al., 2021). This is in line with the statement (Rahmat et al., 2019) that a system is needed to simplify the learning process that can be used as an interactive learning media about the solar system. In the learning process media has a very important role (Fikri et al., 2015). As well as things that can be done to overcome students' misunderstandings on solar system material, namely by using real-time virtual simulations (Yu et al., 2010). As well as changing the way students learn from conventional learning to experiments using interactive multimedia (Oksaviona et al., 2023).

Interactive multimedia is one of the appropriate models in the utilisation of information and communication technology (ICT) through computers, which is the starting point for the investigative practice approach to science learning (Marsida, 2020). Learning media with the utilisation of technology can increase student motivation (Putra et al., 2022) (Neswary & Prahani, 2022) , help teachers who have difficulty conveying abstract solar system material (Fitriani et al., 2018) (Tresnawati et al., 2019) and make teaching effective and efficient (Susilawati et al., 2023). Utilising interactive multimedia can help students understand concepts (Apriani et al., 2020). One of the interactive multimedia that is growing rapidly today is Augmented Reality (Taufiq et al., 2021). Augmented reality is a multimedia technology that can combine two-dimensional and three-dimensional virtual objects into the real world and then projected in real-time (Putra et al., 2022) . The type of interactive multimedia that is the focus of this research is Dry Lab-based Augmented Reality learning media.

Dry Lab cannot replace experiments with a real laboratory (wetlab) in terms of training psychomotor skills in using science tools. However, Dry Lab has many advantages to support the implementation of the experiment (Rijani, 2018). The display and experimental results on the Dry Lab can be simulated according to the real situation. According to (Aidar et al., 2023) the use of Dry Lab is very useful and is considered good for increasing students' interest in learning science at MIN 16 Aceh Barat. The study also said that the experimental method by utilising Dry Lab can increase students' interest and completeness of learning outcomes in learning acid-base solutions. Another study (Nurhafidhah & Hasby, 2018) said the use of Dry Lab-based interactive learning media can reduce the quantity of misconceptions of students of SMAN 2 Banda Aceh on acid-base titration material, namely 34.3% before learning, to 10.3% after learning using Dry Lab-based interactive learning media.

Based on the literature study above, the use of dry lab simulation can increase students' interest in learning, increase the completeness of students' learning outcomes and can reduce the quantity of students' misconceptions in chemistry learning. But in physics learning earth and solar system material no one has examined. Therefore, researchers are interested in knowing the effectiveness of using Dry Lab simulations to overcome the misconceptions of earth and solar system material in junior high school.

Method

This type of research includes quantitative research. This research uses experimental research methods with Pre-experimental research models. Pre-experimental is experimental research conducted on one group called the experimental group without a comparison group or control group (Ahyar et al., 2020). The form of Pre-Experimental research design that will be used is one group pre test-post test design, which is experimental research carried out on only one group that is randomly selected. The research design of this one group pre test-post test design is measured using a pre test, then given treatment and after that a post test is carried out after being given treatment for each lesson.

This research was conducted at Srijaya Negara Junior High School Palembang from October to November 2023. The population of this study were all seventh grade students of Srijaya Negara Junior High School Palembang. In this study, the data to be collected is quantitative data. Quantitative data obtained from this study are students' test scores. Test scores are obtained through the test method using a test question instrument, this instrument is in the form of pre-test and post-test questions. The research instrument used is a four tier diagnostic test instrument that has been developed and validated by experts. (Febria et al., 2021). For data processing in this study, there are two data that will be processed, namely misconception data and effectiveness data.

