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Influence of ISLE-based STEM Physics Learning on Students' Understanding of Physics Concepts

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Abstract. This research aims to provide an overview and determine the influence of ISLE (Investigative Science Learning Environment) based STEM (Science Technology Engineering and Mathematics) physics learning on students' understanding of physics concepts. This research is a quantitative descriptive study using the one group pretest-posttest method. The population in this study were students of class XI Science at MAN Ende for the 2024/2025 academic year and the sample was students of class. Sampling in this research used purposive sampling technique. The data collection method consists of administering tests and LKPD. The data obtained from the research sample was in the form of test scores on students' understanding of physics concepts on global warming materials. Normality test and t-test are the data analysis techniques used. From the results of data analysis, it is known that ISLE based STEM physics learning has an effect on students' ability to understand physics concepts according to the One-Sample Test carried out with sig. (One-Sided p) is 0.001 < 0.05. Students' ability to understand physics concepts increased after implementing ISLE-based STEM physics learning with an average pretest score of 57.119 and an average posttest of 89.381 with the difference between the posttest and pretest scores being 32.252 points. While working on the LKPD students are more active in working with their team in solving problems and students are trained to understand the procedures for working on them. Apart from that, by implementing this learning, it can encourage students to hone their own thinking patterns so that they are able to explain the students' own understanding of physics concepts based on what they have observed and understood.

Keywords: ISLE based STEM, concept understanding

1. Introduction

The quality of a nation's education is one of the determinants of that nation's progress because education has the function of being the key to opening the way in building and improving the nation or country. Indonesia is also one of the developing countries that really cares about the implementation and development of its education [1]. Indonesia always strives to improve the quality of education by making curriculum changes [2]. It can be seen that in Indonesia there have been frequent changes to the curriculum, previously using the 2013 curriculum, now replaced with the Merdeka Belajar curriculum [3]. The independent learning curriculum also seeks to answer the challenges of today's era, namely the 21st century which is referred to as the century of knowledge, the century of information technology, globalization, industrial revolution 4.0, and so on which are developing and advancing very quickly in various aspects of life such as in the field of education [4]. In developing 21st century learning, teachers must change conventional learning that is teacher-centered to student-centered [5]. However, in reality there are still many teachers who use conventional teacher-centered learning models, so this makes the education system in Indonesia still relatively inflexible to current developments and has become a problem in the world of education [6]. Therefore, teachers in Indonesia must be smart in choosing learning models that suit students' current needs while also adapting to the context of the lesson material

that will be provided [7]. The STEM approach is an approach that trains to understand the four aspects of it. The four aspects are science, technology, engineering and mathematics. However, the application of this approach is still not optimally developed in the learning process [8].

Natural Sciences (Science), especially physics, is one of the subjects that requires students to understand concepts, physical laws, physical principles, along with principles which sometimes make it difficult for students to understand [9]. Difficult physics discussion material, varied formulas and so many physics problems that have to be solved on sheets of paper make students feel bored and can affect students' learning motivation, as well as delivering material through lectures or conventionally and solving questions alone is not enough to make students feel interested in studying physics [10].

The above statement is in accordance with the results of the researcher's interview with one of the teachers at one of the high schools in Ende Regency, namely MAN Ende, that there are still several teachers who continue to carry out conventional learning. Physics learning carried out conventionally makes mastery of concepts less meaningful because construction or understanding of physics concepts is not formed properly and correctly, which can trigger the emergence of misconceptions in students [10].

One of the physics materials that triggers understanding of the concept is Global Warming. Where in this material students are required to understand issues regarding natural phenomena that are very close to life on Earth. This is in line with research conducted by Bayu Krisna which stated that 22 out of 29 students (75.86%) experienced misconceptions about global warming [11]. To understand physics concepts in this material, a special learning approach is needed, one of which is ISLE-based STEM physics learning.

STEM (science, technology, engineering, and mathematics) is an approach used to integrate science, technology, engineering and mathematics in the learning process [12]. Meanwhile ISLE (Investigative science learning environment) is a learning model where learning activities using this model involve student development through the students' own ideas which are obtained through stages so as to encourage students to think and be able to explain their understanding of what has been observed. and understood [13].

