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THE EFFECT OF STEM INTEGRATED PROBLEM-BASED LEARNING MODEL (PBL) ON STUDENTS' LEARNING OUTCOMES ON HUMAN RESPIRATORY AND EXCRETION SYSTEM

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Abstract

Learning at UPT SMPN 1 Sutera seems to be still low, this is because the learning model used by teachers is still not appropriate and the discussion process has not been carried out well. One way to overcome this problem is to apply the STEM integrated Problem-Based Learning (PBL) model. This research aims to determine the effect of the STEM integrated Problem-Based Learning (PBL) model on student learning outcomes in human respiratory and excretory system material at UPT SMPN 1 Sutera. The type of research used in the research is Quasi Experiment, namely a research method to find the effect of certain treatments on others under controlled conditions. The design used in this research is the Non-Equivalent Control Group Design. The population in this study were class VIII students at UPT SMPN 1 Sutera. The sample in this study consisted of two classes, namely the experimental class and the control class which were taken using a purposive sampling technique. The instruments used consisted of an observation sheet on the implementation of the STEM integrated PBL model, pre-test and post-test questions. The research data obtained was then analyzed through descriptive statistical tests and inferential statistics using SPSS version 25. Based on the results of the analysis in hypothesis testing, it showed that there was a significant average difference between the control and experimental classes. The results of research hypothesis testing were found to be 0.000 and smaller than 0.05. Thus, it can be seen that the significant difference between Ha is accepted and H0 is rejected, so there is an influence. The conclusion from the hypothesis test is that there is a significant influence between students' scores using the STEM integrated PBL learning model. So H0 is rejected and Ha is accepted. So there is an influence of the STEM integrated PBL model on student learning outcomes.

Keywords: Problem Based Learning, STEM Integration, Science Learning, Respiratory System, Excretion System

Introduction

The era of industrial revolution 4.0 is an era that encourages human change in all aspects, including technology and education. IPTEK is an abbreviation of science and technology, namely a source of information that can increase a person's knowledge or insight in the field of technology (Mulyani & Haliza, 2021). Advances in science and information technology have greatly changed the perspective and lifestyle of Indonesian people (Daud et al., 2021). The presence and role of information technology in the education system has brought about a new era of development in the world of education, but this development is balanced by an increase in human resources which determine the success of the world of education in Indonesia in general (Camelia, 2020). Positive advances in knowledge and technology can be seen in how quickly information spreads around the world and breaks barriers of time and space.

21st Century Skills are an important component that everyone must implement to successfully overcome challenges, problems, life and careers in the 21st century (Vari & Bramastia, 2021). 21st Century Learning is a type of education that is increasingly based on technology. Society and students greatly influence 21st century educational technology (Binkley et al., 2010). So it is hoped that teachers can keep up with developments in information technology so that students understand education effectively. It is also hoped that teachers will design and supervise curriculum that is innovative, effective and sophisticated.

Based on Law Number 20 of 2003 concerning the National Education System, the curriculum is a set of plans and arrangements regarding objectives, content and learning materials as well as methods used as guidelines for implementing learning activities to achieve certain educational goals (Law (UU) Number 20 of 2003 About the National Education System, 2003). The independent curriculum has its own uniqueness compared to the previous curriculum, namely the emphasis on implementing a student-centered method that can train students' independence (Cantika, 2022). The learning objective in the independent curriculum is to take into account the development and achievements of students so that they meet the requirements for qualified teachers in teaching through active learning (M. Maulidia et al., 2023). In addition, the use of an independent curriculum places a lot of emphasis on the use of information and communication technology (Nugraha, 2022). This situation is clear from the framework that has been built to support the implementation of the independent curriculum.

Natural Science or science is the science that studies natural phenomena, both involving living and non-living things, or can also be called the science of life or science (Amaliyah, 2023). According to Sutrisna & Gusnidar (2022) In learning science, it is important to provide first-hand experience so that students can develop skills to scientifically explore and understand the natural environment.. Therefore, in the science learning process, students are required to carry out a research process so that they can easily understand the natural surroundings (Suhelayanti et al., 2023). It can be concluded that science learning emphasizes providing direct learning experiences through developing process skills and scientific attitudes.

