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The Effect of Canva-assisted *PjBL-STEAM* to Improve Creative Thinking and Collaboration on Energy Concept

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Abstract

The purpose of this study was to analyze the effect of *Canva-assisted PjBL-STEAM* learning model to improve students' creative thinking and collaboration skills. This type of research is *quasi-experimental* with *Nonequivalent Control Group Design* with *pretest* and *posttest* forms. Measurement of creative thinking ability is carried out by *pretest* and *posttest*, while collaboration ability is measured by observation sheets by observers as the main data and *Self-assessment* questionnaires as supporting data. The data were analyzed with descriptive statistics. Data analysis of creative thinking and collaboration skills was performed with normality test, *t-test*, and *N-Gain*. The study sample consisted of 62 learners in two groups, experimental and control classes. The research findings showed that the *Canva-assisted PjBL-STEAM* learning model had a significant effect on improving students' creative thinking and collaboration skills in experimental classes compared to control classes using the *Discovery Learning Model*. There are significant differences between the two groups in indicators of creative thinking (*fluency, flexibility, elaboration, and originality*) and indicators of collaboration ability (active contribution, productive performance, sociability, responsibility, and respect for others). The results showed that *Canva's PjBL-STEAM* learning model on energy materials can improve students' creative thinking and collaboration skills. *Canva's PjBL-STEAM* learning model can help teachers prepare students to face the challenges of the 21st century. In the *STEAM* project, students are trained to be able to think creatively and collaborate in solving problems related to life, so that learning is more meaningful.

Introduction

Entering the era of the industrial revolution 4.0 in the 21st century, the development of science and technology is so rapid that the two are inseparable. This has resulted in demands in the world of work which requires having the skills needed in the world of work. The main ability that is emphasized to face challenges in the 21st century is called the 4C, which consists of critical thinking & problem solving, collaboration, communication, and creativity & innovation (Sulak et al., 2020; Wardani & Budiadnya, 2023; Yildirim, & Uzun, 2021). Therefore, these abilities are important to be implemented and taught through the educational process, so that students can have the ability to face the challenges of the 21st century in the future (Fitriyah & Ramadani, 2021).

Responding to the challenges of the 21st century, the government issued a policy of a new curriculum, namely the independent curriculum. This independent curriculum is designed with the aim that students can develop their potential so that students can obtain critical, quality, expressive, applicative, varied and progressive learning (Arifah et al., 2023). This change in the independent curriculum is expected to be able to form students with character, critical thinking, creative, collaborative, and adaptive (Alatas et al., 2023). Efforts to realize the goals of the independent curriculum require support, cooperation, and commitment from all parties in order to instill the profile of Pancasila students in students and mastery of 4C abilities by students (Sari & Amini, 2020). The 4C abilities that will be discussed in this study are the ability to think creatively and collaboratively.

Creative thinking is the ability to think that is able to see a problem from different points of view to give birth to many new ideas, this ability allows someone to connect problems from different perspectives to find a creative solution (Hidayati et al., 2023; Jumadi et al., 2020). Students are important to have the ability to think creatively because the ability to think creatively is the ability to face the challenges of the 21st century that can help students to prepare students for the world of work (Parcha, 2020; Royce et al., 2016; Smith, 2022). Another skill needed to cope with the challenges of the 21st century is collaboration. Collaboration in the learning process is a form of cooperation with each other, helping each other, and complementing each other to perform certain tasks in order to obtain a predetermined goal. The ability to collaborate is an important skill in the 21st century in the world of education and the world of work, this ability is important for students to have as preparation for the world of work, so educators need to provide exercises that can hone students' collaboration skills (Hidayatullah et al., 2022; Nemiro, 2021; Vesisenaho et al., 2023). Collaboration skills are needed in the world of work, especially for companies that need teamwork to be able to convey ideas and solutions and facilitate work. The importance of collaboration skills in the world of work, this is what drives the problem of lack of collaboration skills so that it can be improved from the world of education (Maielfi & Wahyuni, 2020). In order for students to have the ability to think creatively and collaboratively, they can be trained by providing problem-based learning in real life (Priyono & Sinurat, 2020).

The results of the *Global Creativity Index* 2015 show that the creative thinking ability of students is still low, the creative thinking ability of students in Indonesia is in the 115th position out of 139 countries (Florida et al., 2015; Gunay & Kazazoglu, 2016; Widiastuti, & Putri, 2018; Yanuar et al., 2023). Students still have difficulty in providing ideas for a problem-solving solution. So an innovative learning model is needed in order to encourage students' creative thinking skills (Atun & Latupeirisa, 2021; Ndiung et al. 2019; Qonitah et al. 2022; Sompong, 2018). In addition, the results of the study (Le et al., 2018; Mardawati et al., 2022) showed that the collaboration ability of learners is still low. The results of observations and interviews with science teachers at SMP Negeri 10 Semarang show that the creative thinking ability of students is relatively low. This is evidenced by the results of the Midterm Assessment analysis of students who are less able to answer questions related to creative thinking indicators. In addition, the results of teacher observations, show that students have low creative thinking skills due to the length of previous online learning, as a result of students lacking discipline when studying at home. The results of teacher observations also show that the collaboration ability of students is still lacking, this is evidenced by when the implementation of group assignments is only part of the team that carries out its duties, other members are busy playing alone not helping to do group tasks.

The problem of low creative thinking ability and student collaboration needs to be solved with a packaged learning model to improve creative thinking and collaboration skills. The *PjBL* learning model with a *STEAM* approach can be used as an alternative solution to improve creative thinking and collaboration skills, because the stages in the learning model contain elements that can train students to think creatively and collaborate. Science learning by applying the *Project Based Learning* learning model with a *STEAM* approach supported by Canva software aims to provide space for students to improve creative thinking and collaboration skills. This *PjBL learning model* with a *STEAM* approach directs students to create an *integrated STEAM* product related to energy materials. Each stage in this learning will guide students so that their creative thinking and collaboration skills are honed. *STEAM* is an innovative learning process that can hone the ability to find creative solutions in solving problems (Fitriyah & Ramadani, 2021). The choice of energy material in this study is because the *PjBL-STEAM* learning model is very suitable to be applied to energy materials because the material has many applications in everyday life. This study adapts the *PjBL-STEAM* learning steps according to Canva-assisted (Lestari, 2021). *PjBL-STEAM* steps that will be implemented in this study can be seen in Figure 1.

