

# The Influence of Instructional Models and Innovation Ability on Learning Outcomes of Alternative Energy Courses

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**Abstracts:** This study aims to examine and test the use of appropriate instructional models in teaching and learning activities of alternative energy courses by considering students' innovation abilities to improve students' cognitive learning outcomes. As a study of the effect of instructional models, this study aims to help teachers manage student instructional models. This research is quasi-experimental research with a 2x2 factorial design. This study used two classes, namely the Problem-Based Learning (PBL) instructional model class and the Student Team Achievement Division (STAD) instructional model class, with the characteristics of students who have high and low innovation abilities. This study used a sample of 22 students with 12 PBL groups and 10 STAD groups. The data analysis technique used ANOVA. The results showed that: (1) there is no significant difference between learning outcomes with learning models, (2) there is an interaction between the instructional model and innovation ability, (3) there is no significant difference between PBL and STAD learning outcomes in students with innovation ability.

**Keywords:** Student team achievement division model, Problem-based learning model, Innovation ability, Alternative energy learning outcomes.

## 1. INTRODUCTION

Indonesia is currently ranked 45th out of 140 countries in the Global Competitiveness Index (GCI) (Zahid, 2023). The ranking of the country's innovation index is certainly a reflection of improving the ability to innovate. Rosyadi, a researcher at the Laboratory of Electric Machinery Kitami Institute of Technology Japan, said fossil energy such as coal, oil and natural gas will run out in 2050 (Rosyadi, 2020). The problems and demands of the times, such as the depletion of energy sources while the need for electrical energy consumption is increasing, in the field of energy generation require Innovation and can create something that can positively impact electrical energy sources. The hope in the Alternative Energy course is that students will improve their ability to innovate, analysed and solve problems in Alternative Energy today. In this regard, the active role and awareness of community energy innovation need to be raised. Departing from school learning to students to raise this awareness by using the right school learning model so that students grow in the soul to innovate. The learning process is an effort to make students learn. Changes in behaviour can occur due to interactions between students and their environment. (Sunhaji, 2014).

Previous research said that to improve the ability to innovate, it is necessary to conduct special training for students who can create Innovation (Liu et al., 2020). Learners should think towards the future, learn based on problems, and find the solution to these problems in honing students' innovation skills (Safeng et al., 2013). Professional training sets up tools to improve innovation capabilities according to 21st-century skills (Kwek, 2011). The Problem-Based Learning strategy effectively awakens and explores students' potential to increase innovative behaviour (Dondlinger & Wilson, 2017; Insorio & Librada, 2021; Twiningsih et al., 2019).

Learning is generally an activity carried out by the teacher so that student behaviour changes for the better. Teachers try to make conditions and services for all the diverse needs of students. In the learning process, students learn in the construction of knowledge from experiences or things previously learned. Educators have an important role in the learning process, including educators who are expected to create an effective and efficient learning process that can be fun for students so that students can follow the learning process well.

Based on the observations made, the learning model applied in class has not improved students' innovation ability. Therefore, students' creativity and Innovation must be improved to produce quality students who can create

works and compete with millennial society. The observations showed that the learning process used in general uses conventional learning models, namely traditional learning models with lectures and explanations; students listen more to the presentation of cognitive material. The learning model is not following the demands of the times because it can affect student reasoning in absorbing information, lack of ability to hone student skills and make students more creative and able to innovate.

Instructional model is a plan, or a pattern used as a guide in planning classroom learning (Jarudin et al., 2020; Keiler, 2018). The instructional model refers to the learning approach used, including teaching objectives, stages in learning activities, learning environment, and classroom management (Ahmed & Indurkha, 2020; Chaeruman et al., 2018; Nicol, 2021; Salam et al., 2019; J. Singh et al., 2021). Problem-Based Learning is an instructional model that involves the active role of students to analysed and solve a problem through the steps of the scientific method so that students can understand knowledge and then relate it to the problem to have the ability and skills to solve problems (Dondlinger & Wilson, 2017; R. Singh et al., 2016; Slijepčević & Zuković, 2015; Sönmez, 2017).