Tabel 1. One Group Pre test-Post test Scheme

Pre Test	Treatment	Post Test
T_1	X	T_2

Data analysis techniques on misconception data include data reduction and data presentation. The data reduction process will identify misconceptions in each student's answer on the disgnostic test. The result is the identification of misconceptions that occur in students. Data presentation is done by categorisation. The preparation of misconception categories for each learner based on the results of the diagnostic test based on the table of the diagnostic test (Gurel et al., 2015) the analysis was conducted to determine learners who understood the concept, partially understood, did not understand the concept, and misconceptions. The analysis conducted to determine learners who understood, partially understood, did not understand, and misconceptions used the following percentage technique: (Entino et al., 2021)

$$P = \frac{f}{N} \times 100\ \% \quad (1)$$

In determining the level of effectiveness will be reviewed from the comparison of the normalised gain value (N-Gain) obtained from its use. The N-Gain test takes into account the difference between the score increase and the potential increase that can be achieved by someone who initially has a low score. The general formula for calculating the N-Gain test according to Hake 1999 in (Susanto, 2012) is as follows (Formula 2):

$$\text{N} - \text{Gain Test} = \frac{(\text{Post test score} - \text{Pre test scora})}{(\text{maximum post test score} - \text{Pre test score})} \quad (2)$$

From the calculation of N-Gain, it can provide an overview of the extent of changes in understanding or knowledge of students after treatment is carried out. The higher the N-Gain value, the greater the improvement. If the n-gain score is <0.30 then the pre-test and post-test improvement is in the low category. If the n-gain score is 0.30 ≤ g < 0.70 then the increase in pretest and posttest is in the medium category. If the n-gain score is ≥ 0.70 then the pretest and posttest improvement is in the high category.

The category of effectiveness interpretation is based on the N-Gain value. If the percentage of the N-Gain value is <40% then it is included in the ineffective category. If the percentage of N-Gain value is 40% - 55%, it is included in the less effective category. If the percentage of N-Gain value is 56% - 75%, it is included in the moderately effective category. If the percentage of N-Gain value > 76% is included in the effective category.

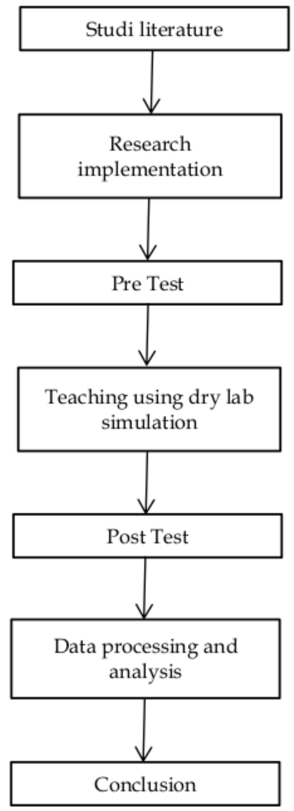

Figure 1. Research flow

Result and Discussion

Analysis of Student Misconceptions

The pretest percentage of all students who had misconceptions was 64.3%, students who did not understand the concept was 10%, students who understood partially by 9.7% and students who understood the concept by 40.9%. Then the percentage on the posttest of all students who experienced misconceptions was 37%, students who did not understand the concept by 13.3%, students who understood partially by 6.7%, and students who understood the concept by 40.9%. Based on the percentage of students' concept understanding above, it is then expressed in the form of the following graph.

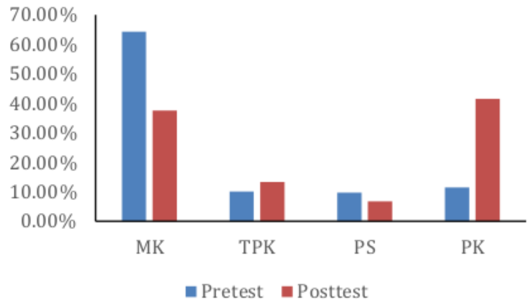

Figure 2. Graph of the percentage of student understandin

After analysing the percentage of student understanding, the next step is to analyse the percentage of misconceptions for each question indicator.

Based on the table above, it can be seen that there is a decrease in student misconceptions in each question indicator, such as in the first achievement indicator, namely Bintang in question numbers 13 and 14, there were 69.4% of students who had misconceptions during the pretest and decreased to 30.5% during the posttest. In the material of the sun, earth, and moon there were 62.5% of students who experienced misconceptions during the pretest and decreased to 40.3% during the post test. In planetary material, there were 77.8% of students who had misconceptions during the pretest and 25% of students who had misconceptions during the posttest. In the material on the revolution and rotation of the earth and the moon, there were 61.6% of students who had misconceptions on the pretest and 39.8% of students who had misconceptions on the posttest. In the solar and lunar eclipse material, there were 69.4% of students who had misconceptions on the pretest and 27.78% of students who had misconceptions on the posttest. From the results of the misconception analysis, there is a decrease in misconceptions in each question indicator.