The Problem-Based Learning (PBL) model is a learning model that requires students' mental activity to understand a learning concept through situations and problems presented at the beginning of learning with the goal of training students (Tomi et al., 2014). The Problem-Based Learning (PBL) model emphasizes innovative collaborative learning, where students are faced with problems and are given active learning conditions through team or group learning (Torlakson, 2022). Throughout the problem-solving process, students build knowledge and problem-solving skills as well as self-regulating learning behavior (Shofiyah & Wulandari, 2018). This makes students more enthusiastic and makes the learning process more meaningful. To make learning more meaningful, teachers can use interesting

learning approaches. In this model, students are given problems that have been previously designed before being given learning material, so that students can discover learning concepts independently (Sulthon, 2017). (Sulthon, 2017). In addition, students are given pre-designed problems before being given lesson material, so that students can discover learning concepts independently (Istiandaru et al., 2014). The PBL learning model is very suitable to be applied to science subjects, where students are required to think creatively, imaginatively and actively.

One approach that can be implemented by student-centered teachers is STEM. STEM is an abbreviation of Science, Technology, Engineering, and Mathematics, which is the relationship between science and technology and other sciences that cannot be separated in science learning, because science requires mathematics as a tool in processing data, while technology and engineering are applications of science (Afriana et al., 2016). The STEM approach can encourage students to develop, use and utilize technology while developing cognitive and affective skills and applying their knowledge (Lestari et al., 2018). In STEM learning, students are also taught to use technology and other tools to solve problems and complete tasks (Maulidia et al., 2020). In addition, students are encouraged to have creative power and be able to utilize and master technology (Yasifa et al., 2023). So it can be concluded that the integration of the STEM approach can help students analyze and solve problems that occur in the learning process. STEM integration education is an approach that explores learning between two or more STEM subject areas or between STEM subjects and other school subjects (Rizalul Fikri et al., 2019). Based on the understanding above, it can be concluded that STEM-integrated PBL model learning can develop students' creativity through the process of solving problems in everyday life.

One of the science materials in science learning in class VIII is the Human Respiratory and Excretory System. The respiratory and excretory systems are material that has many concepts. This respiratory and excretory system material cannot be visualized directly, for example the division of the nephron structure and the existence of a sequence in the urine formation process that students do not yet understand (Padar et al., 2021). Each concept that students learn does not stand alone, but is interconnected between one concept and various other concepts (Karomah et al., 2019). Students' mistakes in understanding the relationship between these concepts often give rise to misconceptions (K. Faizah, 2016). Learning outcomes are the abilities obtained by students after learning activities (Aisyah et al., 2017). Learning outcomes are the achievement of pre-established learning objectives in the form of cognitive, affective and psychomotor aspects (Indah, 2013). It can be concluded that learning outcomes are students' abilities that can be obtained in the form of values or forms of a person's efforts to obtain changes in behavior as well as relatively permanent increases in abilities and skills.

Research Method

The type of research used in the research is Quasi-Experimental, which is a research method to determine the effect of a particular treatment on other treatments under controlled conditions (Kusnandar et al., 2020). The design used in this research is the nonequivalent control group design. Quasi Experimental Design is a design that has a control panel but is not specifically intended to be used to control external variables that influence the experimental procedure (Sugiyono, 2016).

The samples in this research were classes VIII 1 and VIII 5 of SMPN 1 Sutera for the 2023/2024 academic year. The sample chosen was based on classes taught by the same teacher and based on the consideration that the two classes had almost the same average Daily Assessment (PH). This research sample consisted of an experimental class (28 students) and a control class (29 students). During the research process, the experimental class was given treatment by applying the STEM integrated PBL learning model while the

control class used the PBL learning model. This research begins with a pre-test aimed at seeing students' initial abilities and ends with a post-test to see students' abilities after being given treatment.

Table 1. Research design

Nonequivalent Control Group Desain

Source: (Sugiyono, 2016)

Class	*Pre-test*	Treatment	*Post-test*
Experiment	O_1	X	O_2
Control	O_1	-	O_2

Result and Discussion

1. Implementation of Problem Based Learning Model

The implementation of STEM integrated PBL learning can be seen from the observation sheet used. This observation sheet was filled in by two observers who observed the STEM integrated PBL learning process in the classroom. Observers will observe activities carried out by teachers and students. Data analysis of observation results on learning activities.

Table 2. Observation Results of the Implementation of STEM Integrated PBL Model Learning

Meeting	PBL Model Syntax	Percentage of Implementation	
		Teacher Activities	Student Activities
1 to 8	Problem orientation	100%	100%
	Organizing students	100%	100%
	Guiding student investigations	83%	83%
	Presentation of discussion results	81%	81%
	Direct and evaluate the problem-solving process	88%	88%
Average		90%	90%

Based on the table above, the results show that the average percentage of STEM integrated PBL model learning implementation in the experimental class is 90%. In each syntax there are things that are not implemented 100%, such as in the student investigation guidance stage where the percentage is 83%. The next stage in presenting the results of the discussion is the percentage, namely 81%. Finally, at the direction and evaluation stage of the problem solving process, the percentage was 88%. This can be concluded, the implementation of the STEM integrated PBL model in the experimental class, both in terms of teacher and student activities, has been carried out well.