The Student Team Achievement Division (STAD) instructional model is a learning model that groups students into teams or study groups with members who vary in ability, mindset, gender, race, and ethnicity (Ardiyani & Gunarhadi, 2018). In placing students in teams, students cannot choose their teams. The teacher presents the lesson, and then students work in teams or groups to ensure all team members have completed the lesson. At the end of the lesson, all students get an individual quiz on the teaching material, and at that time, everyone should not help the other. The award given is the team award.

This research identifies the learning process in Alternative Energy course lectures is not optimal. Student activeness in the learning process is still low in Learning. Students need to be given a stimulus and trained to face, analysed, and solve a problem in teaching and learning activities. Students' attitudes and abilities are less considered in choosing and using the right learning model. The ability to innovate students' needs to be improved. Students' interest and ability to innovate have not fully become the main concern in choosing and applying the right learning model in Alternative Energy courses.

## 2. RESEARCH METHOD

### 2.1. Research Design

The method used in this research is quasi-experimental. Quasi Experiment is an experimental method that does not allow researchers to control all aspects affecting the study results fully. This study consisted of two experimental groups, experimental group 1 was taught with the Problem-Based Learning model and experimental group 2 was taught with the STAD learning model. Quantitative research Multiple Correlation Model aims to test the effect through an experimental approach with a path analysis design with four variables. The selection of this method is adjusted to the data to be known according to the research objectives, namely, to determine the effect of students' innovation ability because of the alternative energy course learning model from the treatment given.

The dependent variable in this study is the ability to innovate. The first independent variable is the learning model, which is divided into two groups: the Problem Base Learning Model and the Student Team Achievement and Division Model. The second independent variable (the attribute variable / moderator variable) is Alternative Energy Discovery. Visually, this research design is depicted in Table 1.

**Table 1.** Treatment Design by Level 2x2.

Innovation Ability (B)	Instructional Model (A)	
	Problem-Based Learning (A1)	Student Team Achievement Division (A2)
High Innovation (B1)	A1B1	A2B1
Low Innovation (B2)	A1B2	A2B2

## 2.2. Sampling Technique

The sampling technique was carried out using a total sampling technique. Twenty-two fifth-semester students took the Alternative Energy course. According to (Sugiyono, 2016), saturated sampling is a sampling technique that takes all population members as respondents or samples.

Furthermore, the data collection technique in this study used a random cluster technique. According to (Azwar, 2012), data collection using the cluster random sampling technique randomizes the group, not the subject, individually. The sampling stages are as follows:

- [1] Choosing a class to determine the drawing of students who take alternative energy courses as many as 22 people.
- [2] The second stage determines students who have high innovation ability and low Innovation by calculating the score obtained from the results of filling out the innovation ability instrument that has been carried out.
- [3] The results of the instruments that have been carried out are sorted by score. To determine the number of students in the high innovation ability group and the low innovation group based on the scores obtained from the largest to the smallest. The highest score has high innovation ability, and the lowest has low innovation ability.
- [4] Determining students into high innovation ability groups and low innovation ability is selected based on the acquisition of rating scale test scores sorted from the highest to the lowest. Students who are not selected as research samples continue to follow the lesson.

## 2.3. Data Collection Technique

Data collection techniques using three instruments: the ability to innovate, learning models and learning outcomes of alternative energy courses. Criteria for assessment with a Liker scale with five scales, namely very often with a value of 5, often with a value of 4, quite often with a value of 3, rarely with a value of 2 and never with a value of 1. The innovation indicators can be seen in Table 2.

**Table 2.** Innovation Indicator.

Indicator	Question Item	Total of Item
Creativity	1,2,3,4,5,6	6
Leadership	7,8,9,10,11,12	6
Energy	13,14,15,16,17,18,19	7
Self-Efficacy	20,21,22,23,24,25,26,27	8
Risk-propensity	28,29,30,31	4
Total		31

## 2.4. Data Analysis Technique

Data analysis was carried out on the data obtained from the research results to obtain the correct conclusion from hypothesis testing. Data analysis used in this study includes descriptive analysis, prerequisite test analysis and inferential analysis. Inferential analysis to test the hypothesis proposed in the study using a two-way Analysis of Variance model by level 2 x 2 (ANOVA) with a significance level of  $\alpha = 0.05$ . The analysis technique refers to the treatment by level design 2 x 2. The next test is to compare the treatment groups between the experimental class and the control class. For research subjects that are not equal in number in each class, the Scheffe test is carried out.