Research conducted by H Hasrati concluded that the use of ISLE based STEM learning media can increase students' understanding in learning the concept of temperature and heat by obtaining data that is 85% students were happy with the learning approach and 78% of students stated that experiments were effective for learning concepts[14] .

Most studies may only look at the short-term effects of ISLE-STEM-based learning on students' understanding of physics concepts. The gap may lie in the lack of studies evaluating the long-term impact on conceptual understanding or transfer of knowledge to other contexts.

As one of the complex subjects, physics is often challenging for many students, especially in terms of understanding basic concepts. Based on various previous studies, the use of traditional learning models is often less effective in helping students understand physics concepts in depth and in an applicative manner [15–17]. STEM (Science, Technology, Engineering, and Mathematics)-based learning models have been shown to encourage student engagement and improve their understanding in science learning. However, the application of learning models that integrate the STEM-based Investigative Science Learning Environment (ISLE) approach is still rarely found in physics learning, especially at the secondary school level [18]

This research gap indicates that there is a need to explore the effectiveness of the application of the STEM-based ISLE learning model in the context of physics learning. Therefore, the purpose of this study is to test and analyze the impact of the STEM-based ISLE learning model in improving students' understanding of physics concepts. The results of this study are expected to provide significant contributions to the development of more interactive and applicative physics teaching methods, as well as provide practical solutions for teachers in improving the quality of physics learning.

2. Method

This type of research is quantitative descriptive research, namely a type of research that describes research results with numbers [19]. In this research, the author used a pre-experimental design method type one group posttest (single group final test). The research location was carried out at MAN Ende in

the 2024/2025 academic year with the research sample consisting of 26 class XI IPA 2 students with the sampling technique using purposive sampling technique.

In this research, there are three stages that need to be carried out, namely preparation, implementation and final stage. The preparation stage includes initial observations at the school to identify and formulate problems. Next, prepare the research instruments. Next, the second stage, namely the implementation stage, begins with giving a pretest, then students are divided into four groups with many members in one group, namely 2 groups consisting of 6 students and 2 other groups consisting of 7 students who are chosen randomly. The group that was formed then took part in ISLE based STEM based physics learning. The research stages can be seen in the Figure 1.

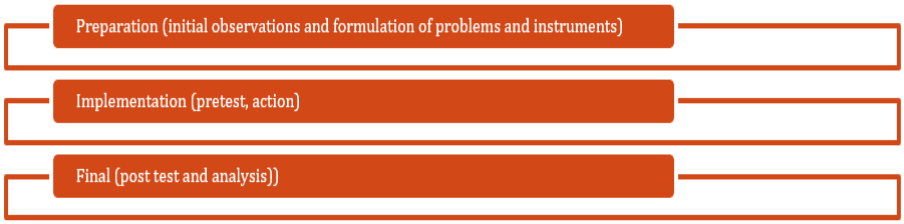

Figure 1. Research stages.

Each group was given a worksheet, white cardboard, pencils, erasers, sharpeners and colored markers. Each group was also given the freedom to design a global warming concept according to what they observed and understood from the reading on the LKPD. There were 20 questions in the conceptual understanding test, but after being validated by experts and analyzed, it turned out that only 15 questions met the valid and reliable criteria. These 15 questions represent 7 indicators of conceptual understanding, namely interpreting, exemplifying, classifying, summarizing, drawing inferences, comparing and explaining. At the final stage, a posttest was given to determine the increase in students' ability to understand physics concepts after being given treatment. The data collection technique consists of pretest posttest questions in the form of multiple choices and descriptions (conceptual understanding ability test) and student worksheets (LKPD) on global warming material. Normality test and t test were used as data analysis techniques. Apart from that, to strengthen the hypothesis, a comparison was made between the t results and the t table. In this research there are two hypotheses used, namely Ho and Ha. Ho's hypothesis is that there is no influence of ISLE Based STEM physics learning on students' understanding of physics concepts. Meanwhile, Ha is that there is an influence of ISLE Based STEM physics learning on students' understanding of physics concepts.

With the decision making criteria:

a. If the significance is <0.05 then Ho is rejected and Ha is accepted.
b. If the significance is > 0.05 then Ho is accepted and Ha is rejected.