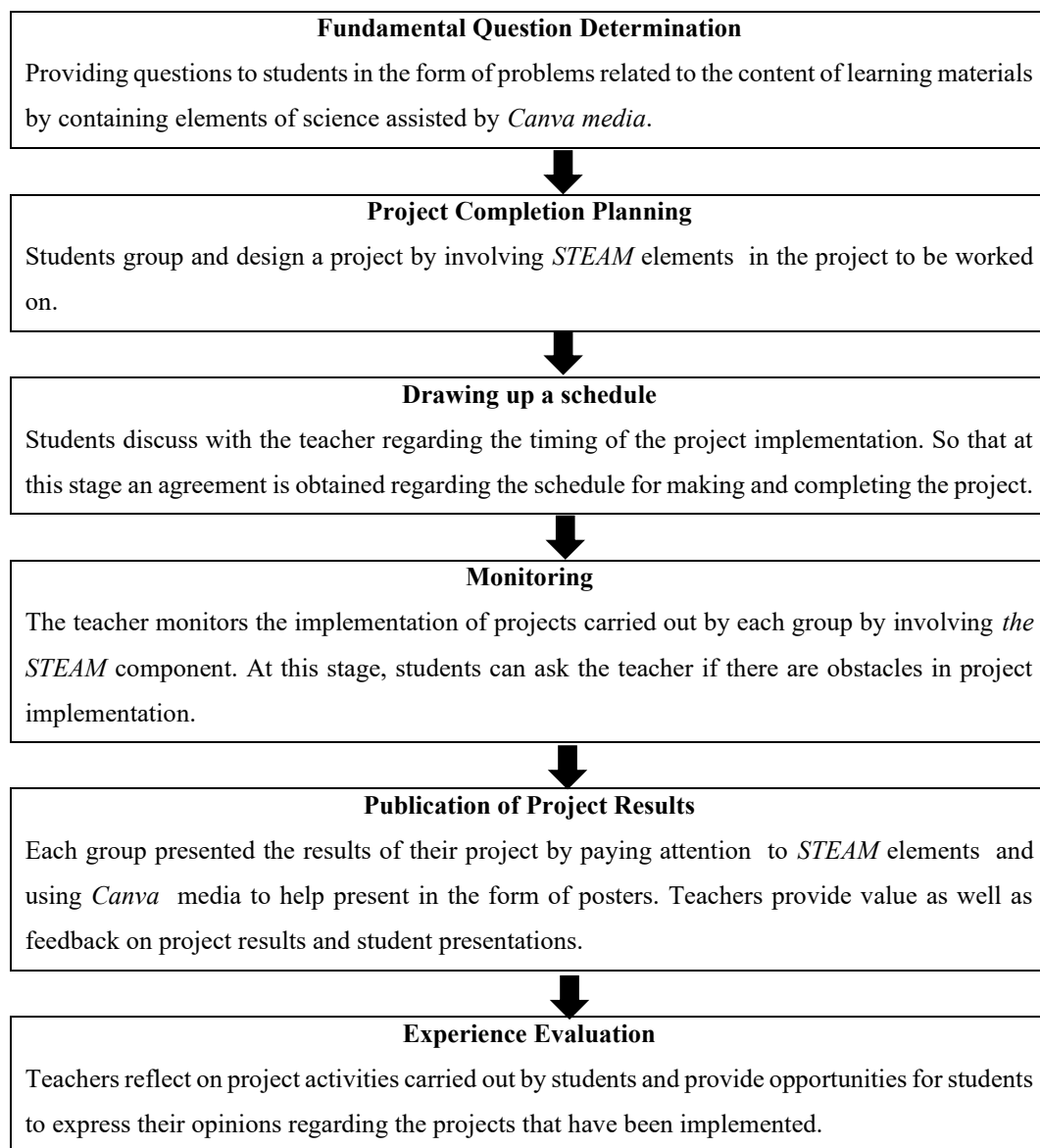


Figure 1. *PjBL-STEAM* Steps, Assisted by *Canva*

In recent years there has been a lot of research related to *PjBL-STEAM* in education. However, only a few studies in Indonesia have examined the topic of energy. In addition, no studies have tested the effect of *Canva-assisted PjBL-STEAM* learning models to measure improvements in creative thinking and collaboration skills simultaneously. The results of Fitriyah & Ramadani (2021) research show that *PjBL-based STEAM* learning affects the ability to think creatively. This is because the integration of *STEAM-PjBL* together can be a learning innovation that can bring up creative and critical ideas and solutions, making it easier to solve a problem. Nurwidodo *et al.* (2022) in his research shows the results that learning with the *STEAM* approach can improve students' collaboration skills, seen when students conduct group discussions and class discussions. In addition, Zebua (2023) in his research stated that *Canva* is an interactive media that can be used to help teachers in learning, the advantages of *Canva* because it is practical, unique, and creative in delivering learning materials.

In accordance with the problems and limitations that have been raised, the purpose of this study is to analyze the effect of the application of the *Canva-assisted PjBL-STEAM* learning model on the ability to think creatively and collaborate students on energy materials. It is assumed that this research will contribute to the experimental research literature on the *PjBL* learning model, the *STEAM* approach, and the ability to think creatively and collaboratively as well as the application of *Canva* in learning. In addition, this research can also be an inspiration and innovation for teachers in applying the *STEAM* project-based learning model to science subjects so that learning is more meaningful and can support 21st century abilities.

In line with the research objectives, 2 research questions were formulated:

1. How does the application of *Canva's PjBL-STEAM* learning model affect students' creative thinking skills on energy concept?
2. How does the application of *Canva's PjBL-STEAM-assisted* learning model affect students' collaboration capabilities on energy concept?

Method

Research Design

This study used a *quasi-experimental* type with the research design used, namely *Nonequivalent Control Group Design* with the form of *Pretest Posttest*, this study first pretested students and then given learning treatment in experimental classes, namely using the *Canva-assisted PjBL-STEAM* model learning, while in the control class with the *Discovery Learning* learning model. Furthermore, at the end of the meeting, *posttests* were carried out in each control class and experimental class, the research design can be seen in Figure 2.