### 3. RESULTS AND DISCUSSION

Based on the research results with treatment by level 2 x 2, using two-way ANOVA. The test criteria are if F-statistic > F-table at the selected significance level of 5%, then  $H_0$  is rejected; if F-statistic < F-table at the 5% significance level, then  $H_0$  fails to be rejected or accepted. The results of hypothesis testing can be seen in Table 3.

**Table 3.** Results of Analysis Varian two Way.

Varian	Db	F Statistic	F Table (0.05;18;1)	Description
Instructional Model (A)	1	0.836	4.41	$H_0$ is accepted
Innovation Ability (B)	1	30.216	4.41	$H_0$ is reject
Interaction A*B	1	32.832	4.41	$H_0$ is reject

Based on the data analysis results in Table 3, the difference in student learning outcomes in alternative energy courses between those taught using the PBL learning model and those taught using the STAD learning model.

Based on the results of the two-way ANOVA calculation, F statistic = 0.836 and  $F_t(0.05; 1; 48) = 4.41$ , at the significance level ( $\alpha$ ) = 0.05, from these results, the null hypothesis ( $H_0$ ) which states:  $\mu A1 = \mu A2$  is accepted and the hypothesis ( $H_1$ ) which states  $\mu A1 > \mu A2$  is rejected, because F counts 0.836 < F table 4.41, then  $H_0$  is accepted. This means that in this study, there is no difference in the learning outcomes of alternative energy courses of students taught using the PBL learning model with alternative energy learning outcomes of students taught using the STAD learning model. Table 4.2 shows that the average learning outcomes of students taught using the PBL learning model are 20.6, while the average learning outcomes of students taught using the STAD learning model are 21.4.

The PBL learning model is a Problem-Based Learning model, the most significant Innovation in education (Sánchez & Olivares, 2011). The Problem-Based Learning model helps to enhance lifelong learning skills in an open, reflective, critical mindset and Active Learning and facilitates successful problem-solving, communication, group work, and interpersonal skills better than other models. (Birgili, 2015; Lee-Cultura et al., 2021; Rohmanawati et al., 2021).

Thus, it can be concluded that the overall average learning outcomes of students taught using the PBL learning model are not higher than the alternative energy learning outcomes of students taught using the STAD learning model. However, for students with high innovation ability, the learning outcomes of students taught using the PBL learning model are higher than those taught using the STAD learning model. Conversely, students taught using the PBL learning model are lower than those taught using the STAD learning model for students with low innovation ability.

The interaction effect between the learning model and innovation ability on student learning outcomes in alternative energy courses.

Based on the two-way ANOVA calculation results, the F statistic = 30.216 and  $F_t(0.05;1;48) = 4.41$ . From these results, the null hypothesis ( $H_0$ ) states:  $H_0: \text{Int. A X B} = 0$  is rejected, and the hypothesis stating  $H_0: \text{Int. A X B} \neq 0$  is accepted. Because F statistics 30.216 > F table 4.41, then  $H_0$  is rejected. This means that this study has an interaction effect between learning models and innovation skills on alternative energy learning outcomes.

Based on testing the second hypothesis, where there is a significant interaction between the learning model and student ability on alternative energy learning outcomes, further tests need to be done. In this study, using the Scheffe test, the number of samples in this study is different. The following summarises further test calculations, as in Table 4

Table 4. Results of Scheffe.

Group	T Statistic	T Table	Description
PBL (A1) High Innovation(B1)-STAD(A2) High Innovation(B1)	0.416	3.079	H <sub>0</sub> is accepted
STAD(A2) Low Innovation(B2)-PBL(A1) Low Innovation(B1)	2.267	3.079	H <sub>0</sub> is accepted

The difference in learning outcomes of alternative energy courses between students taught using the PBL learning model and those taught using the STAD learning model for students with high innovation ability.