Apart from that, hypothesis testing can also be strengthened by comparing the calculated t and t table values with the following test criteria.

a. If the calculated t value < t table then H0 is accepted and H1 is rejected.
b. If the calculated t value > t table then H0 is rejected and H1 is accepted.

3. Result and Discussion

After implementing ISLE-based STEM-based physics learning which aims to provide an overview and determine the effect of ISLE-based STEM-based physics learning on students' ability to understand physics concepts, researchers hope that the results obtained are in accordance with the predetermined objectives.

Before being treated with the implementation of ISLE-based STEM physics learning, students did a pretest. The test questions consist of 5 multiple choice numbers and 5 description numbers that meet each indicator of conceptual understanding, including interpreting, exemplifying, classifying, summarizing, drawing inferences, comparing and explaining. These questions have been validated by expert validators.

Table 1. Pretest and posttest data from research results.

	Pretest	Posttest
Mean	57.119	89.381
Minimum	40.0	78.5
Maximum	71.0	98.5

The data in Table 2 shows that the pretest and posttest results are different. The mean, minimum and maximum scores on the posttest are higher when compared to the pretest. These results define that there was an increase in students' ability to understand physics concepts after being given the treatment. These differences in results were then tested further using SPSS 25.0 software.

The normality test is used as a prerequisite test before carrying out the t test or hypothesis test, the normality test uses the Shapiro-Wilk test because the number of samples used is 21 samples, the results obtained are as follows.

Table 2. Normality test results (Shapiro-Wilk test).

	Sig.	Information
Pretest	.635	Normally distributed
Posttest	.436	Normally distributed

It can be seen in Table 3 that the sig. pretest and sig value. posttest is greater than 0.005 so that the data sample is normally distributed. Next, the data was subjected to a t test to determine the hypothesis to be taken using the One-Sample Test in the SPSS program with a significance level of 5%. The results of the t test are as follows.

Table 3. One-Sample Test results

	Sig.(One-Sided p)
Posttest	<.001

In the One-Samples Test table, it is known that the Sig (One-Sided p) value is $0.001 < 0.05$, so Ho is rejected, so there is a significant difference between before and after being given the ISLE based STEM learning model. So it can be concluded that there is an influence of the ISLE based STEM learning model on students' understanding of physics concepts in class XI IPA 2 MAN Ende.

In the One-Samples Test table above, it is also known that the calculated t value is 11.425 which will be compared with the t table. To find the t table, you can use the TINV (probability; deg_freedom) formula in Excel, with a probability value of 5% and the deg_freedom (df) value is equal to the number of samples (n) minus the number of independent and dependent variables (k), namely as follows [18]. In this research, the t table value obtained was 2.093024. It can be seen that the calculated t value is greater than the t table, which is $11.425 > 2.093024$, so Ho is rejected, so there is a significant difference between before and after being given the learning model.

The results of this study are supported by other studies that reveal that learning with the ISLE based STEM model can improve conceptual understanding and reasoning in physics learning, as well as train students to be independent and active. So that it can maximize students' understanding of physics concepts. One of them is a study conducted by Heryanti There was an increase in understanding of the concept of Energy in PLTMH media through the STEM approach with a Gain value in cycle 1 of 0.54 in the medium category to 0.72 in cycle 2 with a high category. The average value of creative thinking skills in cycle I and cycle 2 which was state by the average creative assessment of the process increased with an acquisition in cycle 1 of 62.4 which was categorized as sufficient and in cycle 2 of 78 which was categorized as good. The average creative assessment of the product in cycle 1 of 63.2 was categorized as sufficient and increased in cycle 2 with an average assessment of 80.3 in the good category [20].

4. Conclusion

Based on the analysis and discussion of the research results, it was concluded that students' ability to understand physics concepts increased as a result of implementing ISLE-based STEM physics learning. Before learning was carried out based on ISLE based STEM, the test results taken by students on average had not reached the KKM, so ISLE based STEM based physics learning was implemented. After implementing learning based on ISLE based STEM, the results obtained by students increased beyond the KKM score. Apart from that, while working on the LKPD students become more active, can think more broadly and are able to explain their understanding of what they observe and understand so that the physics learning they do is more meaningful.

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