Normalised Gain Analysis

The calculation of the average normalised gain is obtained from the students' pretest and posttest scores. The following is an analysis of the average percentage of student understanding.

Tabel 2. Misconception Analysis

Achievement indicators	Question	Number of misconceptions		N	Pre Test (%)	Post Test (%)
		Pre	Post			
Star	13, 14	50	22	72	69.4	30.5
Sun, earth and moon	1, 2, 8, 12	90	58	144	62.5	40.3
Planet	3	28	9	36	77.8	25
Revolution and rotation of the earth and moon	4, 5, 6, 9, 10, 11	133	86	216	61.6	39.8
Solar and lunar eclipses	7	25	10	36	69.4	27.78

Tabel 3. Normalised n-gain calculation results

Achievement indicators	Question	Pre	Post	Post-Pre	Max Pre	N-GAIN SKOR (%)
Star	13, 14	50	22	28	62	45.1
Sun, earth and moon	1, 2, 8, 12	90	58	28	117	23.9
Planet	3	28	9	21	33	63.6
Revolution and rotation of the earth and moon	4, 5, 6, 9, 10, 11	133	86	56	199	27.6
Solar and lunar eclipses	7	25	10	19	29	65.5

This N-Gain percentage analysis was conducted to determine the category of effectiveness of the use of dry lab simulations in overcoming misconceptions of earth and solar system material in seventh grade students of Srijaya Negara Junior High School. Table 2 shows that the use of dry lab simulations on planetary questions with an n-gain score of 63.6% and solar and lunar eclipses with an n-gain score of 65.5% is included in the "effective enough" category to be used. This means that teachers are advised to use dry lab simulations in lessons, especially planetary material, solar eclipses and lunar eclipses.

However, the Bintang question with an n-Gain score of 45.1% is included in the "less effective" category and the sun, earth, and moon question with an n-gain score of 23.9% and Revolution, earth and moon rotation with an n-gain score of 27.6% is included in the "ineffective" category. In accordance with the statement from (Testa et al., 2015) which states that the material of the moon phase and eclipse is difficult material due to the low average score of students.This is because students do not understand the material using simulation. The use of direct laboratory can be a solution to overcome misconceptions in the material of stars, sun, earth, and moon, as well as revolution, rotation of the earth and moon. This is as said by (Maksum & Saragih, 2020) virtual labs cannot be fully applied to replace reality labs, this is because the level of experience and skills of practitioners with virtual labs is not as good as with reality labs.

Some factors that make dry lab simulation less effective in class VII are factors of teachers, students, and facilities and infrastructure. From the teacher factor, the teacher still uses the lecture method so that students are not familiar with the application of learning using dry lab simulations. In terms of students, students have different interests, activeness, and motivation and enthusiasm. There are students who easily understand the material and there are also students who find it difficult to understand the material. Then in terms of learning facilities and infrastructure, the media used to carry out dry lab simulations are still not well maintained, students can open other pages during simulation learning which makes the learning atmosphere less effective. The use of a real laboratory or laboratory directly can be a solution to overcome misconceptions in questions that are still included in the ineffective category.

Conclusion

This type of research includes quantitative research. This research uses experimental research methods with Pre-experimental research models. This study aims to determine the effectiveness of using Dry Lab simulation to overcome the conception of earth and solar system material in junior high school. Based on the research that has been done, overall, the average effectiveness of using dry lab simulation is 45.16%, which shows less effective results. However, in the sub-concept of the moon, solar eclipse and lunar eclipse, the average effectiveness is 65.5%, which shows that the dry lab simulation is effective in changing students' misconceptions. Suggestions for future researchers are to develop dry lab simulations in the sub-concept of reducing misconceptions that are still low.

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Conflicts of Interest

The authors declare no conflict of interest.

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