The results of further test calculations, as in table 4.16 above, obtained t statistic = 0.416 and t (0.05; 12) = 3.079 at a significant level ( $\alpha$ ) = 0.05, from these results the null hypothesis (H<sub>0</sub>), which states:  $\mu_{A1B1} \leq \mu_{A2B1}$  is accepted and the hypothesis (H<sub>1</sub>) which states  $\mu_{A1B1} > \mu_{A2B1}$  is rejected. Because t statistic 0.416 < t table = 3.079, H<sub>0</sub> is accepted. This means that there is no significant difference in the learning outcomes of alternative energy courses for students taught using the PBL learning model with those taught using the STAD learning model for students with high innovation ability.

Based on Table 4, for students with high innovation ability, the average learning outcomes of alternative energy using the PBL learning model are 23.3, and those taught using the STAD learning model are 23. Research by Yuliana et al., namely the Application of a Problem-Based Learning Model on Alternative Energy Material to Improve Learning Outcomes, concludes that the Problem-Based Learning model can improve student learning outcomes in Alternative Energy subjects. So it can be concluded that the alternative energy learning outcomes of students taught using the PBL learning model are higher than those of students taught using the STAD learning model for students with high innovation abilities.

Differences in student learning outcomes between those who use the PBL learning model and those who use the STAD learning model in alternative energy courses for students with low innovation abilities.

The results of the t-Scheffe further test calculation as in Table 4.16 above obtained t statistic = 1.021 and t (0.05; 12) = 3.079, at the significance level ( $\alpha$ ) = 0.05. From these results, the null hypothesis (H<sub>0</sub>), which states:  $\mu_{A1B2} \leq \mu_{A2B2}$ , is accepted and the hypothesis (H<sub>1</sub>), which states  $\mu_{A1B2} < \mu_{A2B2}$ , is rejected because t count 1.021 < t table 3.079 then H<sub>0</sub> is accepted. This means that there is no significant difference in the alternative energy learning outcomes of students taught using the PBL learning model compared to those of students taught using the STAD learning model for students with low innovation ability.

Based on Table 4, for students with low innovation ability, the average learning outcome of alternative energy taught with the PBL learning model is 18.0, and for those taught with the STAD learning model is 19.8. Slavin developed the STAD-type cooperative learning model, the simplest type of cooperative Learning implemented where students are divided into small groups of four to six heterogeneous people. STAD teachers refer to group learning that presents new academic information to students using verbal or text presentations (Salam et al., 2019).

Research conducted by (Zahroh, 2014) with the title Effect of STAD Type Cooperative Learning Model, PBL Model, and Academic Potential on Critical Thinking Ability and Social Skills of MTs Al Fithrah Surabaya Students on Material Human Interaction with the Environment. The results prove a significant interaction between learning models and academic potential on learning activities and outcomes. Thus it can be concluded that the alternative energy learning outcomes of students taught using the PBL learning model are lower than those of students taught using the STAD learning model for students with low innovation ability.

Based on the results of testing the first hypothesis, it shows that student learning outcomes in alternative energy courses, students taught using PBL learning models are higher than those taught using STAD learning models for students with high innovation abilities. Problem-Based Learning (PBL) is a method of Learning in which learners first encounter a problem followed by a systematic, Learning centred inquiry and reflection process (Guinibert, 2020; Silen & Uhlin, 2008). This means that Problem-Based Learning (PBL) is a method where learners first encounter a problem, followed by a systematic, learner-centred inquiry and reflection process.

Problem-based Learning is one of the instructional models associated with contextual Learning. Learning means being confronted with a problem, which then, through solving the problem, students learn more fundamental skills (Brusesels, 2018). Problem-based Learning is a model for teaching students to develop thinking and problem-solving skills, learn authentic adult roles and become independent learners. Problem-based Learning is not designed to help teachers provide students with as much information as possible. Still, problem-based Learning is developed to help students develop thinking, problem-solving and intellectual skills, learn various adult roles through their involvement in real experiences and become independent learners (Glover, 2013).

Judging from the overall average of student learning outcomes taught using PBL learning models is not higher than the learning outcomes of students taught using STAD learning models, where the overall average of alternative energy learning outcomes taught with PBL learning models is 20.6 while taught with STAD instructional models is 21.4. However, for students with high innovation ability, the average value of learning outcomes of students who are applied to the PBL learning model is greater than those who are applied to the STAD learning model. According to the researcher, this may be because the indicators to be achieved have not been completed in the learning process. In addition, a small sample size is also a possible cause in this study, so a larger sample size is needed.