Kelas	Pretest	Perlakuan	Posttest
E	O ₁	X	O ₂
K	O ₃	Y	O ₄

Figure 2. Nonequivalent Control Group *Design Research Design*
(Sugiyono, 2016: 75).

Research Sample

The sampling technique used in this study is a *simple random sampling technique*. In this technique, the collection does not pay attention to strata in the population so it is taken randomly (Sugiyono, 2016: 82). The selection of *simple random sampling* techniques in this study can be done provided that students are homogeneous and in each class have the same opportunity to become research samples. In this study, 2 classes have been selected, namely class VIII F as a control with the *Discovery Learning* learning model and class VIII C was chosen as an experimental class with the *Canva-assisted PjBL-STEAM* learning model.

Research Procedure

1. Provide pretest questions on energy material to find out the initial understanding of students in experimental and control classes.
2. Carry out learning about energy materials both in experimental and control classes. Learning in experimental classes is carried out using the *PjBL-STEAM* learning model assisted by *Canva*, while the implementation of learning in control classes uses the *Discovery Learning* learning model which is often done in schools. The recapitulation of the learning implementation is presented in Table 1.

Table 1. Recapitulation of Learning Implementation at Each Meeting

No	Meeting to	Experimental Class	Control Class
1.	First	<i>Pretest</i> Submission of problems and delivery of preparation of tools and materials needed by students to make <i>PjBL-STEAM projects</i> .	<i>Pretest</i>
2	Second	Learning plans and project design in <i>Canva</i>	Working on LKPD 1
3	Third	Making skeletons and waterwheels	Continuing LKPD 1 + LKPD Presentation 1
4	Fourth	Making electrical circuits	Introduction to PhET Simulation and working on LKPD 2
5	Fifth	Designing posters and explanations of energy matter	Presentation of LKPD 2 and explanation of energy matter
6	Sixth	Decorating projects, finishing, and rehearsing energy material problems	Working on LKPD 3 and energy exercises
7	Seventh	Presentations and exercises on energy matter	Presentations and exercises on energy matter
8	Eighth	<i>Posttest</i>	<i>Posttest</i>

3. Carry out observations during learning activities in control classes and experimental classes to measure the collaboration ability of students during the learning process. Observations are made by observers.
4. Measuring the influence of the learning process on the creative thinking ability of students, by carrying out *a posttest* at the end of learning both in experimental and control classes.
5. Researchers asked students to fill out a *Self-assessment* questionnaire to find out students' self-assessment of the *PjBL-STEAM learning model* that had been implemented.

Data Collection Instruments

Data on creative thinking ability is taken from *pretest & posttest* creative thinking ability at the end of learning. Data on collaboration ability is taken from the observation of students' collaboration ability during learning by observers. In addition, it also uses *Self-assessment* Questionnaires as supporting data to measure collaboration capabilities. Detailed information related to the instruments used in data collection is shown in the table 2

Table 2. Data Collection Instruments

No	Data Type	Data Collection Methods	Data Analysis Methods	Instruments
1.	Instrument Validation	Expert validity test	Descriptive Statistics	Expert validation sheet
2.	Creative Thinking	Description Test	<i>N-Gain</i> <i>T-Test</i>	Pretest & posttest questions
3.	Collaboration	Observation	<i>N-Gain</i> <i>T-Test</i>	Student observation sheet
		Self-assessment questionnaire	Descriptive statistics	Student assessment questionnaire sheet

Data Analysis

Before the implementation of research, the instrument is validated first to experts. Experts in this study are 1 lecturer of media and material experts, and 2 science teachers. After being declared valid by experts, a test question was carried out. The results of the trial of the then question are analyzed to determine the validity of the question, reliability, discriminating power, and the level of difficulty of the question. Once declared valid, the instrument can be used in research. The collected data was analyzed using *Microsoft Excel* number processing software using *N-Gain* and *t-test*. The creative thinking ability of students is analyzed from *the pretest* and *posttest results*. Meanwhile, collaboration skills are analyzed through observation sheets and self-assessment questionnaires.

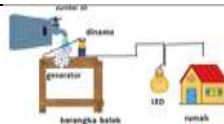
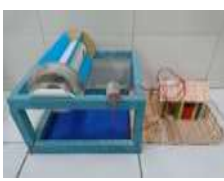
Results

The research has been carried out at SMP N 10 Semarang in the 2023/2024 academic year in the odd semester in October. This research is a type of experimental research that aims to analyze the effect of Canva-assisted *PjBL-STEAM* learning models to improve students' creative thinking and collaboration skills on energy materials.

Measurement of creative thinking ability is carried out by *pretest and posttest*, while collaboration ability is measured by observation sheet as the main data and Self-assessment questionnaire as supporting data. Data analysis of creative thinking and collaboration skills was performed with normality test, T test, and *N-Gain*. Especially for collaboration capability data because it is in the form of ordinal data, before being analyzed the data is converted first to interval data so that parametric data analysis can be carried out.

Table 2. Canva-Assisted *PjBL-STEAM* Products Created by Students in Experimental Classes

Group	Project	Group	Project
1	 Simple hydropower design  Simple hydropower products  STEAM poster on a simple hydropower plant	4	 Simple hydropower design  Simple hydropower products  STEAM poster on a simple hydropower plant
2	 Simple hydropower design  Simple hydropower products  STEAM poster on a simple hydropower plant	5	 Simple hydropower design  Simple hydropower products  STEAM poster on a simple hydropower plant

Group	Project	Group	Project
3	 Simple hydropower design  Simple hydropower products  STEAM poster on a simple hydropower plant		

Based on Table 2, it can be seen that the application of *STEAM* in project learning to improve creative thinking skills is the most prominent element of *Art*. Classically, each group is able to creatively design posters and product designs in *Canva*. Each group is also creative in making simple hydropower products by utilizing goods in the surrounding environment. Students are also creative in decorating hydropower products by making houses made from used goods such as straws, ice cream sticks, and cardboard. They also apply elements of art by coloring simple hydropower products to make them more attractive.