2. Analysis of Pre-test and Post-test Results on Indicators of Achievement of Learning Goals

The influence of the STEM integrated PBL learning model can be seen from student learning outcomes. Based on the research results, in the experimental class the mean pre-test score was 42 and the mean post-test score was 80. In the control class the mean pre-test score was 40 and the mean post-test score was 70.

The influence of the STEM integrated PBL learning model can be seen from the difference in the mean pre-test and post-test scores for the experimental class and the control class. Where the average pre-test score for the experimental class is 42 while the dick class is 40. Furthermore, the post-test for the experimental class is 80 while the dick class is 70. To see the comparison of the average scores for these two classes, you can see the graph below.

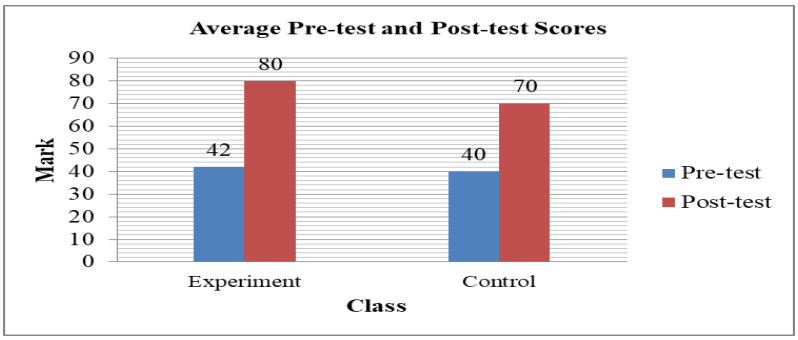

Figure 1. Average Value of Experimental and Control Classes

From the graph above, it can be seen that a greater average value was obtained by the experimental class, namely class VIII.1, which shows that the application of the STEM integrated PBL learning model is more effective or better than learning using the PBL model.

From the analysis of the test results, it was found that 24 questions from the 30 pre-test questions were significant or valid and 24 questions from the 30 post-test questions were significant and valid. Of the 24 pre-test questions and 24 post-test questions, the researcher only took 20 pre test questions and 20 post-test questions and then used them to see whether the hypothesis was accepted or not.

From the results of the number of students who answered the pre-test and post-test questions correctly for IKTP, it shows that there are differences between the experimental class and the control class. The results of the number of students who answered the pre-test and post-test questions correctly for IKTP can be seen in the graph below.

