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The Effect of E-LKPD Assisted PJBL-STEM Learning Model on Scientific Reasoning Ability and Argumentation Performance of Class XII Science Students in Renewable Energy Materials

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ABSTRACT

This research aims to analyze and prove the influence of scientific reasoning ability and argumentation performance of students who follow the PjBL-STEM learning model assisted by e-LKPD with conventional models in learning Physics class XII IPA SMAN 15 Bandar Lampung. The research design was quasi-experimental (quasi-experimental), and the pretest posttest design was used. The population in this study were all students of class XII IPA. The research sample was determined by random sampling technique. The sample in this study was XII IPA 1 as the control class and class XII IPA 3 as the experimental class. Data was collected using test questions, questionnaire sheets and observation sheets. Hypothesis testing using t test and Manova test. The results showed that there was an effect of scientific reasoning ability and student argumentation performance between students who took the PjBL-STEM learning model assisted by e-LKPD and students who followed the conventional learning model based on the results of the Manova test with an F value from Wilks' Lambda. = 43.208 and the significance value = 0.000. Based on these results, it can be concluded that there is an influence of scientific reasoning ability and argumentation performance of students who follow the PjBL-STEM learning model assisted by e-LKPD with conventional learning models in learning Physics class XII IPA SMA Negeri 15 Bandar Lampung.

Introduction

The quality of education in Indonesia is increasing along with the improvement or reform of education that follows the changes and developments in life that are currently happening in the 21st century. One of them is the change in the education curriculum in Indonesia from the original KTSP to the 2013 Curriculum. The 2013 curriculum focuses on increasing student activity. through a scientific process, so that learning does not only create students mastering knowledge competencies, but is also able to create students both in attitude and ability (Anjani et al., 2020).

The development of the educational curriculum is also an influence of the industrial revolution, where education is required to keep up with rapidly developing technological developments and utilize information and communication technology as more and more sophisticated facilities to expedite the learning process. In addition, the expected expectation from this curriculum change is to shift from teacher-centered to student-centered (Putriani & Hudaidah, 2021). Learning in the 21st century certainly requires appropriate learning, it requires teachers who are able to design effective learning strategies, because at this time educators are required not only to transfer knowledge, but more than that, namely to condition

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students to have appropriate learning experiences. with need (Kartini et al., 2022).

The learning model is a tutorial learning plan that is arranged systematically and forms a pattern that is used as a guide in planning learning in class, so that learning activities in class are truly purposeful activities that are systematically arranged. Project based learning is a project-based learning model that relates a problem to everyday life. The project in question is a design that can be in the form of knowledge, technology, etc. In the 2013 curriculum, one of the learning models that is highly recommended to achieve a level of student activity and creativity as well as achieve several abilities is the project-based learning model. (Festiawan, 2020). The basis for using learning models usually depends on the learning objectives, the character of the lesson, the media that are relevant to the objectives (Marliani, 2015).

STEM is an approach that can be used in the PjBL learning model. PjBL-STEM has the potential to provide meaningful learning that can train students to solve problems through a project that is integrated with four scientific fields such as science, technology, engineering and mathematics. Science is the ability of knowledge to understand natural phenomena in real life, Technology is the ability to recognize, develop, analyze new technologies that affect people's lives. Engineering is the ability to develop technology through an engineering design process in the form of projects in learning. Mathematics is the ability to analyze, formulate, solve problems, and interpret solutions to mathematical problems in applying a variety of different situations (Lestari et al., 2018).

There are four aspects of STEM theory in research (Dwita & Susanah, 2020):

1) Science

Science is the process of finding out about something involving observations related to natural phenomena to explain objectively from the phenomena that occur in nature. Characteristic features aspects of science in the STEM approach include: (1) observing a problem related to natural phenomena, (2)asking questions, (3) gathering information, (4)reasoning, and (5) delivering or communicating results observation.

2) Technology

Technology is a device or tool that is used by humans to facilitate problem solving in daily life. The characteristics of the technological aspects of STEM approaches include: (1) using technology such as internet, geogebra, autocad applications, etc learning. This technology can be used by teachers and students, (2) facilitate and assist students in solve the problem. For example students can use the app to visualize objects compared to using manual equipment.

3) Engineering

Engineering is the knowledge to design a procedure for solving a problem. Characteristic features engineering aspects of the STEM approach include: (1) involving students in designing/designing a procedure. These activities can develop ideas and hone students' skills in making a design concept that according to the problem, (2) engineering uses concepts of science, mathematics, and tools of deep technology designing.designing a procedure.