In addition, the element of *Engineering* also stands out shown by learners. Each group is skilled and able to work on the project well. They are creative in assembling products to create simple hydropower plants to solve the energy crisis as a form of real application in applying meaningful learning to energy materials. Students are also able to use creative thinking skills to find creative solutions in dealing with problems in the implementation of this learning project. These abilities are very useful in the future to be applied in the real world so that students are trained to solve future challenges.

In the Science element, it is also clear that students show it by actively asking questions related to energy materials to be applied to the project. Students in groups actively seek out scientific knowledge related to the concept of energy so that they can turn on the lights. They discussed creative ideas with their groups to make products that could solve the energy crisis. Students can also learn material with hydropower products that they have made.

Elements *Technology* classically not evenly skilled in each group. Because in this learning, many students are still in the stage of learning to design and use technology in *Canva*. But students do not give up easily, instead they want to learn and process in order to use technology well. By being accompanied by a teacher, in the end each group was able to use *Software Canva* is so good that it is able to complete group assignments. On the element

mathematic Some students lack mastery because they do not like learning that uses calculations. However, with project-based learning *STEAM* This intrigues them and encourages them to learn to love math. They apply mathematical elements by using mathematical calculations in making product designs. Mathematical calculations are also applied when solving energy-related problems.

Based on Table 2, it can be concluded that the ability to collaborate during project learning with the approach *STEAM* On each group is excellent. They show mutual respect between groups. Each member feels their own responsibility. So that they contribute actively both in conveying ideas and making products. With monitoring from teachers, students can be productive in carrying out the learning process of this project. This learning also makes students who were originally shy when interacting with their friends can now work well together to discuss completing projects.

Data Normality Test Results of Students' Creative Thinking Ability

The results of the data obtained from *the pretest* and *posttest* of students' creative thinking skills in the form of 10 description questions, were tested using a normality test to find out whether the data was normally distributed or not. This normality test is performed to determine the influence test analysis to be used. The normality test analysis in this study uses the *Chi square* formula with Microsoft excel *number processing* software *tools*. The results of the data normality test of students' creative thinking ability in experimental and control classes are presented in Table 3.

Table 3. Results of the Normality Test of Pretest and Posttest Data Creative Thinking Skills

Picking Method	Question Type	Class	χ^2_{Count}	χ^2_{Table}	Criterion
Description Test	Pretest	Experiment	4.07	11.01	Normal Distributed
	Pretest	Control	4.92	11.01	Normal Distributed
	Posttest	Experiment	8.28	11.01	Normal Distributed
	Posttest	Control	10.52	11.01	Normal Distributed

Table 3 shows the results of the normality test of *pretest* and *posttest scores* of creative thinking skills of learners in both experimental and control classes. The data obtained in the *experimental class pretest* are χ^2_{count} values of $4.07 < 11.01 \chi^2_{\text{tables}}$, so it is declared normally distributed. The data obtained from the *pretest value of the control* class is a value of $\chi^2_{\text{count}} 4.92 < 11.01 \chi^2_{\text{table}}$, so that the data is normally distributed. The data obtained from the *experimental class posttest* are χ^2_{count} values $8.28 < 11.01 \chi^2_{\text{tables}}$, so that the data is normally distributed. In the data obtained from the *control class posttest*, the value of $\chi^2_{\text{counts}} 10.52 < 11.01 \chi^2_{\text{tables}}$, so that the data is declared normally distributed. Because all data is normally distributed, parametric analysis of influence tests can be carried out using the t-test.

N-Gain Test Analysis Results

After the normality test analysis was carried out, the *N-Gain* analysis continued to find out how much the increase

in students' creative thinking skills due to the treatment of the Canva-assisted *PjBL-STEAM* learning model. Indicators of creative thinking ability measured in this study include *fluency*, *flexibility*, *elaboration*, and *originality*. The N-Gain score shows that students' creative thinking ability has improved after the treatment of the *Canva-assisted PjBL-STEAM model* on each creative thinking indicator. The results of the *N-Gain* test of each indicator on the creative thinking ability of learners are presented in Table 4 and 5.

Table 4. *N-Gain Test Results of Each Indicator of Creative Thinking Ability of the Experimental Class*

Indicators	Average value (%)		<i>N-Gain</i>	<i>Criteria</i>
	<i>Pretest</i>	<i>Posttest</i>		
<i>Fluency</i>	40.32	81.6	0.69	Medium
<i>Flexibility</i>	16.77	59.13	0.5	Medium
<i>Elaboration</i>	12.15	52.9	0.46	Medium
<i>Originality</i>	3.54	87.4	0.85	High

Table 5. *N-Gain Test Results of Each Indicator of the Creative Thinking Ability of the Control Class*

Indicators	Average value (%)		<i>N-Gain</i>	<i>Criteria</i>
	<i>Pretest</i>	<i>Posttest</i>		
<i>Fluency</i>	35.5	59.7	0.38	Medium
<i>Flexibility</i>	9.35	33.6	0.26	Low
<i>Elaboration</i>	10.96	28.6	0.19	Medium
<i>Originality</i>	17.74	19.67	0.02	Low

The *N-Gain scores* in Table 4 and 5 show that in the analysis of creative thinking skills in experimental classes experienced a rapid increase after the implementation of *Canva-assisted PjBL-STEAM* learning. If both *N-Gain values are compared*, the experimental class's *N-Gain value* is higher than that of the control class. This means that the *Canva-assisted PjBL-STEAM* learning model is more influential for improving creative thinking skills when compared to the *Discovery Learning model*. The *N-Gain* results of learners' creative thinking ability are presented in Figure 3.