The results of testing the second hypothesis show an interaction effect between the learning model and the ability of Innovation on the learning outcomes of alternative energy courses. Research conducted by Ulfi Aminatuz listed in the UNNES journal, with the title Effect of STAD Type Cooperative Learning Model, PBL Model, and Academic Potential on Critical Thinking Ability and Social Skills of MTs Al Fithrah Surabaya Students on the Material of Human Interaction with the Environment. The study's results prove a very significant interaction between learning models and academic potential on learning activities and learning outcomes. KWEK also conducted the research titled Innovation in the Classroom: Design Thinking for 21st Century Learning, which states that the curriculum, including the learning model, can increase the ability to innovate according to 21st-century skills. Therefore, the learning model and innovation ability affect student learning outcomes.

The results of testing the third hypothesis show that the alternative energy learning outcomes of students taught with the PBL learning model are higher than those of students taught with the STAD learning model for students with high innovation abilities. Research by Yuliana et al., namely the Application of a Problem-Based Learning Model on Alternative Energy Material to Improve Learning Outcomes, concludes that the Problem-Based Learning model can improve student learning outcomes in Alternative Energy subjects.

Supported by other research by (Yang & Yu, 2019). on Harbin Institute of Technology students with the title Research on Innovation Ability Cultivation of Engineering Graduate Students Based on the Innovation Platform concluded that in improving the ability to innovate in engineering students, it is necessary to apply the right learning model, one of which is solving theoretical problems that can create ideas and innovations.

In this study, it can be seen from the average learning outcomes of alternative energy taught using a learning model of 23.3 while taught using the STAD learning model of 23. This means that the learning outcomes of alternative energy taught with the PBL learning model are better than those of students taught using the STAD learning model who has high innovation abilities.

Fourth, in testing the fourth hypothesis conducted with the Scheffe further test as in Table 4, obtained  $t$  count = 2.267 and  $t$  (0.05: 18.1) = 3.079. Because  $t$  count = 2.267 <  $t$  table = 3.079 indicates that  $H_0$  is accepted. This shows that for students who have low innovation ability, the learning outcomes of alternative energy courses taught using the PBL learning model are lower than the learning outcomes of alternative energy courses taught using the STAD learning model, as seen in Table 4.1, where the average learning outcomes of students who have low innovation ability with the PBL learning model are 18 while the average count of student learning outcomes with the STAD learning model is 19.8 with a difference of 1.8. Research by (Prastiti et al., 2020) titled Effect of Application of Problem-Based Learning Model and STAD Type Cooperative on Student Learning Outcomes in Class X Light Vehicle Engineering SMK. This shows that implementing PBL learning strategies in teaching and learning activities

in vocational schools is currently very effective because it arouses and explores the potential of students to increase innovative behaviour. This research was conducted with more emphasis on the variable ability to innovate to bring up innovative behaviour and student learning outcomes in alternative energy courses. The novelty of the research is in the level or ability of student innovation that has not existed in previous studies, especially the ability of students to innovate in Alternative Energy.

#### 4. CONCLUSION

This research was conducted more on the ability to innovate variables to bring up innovative behaviour and student learning outcomes in alternative energy courses. This study uses an associative quantitative research model to find the effect of learning models on cognitive abilities according to students' innovation abilities. The novelty of the research is in the level or ability of student innovation that has not existed in previous studies, especially the ability of students to innovate in Alternative Energy.

The findings in this study are that the learning model and innovation ability affect students' alternative energy learning outcomes. Students who are taught using the PBL learning model obtain higher learning outcomes than those who are taught using the STAD learning model in groups of students with high innovation abilities.

Researchers realize that in implementing this study, there are limitations that can affect the condition of the research conducted, including the limited time to complete this research, which is relatively short. Besides, researchers only examine student learning outcomes based on learning models and innovation abilities. In addition, researchers only involved 22 students as research subjects. Therefore a larger number of subjects is needed so that the results of this study can be generalized more broadly.

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DOI: <https://doi.org/10.15379/ijmst.v10i2.1264>

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