4) Mathematics

Mathematics is a science that studies patterns and relationships which are used as a language for knowledge, technology, and engineering in solving problems. The characteristics of the mathematical aspects of the STEM approach include: (1) mathematics is used as a language for knowledge, technology, and engineering, in this case mathematics is used for calculations and managing data related to problem solving, (2) applying topics/subtopics certain mathematics to solve problems. These activities can train students in analyzing and determining mathematical topics/subtopics which are interrelated with problems (Dwita & Susanah, 2020).

The STEM approach is believed to be in line with the 2013 curriculum which can be implemented through the use of a project-based learning model (PjBL). Project-based learning is a learning model that involves students in an activity (project) that produces a product. Student involvement starts from planning, designing, implementing, and reporting the results of activities in the form of products and implementation reports. This learning model emphasizes long-term learning processes, is directly involved in various issues and problems of everyday life, learns how to understand and solve real problems, is interdisciplinary, and involves students as actors starting from designing, implementing and reporting the results of activities (student centered) (Triastuti, 2020).

Based on the results of a preliminary study in the form of interviews with physics subject teachers at SMAN 15 Bandar Lampung it is known that in carrying out the learning process activities using lecture methods, demonstrations, and conventional learning models. The PjBL learning model has not been implemented which results in students' reasoning and argumentation abilities being low. Therefore this study aims to

determine whether or not there is an influence from the implementation of the PjBL-STEM learning model assisted by e-LKPD on scientific reasoning abilities, argumentation performance, as well as on scientific reasoning abilities and argumentation performance of class XII IPA students on renewable energy material.

The use of the PjBL-STEM learning model in this study aims to facilitate students to explore free ways of learning, by reading from various sources such as books, research journals, and the internet. In addition, the use of the PjBL-STEM learning model is considered to be able to give freedom to students to think creatively in creating simple visual aids to support physics learning in class. Renewable energy materials were used in this study because they were considered very suitable when combined with the PjBL-STEM learning model. Renewable energy is an energy source that can be renewed and used repeatedly, one of which is wind energy. The application of the PjBL-STEM learning model is considered to be able to motivate students to think creatively in creating a tool to conserve or utilize renewable energy sources, one example is a windmill which will later be connected to a generator that can generate electricity for human needs.

One of the teaching materials that is most needed by teachers and students in online learning in particular is the E-LKPD. The advantage of E-LKPD is that it can simplify and narrow space and time so that learning becomes effective, besides that E-LKPD can be an interesting tool when students' interest in learning decreases (Suryaningsih & Nurlita, 2021).

On renewable energy material STEM integrated project-based learning is applied where students are required to be able to create real products in the form of wind turbines and water turbines accompanied by analysis including design, sketches, assembly, until finally a product is produced. This study uses STEM-integrated project-based electronic student worksheet teaching materials, the aim is to facilitate students to more easily understand the material and learning is not monotonous.

Scientific reasoning ability (scientific reasoning) is a process in which logical principles are applied to scientific processes, namely finding problems, formulating hypotheses, making predictions, solutions and problems, creating experiments, controlling variables and analyzing data. Scientific reasoning abilities are needed by students so that the knowledge they have acquired can be applied in solving various problems they encounter. Scientific reasoning abilities in science and technology also play an important role in instilling a scientific attitude in students. Aspects of scientific reasoning include conservative reasoning, proportional reasoning, variable control, probability reasoning, correlation reasoning and hypothetical-deductive reasoning. The aspect of scientific reasoning ability is very closely related to science subjects at school, especially physics (Anjani et al., 2020).

Argumentation is an inseparable part of Science. In science learning practice, argumentation is the main thing that underlies students in learning how to think, act and communicate. Argumentation has an important role in physics learning activities because it provides opportunities for students to engage in group discussions and give each other opinions that show the extent to which students understand concepts and reasoning abilities. Toulmin's argument pattern or also (Toulmin's Argument Pattern) or PAT contains six important elements, namely data, claims, warrants, backing, qualifiers and rebuttals (Irvan et al., 2020). Reasoning is trained so that students have a complete understanding of both the concept and the thinking process itself to solve problems in their lives. Humans are able to develop their knowledge quickly because humans reason. Reasoning is a thinking process in drawing conclusions in the form of knowledge (Ekanara et al., 2018).

"Statement" is a descriptive statement that answers is research. “Evidence” refers to measurements, observations, or other research results that have been collected, analyzed, and interpreted. The argument component is ultimately obtained from a statement explaining a phenomenon accompanied by relevant evidence and based on the concept or assumption that underlies it. A good scientific argument must meet the criteria, empirical, theoretical, and analytical (Tama et al., 2016).

Methods

This research method is a quasi-experimental or quasi-experimental with a pretest posttest design as shown in Table 1.