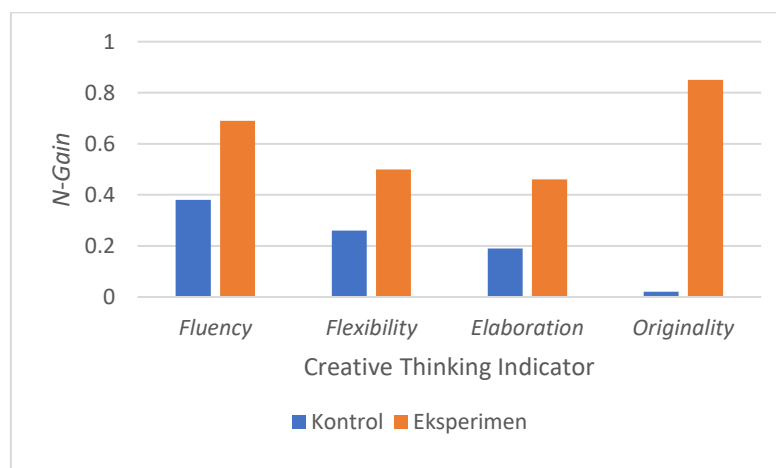


Figure 3. *N-Gain Creative Thinking Ability*

Table 6. Criteria Analysis Creative Thinking Ability of Experimental Class

Indicators	Experimental Class				Control Class			
	Average value (%)		Criteria		Average value (%)		Criteria	
	<i>Pretest</i>	<i>Posttest</i>	<i>Pretest</i>	<i>Posttest</i>	<i>Pretest</i>	<i>Posttest</i>	<i>Pretest</i>	<i>Posttest</i>
Fluency	40.32	81.6	Quite Creative	Very Creative	35.05	59.7	Enough Creative	Enough Creative
Flexibility	16.77	59.13	Not Creative	Quite Creative	9.35	33.6	Not Creative	Less Creative
Elaboration	12.15	52.9	Not Creative	Quite Creative	10.96	28.6	Not Creative	Less Creative
Originality	3.54	87.4	Not Creative	Very Creative	17.74	19.67	Not Creative	Not Creative

The Results of the Analysis Test the Influence of Creative Thinking Ability

The results of the data obtained from the *pretest* and *posttest* scores of students' creative thinking skills on energy matter that have been tested for normality and obtained normally distributed data. Next, parametric analysis of the influence test was carried out using the T test. This aims to analyze whether the learning treatment provided affects the creative thinking ability of students. The results of the T test analysis of the influence of learning models on creative thinking skills in experimental and control classes can be observed in Table 7.

Table 7. Creative Thinking Ability t-Test Results

Class	Sig	Information	Mean
Experiment	0.00	There are significant differences	48.2
Control			36.29

The data in Table 7 show that the results of the experimental and control class T test analysis obtained P chances or significance generated by both samples of $0.00 < 0.05$. Because the calculated sig value is smaller than the value of 0.05, then H_0 rejected H_a is accepted, meaning that there is a significant effect. The average gainscore of the experimental group was higher than the control group of $48.2 > 36.29$, meaning that the *Canva-assisted PjBL-STEAM* learning model was more influential for improving students' creative thinking skills when compared to the *Discovery Learning* model. The *t-test results* of each indicator on creative thinking ability are presented in Table 8.

Based on the data from the table, the results of the t test analysis of each indicator of the creative thinking ability of the experimental class and control class obtained significance values on the *fluency indicators* of $0.00 < 0.05$. Because the calculated sig value is smaller than the value of 0.05, then α_{H_0} is rejected H_a is accepted. This means that there is a significant influence. Because the average gainscore value of the experimental group was higher than the control group on the fluency indicator of $12.38 > 7.41$, this means that the *Canva-assisted PjBL-STEAM* learning model is more influential for improving students' creative thinking skills (fluency indicators) when

compared to *the Discovery Learning model*. This is also the same in indicators of *flexibility, elaboration, and originality*.

Table 8. The t-Test Results of Each Indicator on the Ability to Think Creatively

No	Indicators	Sig	Class	Mean
1.	<i>Fluency</i>	0.00	Experiment	12.38
			Control	7.41
2	<i>Flexibility</i>	0.00	Experiment	12.7
			Control	7.29
3	<i>Elaboration</i>	0.00	Experiment	7.67
			Control	5.61
4	<i>Originality</i>	0.00	Experiment	7.67
			Control	0.19

Data Normality Test Results of Student Collaboration Capabilities

The results of the data obtained from observing the collaboration ability of students, then a normality test was carried out to find out whether the data was normally distributed or not. This aims to determine the influence test analysis to be used. The data from observations of collaboration capabilities are still in the form of ordinal data, so parametric analysis cannot be carried out. Therefore, the data is converted first into interval data with the help of MSI so that parametric normality test analysis can be carried out using *Microsoft Excel software* assistance tools with *Chi Square formulas*. The results of the normality test of data on the collaboration ability of students in experimental and control classes can be seen in Table 9.

Table 9. Collaboration Capability Observation Data Normality Test Results

Picking Method	Class	χ^2_{Count}	χ^2_{Table}	Criterion
Observation	Experiment	4.37	11.01	Normal Distributed
	Control	9.06	11.01	Normal Distributed

Table 9 shows the results of the normality test of the results of observing the collaboration ability of students in both experimental and control classes. The data obtained in the experimental class observations are 2count values $\chi^2 4.37 < 11.01 \chi^2_{\text{table}}$, so it is stated to be normally distributed. The data obtained from the observations of the control class are 2count values $\chi^2 \text{ of } 9.06 < 11.01 \chi^2_{\text{table}}$, so that the data is normally distributed. Because all data is normally distributed, parametric analysis of influence tests can be carried out using the t test.

N-Gain Test Analysis Results

After the T test analysis was carried out, the N-Gain analysis continued to find out how much the increase in student collaboration ability due to the treatment of the Canva-assisted PjBL-STEAM learning model. The results of the N-Gain calculation along with the criteria for student collaboration ability are presented in Table 10.

Table 10. *N-Gain Test Results* of Each Indicator on the Collaboration Ability of Experimental Class Learners

Indicators	Average value (%)		N-Gain	Criteria
	OA	OI		
Active Contribution	48	80	0.61	Medium
Productive Performance	53	85	0.69	Medium
Easy to socialize	74	93	0.73	High
Responsible	53	85	0.68	Medium
Respect for Others	65	88	0.65	Medium

Information: OA = Initial observation, OI = Final observation

Table 11. *N-Gain Test Results* of Each Indicator on the Creative Thinking Ability of Experimental Class Learners

Indicators	Average value (%)		N-Gain	Criteria
	OA	OI		
Active Contribution	59	79	0.48	Medium
Productive Performance	61	75	0.35	Medium
Easy to socialize	64	84	0.55	High
Responsible	67	73	0.18	Medium
Respect for Others	65	73	0.22	Medium

The N-Gain score in table 10 and table 11 shows that in the analysis of collaboration ability in the experimental class experienced a rapid increase after the implementation of *Canva-assisted PjBL-STEAM* learning. If both *N-Gain values* are compared, the experimental class's N-Gain value is higher than that of the control class. This means that *Canva's PjBL-STEAM* learning model is more effective at improving collaboration capabilities when compared to the *Discovery Learning learning model*. The results of *N-Gain* learners' collaborative thinking skills are presented in Figure 4.