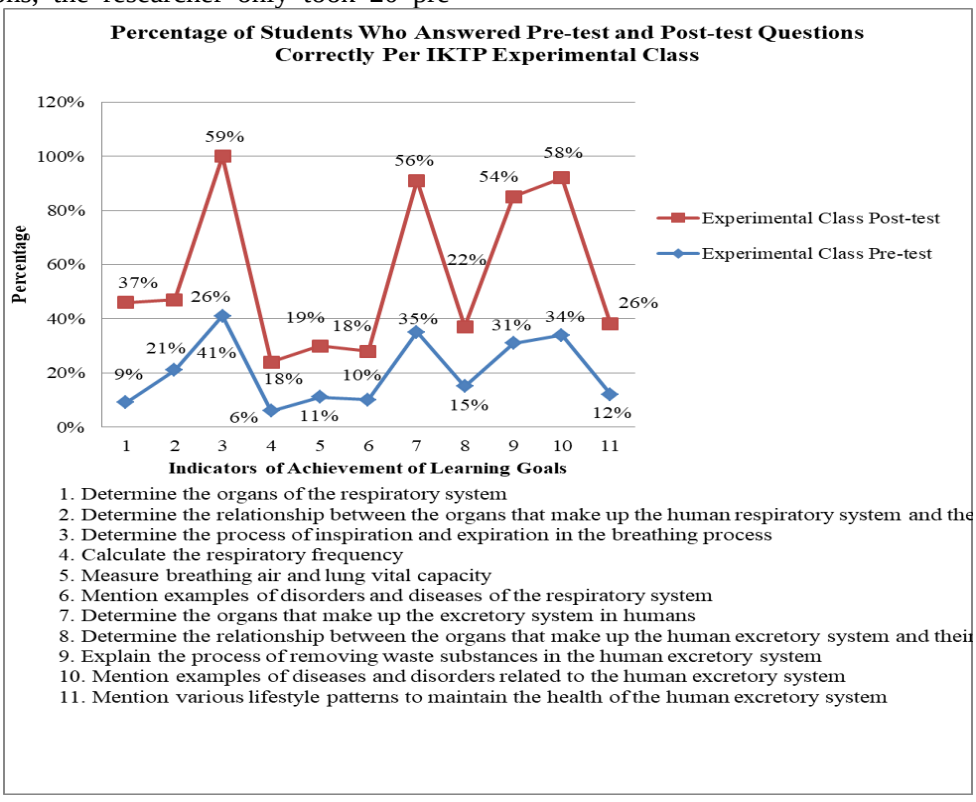

Figure 2. Analysis Per Student IKTP Answer Correct

From the comparison graph above, it can be seen that in the experimental class the number of students who answered the post-test questions correctly was higher than the pre-test questions. So it can be concluded, there is a significant effect before and after being given treatment.