Table 1
Pretest-posttest Design

Groups	Pretest	Treaments (X)	Posttest
Experiment Class	O_1	PjBL-STEM Learning Model	O_2
Control Class	O_1	Conventional Learning Methods	O_2

(Utami et al., 2017)

The research was conducted at SMAN 15 Bandar Lampung even semester of class XII IPA on renewable energy material. The population in this study were all students of class XII IPA, while the sample used was only two sample groups, namely the experimental class and the control class. The sampling technique used is random sampling where there are no specific criteria to become a benchmark, meaning that all students are given the opportunity to be a sample. This study used class XII IPA 1 as the control class and XII IPA 3 as the experimental class. The independent variable in this study is the e-LKPD assisted PjBL-STEM learning model. The dependent variable in this research is scientific reasoning ability and students' argumentation performance.

The data collection instrument included 5 essay test questions in which there were indicators of scientific reasoning abilities, questionnaires and student argumentation performance observation sheets. The test instrument used was a content validity test which in this study was carried out by asking for expert judgment by educational practitioners, namely lecturers, as well as reliability tests. The purpose of instrument testing is to find out whether the instrument to be used is valid and reliable. Data analysis techniques include normality test, homogeneity test, t test and Manova test. The observation sheet analysis technique uses the percentage formula.

Result and Discussions

Learning is carried out to find out whether or not there is an influence from the implementation of project-based learning (PjBL) integrated STEM assisted by e-LKPD. The test was carried out by comparing two sample classes, namely the experimental class and the control class. Both classes were tested for homogeneity, it was known that the sig. 0.282 and 0.057 (> 0.05) so that it can be said that the two classes have the same variance (homogeneous).

Both of classes were tested for normality to find out the distribution of research data. The normality test results show that the data is normally distributed with Asymp values. Sig > 0.05. In scientific reasoning ability, the test results obtained were 0.170 in the experimental class and 0.145 in the control class. Meanwhile, in the argumentation performance, the test results obtained were 0.084 in the experimental class and 0.112 in the control class.

Scientific reasoning abilities (scientific reasoning) and argumentation performance are obtained from students' pretest and posttest scores in the form of test questions and questionnaires. In argumentation performance the data will be supported by the percentage value of the observation sheet to strengthen the results obtained from the questionnaire sheet. The data obtained were in the form of pretest and posttest scores of students' scientific reasoning abilities and argumentation performance as well as the score of the observation sheet. Implementation of learning begins with face-to-face learning, then students are given a pretest and posttest in the form of test questions and questionnaires. Project assignments are done in groups outside of class hours on E-LKPD sheets using the WhatsApp group application. The process of working on project assignments will be monitored directly by the teacher. The E-LKPD in the experimental class contains STEM-integrated PjBL syntax, while the control class uses the learning system as used by the teacher as usual.

The purpose of giving project assignments includes making an experimental design as a condition before obtaining approval from the teacher to conduct an experiment in the next meeting. In the experimental class, the experimental design tasks included designing tools and materials, experimental work steps, sketching the project to be made, as well as analysis in the form of formulating the problem of the tool being made, determining the variables of the tool being made, then analyzing the experimental results and concluding the experimental results. This learning model focuses on the construction of student knowledge, where students are expected to be able to find important information in real terms and construct their own knowledge.

Based on the results of the instrument test, 5 essay questions were obtained, 10 questionnaire items and observation sheets were used to observe students while learning took place, the results obtained from the observation sheets were used as supporting data for student argumentation performance.

Based on the statistical test results, it was found that the average posttest score of the scientific reasoning ability of the experimental class students was higher than that of the control class. The average N-gain value for the experimental class was 0.5370 in the medium category and the average N-gain for the control class was 0.3762 in the low category. This indicates that learning using the PjBL-STEM learning model assisted by e-LKPD is more effective in increasing scientific reasoning abilities, while in argumentation performance it is found that the average N-gain is 0.5955 in the medium category and in the control class it is 0.3639 with low category. Figure 1 is a graph of the difference in pretest and

posttest scores between the experimental class and the control class.

Figure 1
Pretest and Posttest Average Score Data in the Control and Experimental Classes

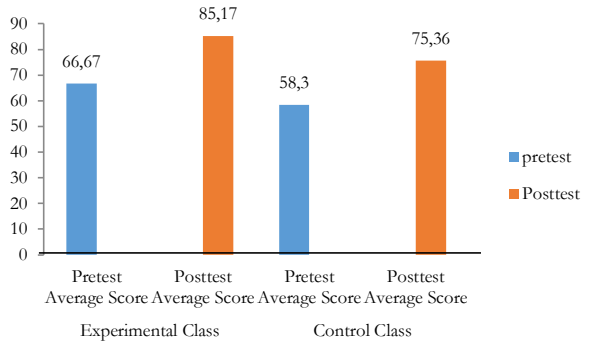
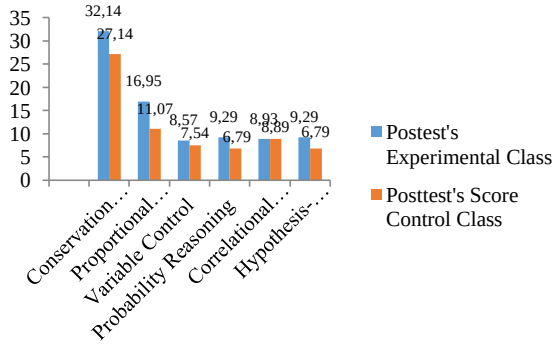