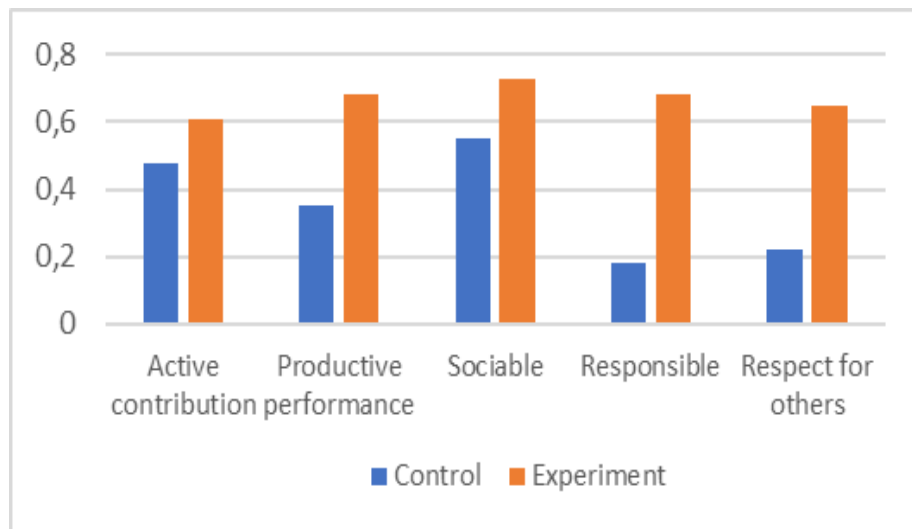


Figure 4. *N-Gain* Collaboration Capabilities

Results of the Analysis of the Influence Test of Collaboration Capabilities

The results of the data obtained from the observation of the collaboration ability of students who have been tested for normality and obtained normally distributed data. Next, parametric analysis of the influence test was carried out using the T test. This aims to analyze whether the learning treatment provided affects the collaboration ability of students. The results of the T test analysis of the effect of learning models on collaboration ability in experimental and control classes can be observed in Table 12.

Table 12. Collaboration Capability t-test results

Class	Sig	Information	Mean
Experiment	0.02	There are significant differences	23.74
Control			20.09

The data from Table 12 shows that the results of the experimental and control class T test analysis obtained P chances or significance generated by both samples of $0.02 < 0.05$. Because the calculated sig value is smaller than the value of 0.05, then H_0 rejected H_a is accepted, meaning that there is a significant effect. Because the average gainscore of the experimental group is higher than that of the control group of $23.74 > 20.09$, it means that the intervention given to the experimental group effectively increases the value of the dependent variable. This means that the *Canva-assisted PjBL-STEAM* learning model is more influential for improving student collaboration capabilities when compared to the *Discovery Learning learning model*. The t-test results of each indicator on creative thinking ability are presented in Table 13.

Table 13. T-Test Results of Each Indicator on Collaboration Capability

No	Indicators	Sig	Class	Mean
1.	Active Contribution	0.02	Experiment	30.71
			Control	20.44
2	Productive Performance	0.00	Experiment	32.17
			Control	14.46
3	Easy to socialize	0.04	Experiment	23.78
			Control	20
4	Responsible	0.00	Experiment	22.78
			Control	6
5	Respect for Others	0.04	Experiment	19.12
			Control	7.57

Based on the data from the Table, the results of the t test analysis of each indicator of the creative thinking ability of the experimental class and the control class obtained a significance value on the active contribution indicator $0.02 < 0.05$. Because the calculated sig value is smaller than the value of 0.05, then α_{H_0} is rejected H_a is accepted. This means that there is a significant influence. Because the average gainscore value of the experimental group was higher than the control group on the active contribution indicator of $30.71 > 20.44$. This means that the *Canva-*

assisted PjBL-STEAM learning model is more influential for improving the collaboration ability (active contribution indicator) of students when compared to the *Discovery Learning* model. This is also the same in indicators of productive performance, easy to socialize, responsible, and respect others.

Discussion

The results of the creative thinking ability test covering 4 aspects including *fluency indicators*, flexibility, *elaboration*, and *originality* showed that there was an improvement in every aspect of creative thinking indicators after being given the learning model treatment. The most significant improvement was in experimental classes with *Canva's PjBL-STEAM* learning model.

Fluency indicators are analyzed from the ability of students to answer questions number 1, 2, and 3. Based on the average *N-Gain results on the fluency indicator*, the increase in creative thinking ability of students in the experimental class was higher than in the control class. In the *PjBL-STEAM* learning process assisted by Canva, students are given problems related to daily life that they must solve by implementing *STEAM* elements in problem solving. This encourages students to fluently express their ideas and answer various problems with various ideas (Fitria et al., 2023). In this learning, researchers propose challenging problems with an interesting approach (*STEAM*) so that students are motivated to participate. This can improve the creative thinking ability of students to solve problems with various creative solutions.

Good fluency *ability* is shown by students being able to provide many answers for problem solving (Cahyani, 2023). This is in line with the research of Firdaus *et al.* (2018) which states that the ability to think creatively on *fluency* indicators is directly proportional to the ability of students to provide many answers from problem solving. The ability of *Fluency* is also proven when the implementation of the project students can fluently express their ideas. In addition, in the implementation of presentations, students fluently express their ideas and are able to answer questions given by teachers and other group members.