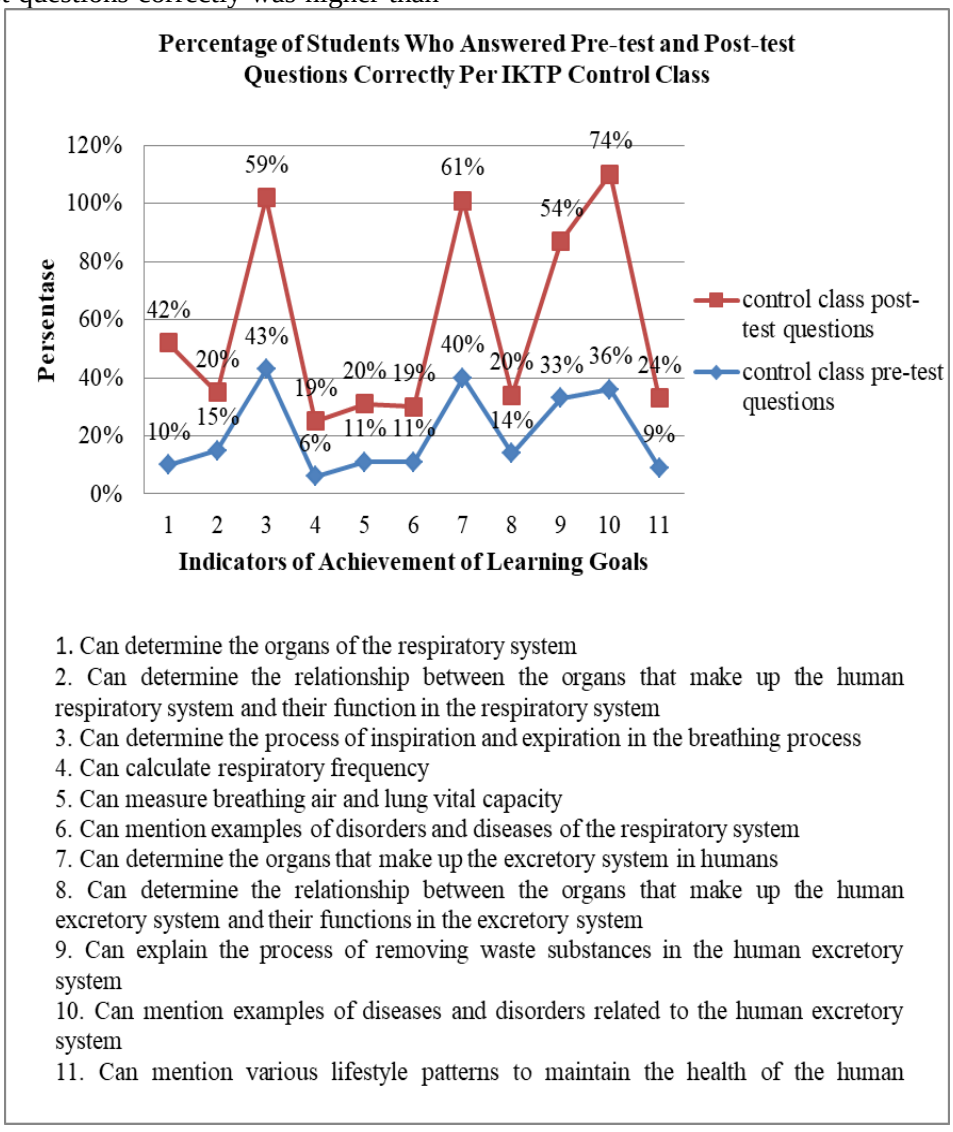

Figure 3. Analysis Per Student IKTP Answer Correct

From the comparison graph above, it can be seen that in the control class the number of students who answered the post-test questions correctly was higher than the pre-test questions. So it can be concluded, there is a significant effect before and after being given treatment. Shows that the application of the STEM integrated PBL model is more effective than learning with the PBL model. The STEM integrated PBL model is more effective than the PBL model because learning with the STEM integrated PBL model means students are required to be active in solving problems and collaborating with currently developing technology.

3. Test Prerequisites

To see whether there was an influence on student learning outcomes, the pre-test and post-test data were analyzed using a normality test and homogeneity test before testing the hypothesis (t-test). Statistical data was tested using SPSS version 25.

Normality was tested using the Liliefors test which was stated if the

significant value was greater than 0.05. The table shows the four data with normal distribution. Homogeneity is tested to determine the similarity of variance between the two data sets. Normal distribution is declared if the significant value is greater than 0.05. The table shows the four homogeneous data.

In the normality test the experimental and control classes gave significant values of 0.094, 0.200, 0.200, and 0.66 respectively which were greater than 0.05. The homogeneity test obtained 0.093 and 0.069 indicating homogeneous data. Because the data is normally distributed and homogeneous, a parametric test was carried out using the t test. The post-test value for the experimental and control classes in the t test was found to be 0.000 and smaller than 0.05. Thus, it can be seen that the significant difference between Ha is accepted and H0 is rejected, so there is an influence. The conclusion from the hypothesis test is that there is a significant influence between students' grades using the STEM integrated PBL learning model.

Table 3. Normality Test Results

Class	Normality test	
	Sig.	Distribution
Experimental Class *Pre-test*	0,094	Normal
Experimental Class *Post-test*	0,200	Normal
Control Class *Pre-test*	0,200	Normal
Control Class *Post-test*	0,66	Normal

Table 4. Homogeneity Test Results

Class	Homogeneity Test	
	Sig.	Distribution
Experimental and Control Class *Pre-test*	0,093	Homogeneous
Post-test Experimental and Control Class	0,069	Homogeneous

Table 5. Hypothesis Test Results

Class	Hypothesis testing	
	Sig.	Distribution
Experimental and control classes	0,000	H0 is rejected and Ha is accepted (there are differences)

STEM-integrated PBL learning can improve student learning outcomes. This is caused by the steps in learning that stimulate students to learn to solve problems, namely participating in conducting investigations in groups, finding solutions and communicating the results of discussions. PBL makes students actively work together in groups to solve a problem Mustofaet al., (2021). Students in STEM learning are faced with real-world problems that students may have experienced in the form of questions that are direct in nature and connect the material with currently developing technology. This is in line with research conducted by (Yusra, 2019), the STEM approach emphasizes providing direct experience that can help students gain a deeper understanding of the natural environment, as well as encouraging students to design , develop and use technology, refine your cognitive skills. skills and apply them. They. knowledge. It can therefore be concluded that the PBL integrated STEM model in learning can improve students' learning abilities.

PBL is a student-centered learning model that trains problem-solving skills and abilities. This explanation is in line with the opinion of Sulthon (2017) that in this model, students are given problems that have been previously designed before being given lesson material, so that students can discover learning concepts independently.

Apart from the PBL model, the integrated learning STEM approach makes learning very interesting for students because the STEM approach integrates four fields of knowledge, namely science, technology, engineering and mathematics. Science learning that is integrated with a STEM approach can relate directly to real problems in everyday life, thus making

learning more interesting. This is in accordance with what was stated by (Torlakson, 2014) stating that the approach from these four aspects is a harmonious match between problems that occur in the real world. It can be concluded that learning with a STEM approach can improve student learning outcomes.

Conclusion

Based on the research results, it can be concluded that the application of the STEM integrated PBL model can improve students' learning outcomes. the experimental class obtained a higher average score than the control class. The results of the research hypothesis test were found to be 0.000 and less than 0.05.Thus, it can be seen that the significant difference between Ha is accepted and H0 is rejected, so there is an influence. The conclusion of the hypothesis test is that there is a significant influence between the scores of students using the STEM integrated PBL learning model. So H0 is rejected and Ha is accepted. So there is an influence of the STEM integrated PBL model on student learning outcomes.

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