Figure 2 shows the differences in posttest scores or scores after being treated for each aspect of scientific reasoning in the experimental class and the control class. The normality test was carried out with the aim of knowing whether the data from the two samples that were given were normally distributed or not by using the SPSS 26 application via the Kolmogorov-Smirnov method. The results were found to be greater than 0.05 so that it can be said that the two data are normally distributed. The homogeneity test using the Levene test found that the probability value in the significance column was more than 0.05 so that it could be said that the data of the two samples were homogeneous.

Figure 2
Posttest mean of experimental class and control class in every aspect of scientific reasoning



From the analysis of the observation sheet data, the results are obtained according to Figure 3. Based on Figure 3, it can be seen that the data obtained for each aspect observed, both in the experimental class and in the control class, can be seen in the experimental class having a larger percentage of data than in the control class, but in the Rebuttal aspect the data obtained in the control class is higher. High compared to other aspects. Figure 4 is the percentage of student argumentation performance in the experimental class and control class.

Figure 3
Percentage of Performance Argument Data on every aspect

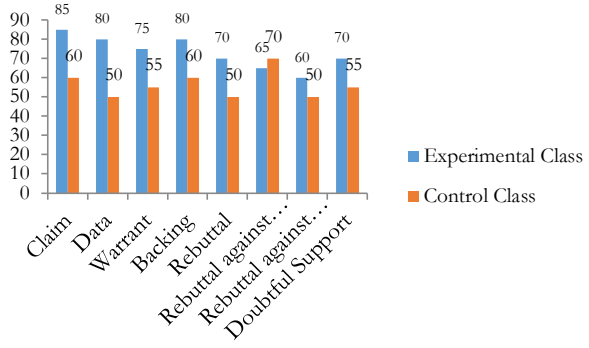
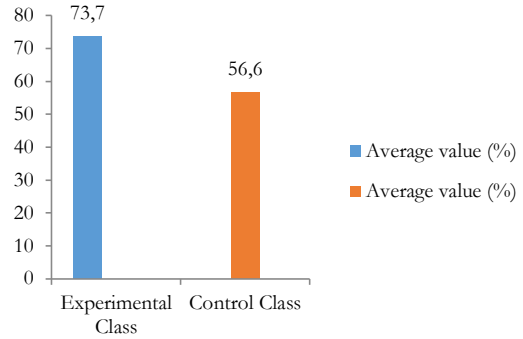


Figure 4
The average value of the percentage of argumentation performance in the experimental class and the control class



Based on the results obtained from data analysis using the t test, there is an influence from the application of the PjBL-STEM learning model assisted by e-LKPD on scientific reasoning abilities shown with a significance value of 0.000 <0.05. There is also the influence of the e-LKPD assisted PjBL-STEM learning model on student argumentation performance. The results obtained are 0.000 <0.05, assisted by supporting data obtained from observation sheets of 65.1%. Through the Manova test, the results show that there is an influence from the application of the PjBL-STEM learning model assisted by e-LKPD on scientific reasoning abilities and argumentation performance, this is indicated by the result of 0.000 <0.05.

The PjBL-STEM learning model is assisted E-LKPD has an effect on scientific reasoning abilities and argumentation performance, because this learning model can be applied in overcoming problems that arise during the learning process, because it provides

opportunities for students to explore material using various meaningful ways for themselves and conduct experiments (Daniel, 2017). The focus of PjBL learning lies on the core concepts and principles of a scientific discipline, involves students in problem-solving investigations and task activities, provides opportunities for students to work individually or in groups to construct their own knowledge, and reaches the peak of producing real product, then presented in front of other friends (Insyasiska et al., n.d.).

Conclusions

There is an influence from the application of the PjBL-STEM learning model assisted by e-LKPD on scientific reasoning abilities. This is indicated by a significance value of 0.000 <0.05. There is an influence from the application of the PjBL-STEM learning model assisted by e-LKPD on student argumentation performance. This is indicated by a significance value of 0.000 <0.05 and is supported by the percentage value of the observation sheet of 61.5%. There is an influence from the application of the PjBL-STEM learning model assisted by e-LKPD on scientific reasoning abilities and student argumentation performance. This is indicated by a significance value of 0.000 <0.05. Scientific reasoning ability and argumentation performance of students in the experimental class is higher than the control class.

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