Flexibility indicators are analyzed from the ability of students to answer questions number 4, 5, and 6. Based on the average *N-Gain results on the flexibility indicator*, the increase in students' creative thinking ability in the experimental class was higher than in the control class. *Flexibility* can be seen from the provision of varied interpretations, and the diversity of problem solving (Cahyani, 2023). *Flexibility* is seen from the ability of students to produce ideas that vary on a question asked even though the goal is the same (Fatma, 2021). Students who have the ability to present varied answers, usually if given a problem have various ways to solve problems. In addition, in solving a problem, students are able to see from different perspectives (Nurfadilah and Siswanto, 2020). The ability of *flexibility* (flexible thinking) is proven by when implementing projects every time there is a problem, students are able to think flexibly, are able to see from different points of view and think of various different ways to solve them. Students are also able to answer questions flexibly when asked by teachers and other group members.

Elaboration indicators are analyzed from the ability of students to answer questions number 7, 8, and 9. Based on

the average results of *N-Gain* on the *elaboration* indicator, the increase in creative thinking ability of students in the experimental class was higher than in the control class. *Elaboration* is the ability to explain in detail or in detail the answers given to solve problems. *Elaboration* is the ability to explain in detail ideas (Cahyani, 2023). The *elaboration* aspect shows how detailed or detailed students are in providing answers to solve the problems posed (Yuliani, 2017). The ability to think creatively on *elaboration* indicators during learning with projects is shown by students in detail students design project designs. Starting from compiling tools, materials, sizes, and project sketches and in the process of making products. Students also compile detailed project implementation schedules by discussing with teachers. Students also present activities by explaining the product in detail and explaining the application of *STEAM* in the product.

Originality indicators are analyzed from the ability of students to answer question number 10. Based on the average *N-Gain results on the originality indicator*, the increase in creative thinking ability of students in the experimental class was higher than in the control class. *Canva-assisted PjBL-STEAM* learning helps students to hone their creative thinking skills to generate creative ideas to solve a problem, for example designing hydropower projects to overcome the energy crisis by providing alternative solutions using renewable energy in the form of water. This is in line with the statement of Yustina *et al.* (2020) which states that the ability to think creatively in the aspect of *originality* makes students creatively convey their ideas without copying exactly what the teacher conveys.

Originality allows students to convey ideas with a variety of answers and get used to creating a new work, not only limited to delivering the exact same material in the book. *Originality* is authenticity in producing capable or appropriate answers. This aspect of *originality* can be seen from the answers given by students to solve problems contained in the creative thinking test. The ability to think originally, is the ability of students to issue unique or unusual ideas, for example, the ideas given are different from those contained in the book. The (Candra *et al.*, 2019) *originality* aspect shows that students not only answer correctly but can provide new innovations in solving problems (Qomariyah & Subjection, 2021).

In the *originality indicator*, the average value of learning influence between the experimental class and the control class is significantly different, when compared to more influential learning treatment with the *Canva-assisted PjBL-STEAM* model in the experimental class. This difference when connected with learning is very appropriate. This is because during the learning process students in the experimental class are very creative, they are able to provide ideas, ideas, and create a work. Students are able to provide new creative solutions to solve problems, especially in making *STEAM* projects. Students in the experimental class in conveying their ideas are not exactly the same or copying in books, they provide new innovations according to their thoughts and dare to express their unique ideas. Unlike the experimental class, in the control class students tend to be less able to express their creative ideas. Students tend to copy what is in books and other literature. Learners are not used to using creative thinking skills to solve problems with creative solutions. Some students are also still shy in expressing their ideas. They also lack the ability to create a unique work in learning related to energy matter.

The results showed that the ability to think creatively in each class increased, but a higher increase was shown in

the experimental class. This can be seen from comparing the average value of *N-Gain* increase in creative thinking ability of experimental and control classes and by looking at the percentage difference in each aspect of the creative thinking ability indicator. This means that *Canva's PjBL-STEAM* learning model is more influential than *Discovery Learning* to improve creative thinking skills. This is in line with Marwani's research (2020) which states that the *PjBL* learning model is able to significantly improve creative thinking skills because the project-based learning model makes learning more active, creative, and fun. So that students' creative thinking skills can be honed. This is different from learning using the *Discovery Learning* model in the control class, it can be seen that students are less enthusiastic and there are still many students who are passive, students are not optimal in pouring their creative ideas to pour them in the form of solving problems in life. So that the ability to think creatively is less honed. In addition, students are more interested in project-based learning because they can apply the theory they get in real time in the form of making works.

PjBL with a *STEAM* approach can provide challenges and motivation for students because it is able to train students to think, analyze and improve higher-order thinking skills, and creativity (Arifah et al., 2023). *STEAM* learning is an effective way to improve the ability of students in the field of science (Quigley et al., 2017). *Art in STEM learning* can increase student engagement in the project process, creativity, innovation, problem-solving skills, and other cognitive benefits (Liao, 2019). Each *Canva-assisted PjBL-STEAM* learning syntax has facilitated indicators of students' creative thinking abilities, so as to improve and develop students' creative thinking skills.

Student collaboration ability can be analyzed from obtaining collaboration ability scores on each collaboration ability indicator. Rahmawati et al. (2019) explained that there are 5 indicators of collaboration ability including, (1) Active Contribution, (2) Productive performance, (3) Easy to socialize, (4) Responsible, and (5) Respect for others. The five collaboration indicators were measured through observation by observers during 6 meetings (meetings in the learning process to 2, 3, 4, 5, 6, and 7) in experimental and control classes. In the first and eighth meetings, no observations were made because students were carrying out *pretests* and *posttests*, so it was not appropriate to make observations to measure students' collaboration skills. The results of observations of collaboration ability in both experimental and control classes were then accumulated to determine the score on each indicator of collaboration ability. The collaboration capabilities in each indicator are described as follows

Based on the average *N-Gain* results on active contribution indicators, the increase in collaboration ability of students in the experimental class was higher than in the control class. This shows that *Canva's PjBL-STEAM* learning model is more influential for improving students' collaboration skills. In the learning process using *PjBL-STEAM* assisted by *Canva*, students are more active in conveying their ideas, they discuss with each other between groups and after feeling the ideas are appropriate, in experimental classes tend to actively consult the teacher to get comments and suggestions for improvements to their ideas. Students also actively respond to ideas presented by other groups, especially during presentations. This indicator also shows that students in each group actively play an important role in each project implementation in their respective groups. *STEAM* can encourage enthusiasm and increase participation and collaborative involvement of students in learning (Sari et al., 2023).

Based on the average *N-Gain* results on productive performance indicators, the increase in collaboration ability of students in the experimental class was higher than in the control class. This shows that Canva's *PjBL-STEAM* learning model is more influential for improving students' collaboration skills. In the learning process using *PjBL-STEAM* assisted by Canva, students are more focused on working on projects, they and their groups divide tasks with each other to be productive in learning. Therefore, in the experimental class, there are no students who do not work. Each group also tries to complete its project according to the agreed time allocation. The *PjBL-STEAM* learning model tends to encourage productivity in its implementation, this is in line with Rahmawati's statement (2019) which states that *STEAM* increases students' confidence to be productive and encourages them to contribute optimally to learning, increasing curiosity and the ability to be able to design innovative products.

Based on the average *N-Gain* results on the sociability indicator, the increase in collaboration ability of students in the experimental class was higher than in the control class. This shows that Canva's *PjBL-STEAM* learning model is more influential for improving students' collaboration skills. In the learning process using *PjBL-STEAM* assisted by Canva, students communicate well with fellow group members in carrying out project tasks. Learners confidently interact with their group mates in carrying out projects. This *STEAM* integrated project learning process also makes students build trust with each other to achieve a common goal, namely the project product. Collaboration skills can help students socialize with their peers in meaningful learning. Students can actively participate, discuss, work together, and socialize positively to improve collaboration skills and by collaborating can create positive interdependence on each other. This is in line with the statement of (Sarifah & Nurita, 2023; Mansuret *et al.*, 2022) which states that collaboration skills can improve the ability of students in the realm of education and social affairs, with the ability to collaborate with students more adaptive in socializing.

Based on the average *N-Gain* results on the responsible indicator, the increase in collaboration ability of students in the experimental class was higher than in the control class. This shows that Canva's *PjBL-STEAM* learning model is more influential for improving students' collaboration skills. In experimental class students, classically students are already responsible, they complete tasks well in accordance with their responsibilities, students work together in making projects, so that all difficulties are overcome together. Students are very enthusiastic in carrying out the *PjBL-STEAM* learning process. In project-based learning, students play an active role and the learning process is student-centered so as to increase their sense of responsibility for their learning process. The growth of this responsible character is important, it needs to be familiarized and instilled by teachers through the learning process. Being responsible is part of the ability to collaborate on students' social processes to establish good social relationships in the school environment (Aninda *et al.*, 2019; Açıkgöz & Güler, 2021)

Based on the average *N-Gain* results on the indicator of respect for others, the increase in collaboration ability of students in the experimental class was higher than in the control class. This shows that Canva's *PjBL-STEAM* learning model is more influential for improving students' collaboration skills. In the learning process using *PjBL-STEAM* assisted by Canva, students discuss with each other to listen and accommodate ideas from each group member, they are free-chested, respect each other and decide to choose ideas that will make the group better. Learning that develops mutual respect, if carried out continuously will produce students who are able to appreciate those around them so as to create a peaceful atmosphere that supports the smooth running of learning activities.

This ability to collaborate with mutual respect for each other will be useful for the future (Aydede, 2022; Sarah & Witarsa, 2023)

Self-assessment *questionnaires* were used as supporting data in this study on the variable of collaboration ability, to support the results of observations of students' collaboration abilities. The results of the questionnaire showed that students in the experimental class felt that they had maximized in collaborating on the *PjBL-STEAM* project. Classically, students feel that they have been optimal in expressing their ideas and implementing them in project work, they exchange opinions, and feel responsible and help each other in project implementation. The learning of the *PjBL-STEAM* model makes students feel more able to work with their teammates, respect each other if there are differences of opinion, and help each other if colleagues experience difficulties. Students also feel happy to be introduced to Canva media to design projects, because they think Canva media is more attractive, easy to apply, and aesthetic so that it can support their creative ideas. Learners also tend to feel happier with their existence. Both students and teachers are interested in implementing *PjBL-STEAM* for other materials.

Researchers stated that based on the discussion of differences in significance values and the average *N-Gain* of experimental and control classes, it showed that experimental classes treated with *Canva-assisted PjBL-STEAM* learning models had a positive effect and higher increases in improving creative thinking and collaboration skills. This is supported by the research of Parihah *et al.* (2023) which states that project-based learning can improve creative thinking skills. In addition, Awaludin *et al.* (2023) in his research states that project-based learning can improve students' collaboration skills. (Suryaningsih & Nisa, 2021) state that *PjBL* innovation with *STEAM* can foster students' creative thinking skills.

Science learning with the *PjBL-STEAM* learning model, can train students' creative thinking and collaboration skills. This is because every syntax in *PjBL-STEAM* can train students' creative thinking and collaboration skills. In addition, the implementation of *STEAM* in learning is able to improve the ability to think creatively and collaboratively of students as outlined in making projects. The importance of having the ability to think creatively and collaborate because it is a fundamental ability in the 21st century. The existence of *PjBL-STEAM* learning assisted by *Canva* can be an alternative solution for teachers to prepare superior students in the future with creative thinking and supported by good collaboration skills.

Conclusion

Based on the results of research that has been conducted, it can be concluded that the *Canva-assisted PjBL-STEAM* learning model has an effect on increasing students' creative thinking and collaboration skills on energy materials.

The following recommendations can be made based on this study:

1. Project-based learning uses several sharp tools, therefore maximum supervision and assistance should be carried out in project implementation so that students can be careful in working on projects and productive in carrying out projects.
2. The implementation of a project-based learning model requires a realistic long time, assistance and

supervision should be carried out so that students can use time efficiently for project implementation.

3. Further research may be able to test the effectiveness of the PjBL-STEAM learning model in improving creative thinking and collaboration skills in different samples. Qualitative studies or mixed design can be designed to understand the practicality of such techniques. In addition, further research can also develop learning media in the form of modules / ebooks / flipbooks and others that are integrated with the *PjBL-STEAM* learning model. Furthermore, further research can also add Augmented Reality media to the learning process to support 21st century skills.

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