The Influence Of Project Based Learning (Pjbl) For Students Creative Thinking Ability Of Twelfth Grade At Yabhinka Welding Techniques Vocational High School In Cilegon

Helleni Febnesia [1], Atep Iman [2], Deddy Supriyatna [3]
[1] Sultan Ageng Tirtayasa University, Indonesia
[2] Sultan Ageng Tirtayasa University, Indonesia
[3] Sultan Ageng Tirtayasa University, Indonesia

Corresponding Author: Helleni Febnesia,   E-mail; jhopellen@gmail.com,

Article Information:	ABSTRACT
	The purpose of this study is to examine the impact of the Project Based Learning (PjBL) learning model on the creative thinking skills of Twelfth Class Welding Engineering students at Yabhinka Vocational High School in Cilegon. This research employs a quantitative approach and a quasi-experimental methodology. Students of Twelfth Class Welding Engineering at Yabhinka Vocational High School for the academic year 2020/2021 comprised the research sample, with of Twelfth Class Welding Engineering 1 comprising 18 student samples serving as the experimental class and class of Twelfth Class Welding Engineering 2 totaling 18 student samples serving as the control class. The data collection instrument was an essay-based, 10-question test of creative reasoning abilities. Examine the hypothesis using the Paired Sample t Test and Independent Test in this study. The posttest mean is 82.9, the mean observation value is 86.11, and the project mean is 84.14, according to the results of the study conducted in of Twelfth Class Welding Engineering 1, which employs the Project Based Learning (PjBL) learning model. of Twelfth Class Welding Engineering 2 students who did not use the Project Based Learning (PjBL) learning model achieved a posttest mean of 71.7, an observation mean of 74.56, and a project mean of 49.9. The results of hypothesis testing with the Independent t-test statistic show a significant value of 0.000 or less than 0.05, so it can be concluded that the Project Based Learning (PjBL) learning model has an effect on the creative thinking abilities of of Twelfth Class Welding Engineering. **Keywords**: *Creative Thinking Ability,Project Based Learning (PjBL)*

INTRODUCTION

The development of an era that advances science and technology requires innovation from the field of education in order to create and adapt human resources (HR) with quality that can compete in this globalization era. Learning innovations carried out in the 21st century carry the 4C concept, namely communication, collaboration, critical thinking, and creativity. It is hoped that innovation in the field of education in the 21st century will be able to support student learning through good facilities and infrastructure. Learning to train 4C skills places students in the center (Abram & McCloskey, 2022; Ashfahani, A., Haryono, H., & Kustiono, 2020; Yulianti dkk., 2014), makes them interactive, and allows them to learn about reading in the context of their daily lives (Artobatama dkk., 2020). With the demands of competency in the 21st century, students are required to analyze and solve problems.

SMKS Yabhinka Cilegon was founded in 1993. SMKS Yabhinka Cilegon is under the Bhinneka Karya Foundation. SMKS Yabhinka has five expertise programs, one of which is welding engineering (Abdekhoda dkk., 2022; Abram & McCloskey, 2022; Nurullah, 2021). The problem that arose at SMKS Yabhinka was that student learning outcomes experienced a decrease in grades from the 2020–2021 academic year. In the odd semester, welding engineering students had an average final exam score of 74.25; in the even semester, they had a score of 64. And in the academic year 2021–2022, with an average score of 53.11 for the odd semester and 48.73 for the even semester (Abramova, 2023; Adefuye dkk., 2021; Ahmadipour, 2022), During the learning process, it can also be seen from the record of student scores obtained that students are learning from each basic competency as a whole (Ademuyiwa dkk., 2023a; Derebew dkk., 2023). Based on the calculations that have been carried out by the researcher descriptively, it can be seen that there are only six out of twenty-six students in Twelfth Class of Welding Technique 1 who have scores above the Standard Score for Basic Competencies 3.12 and 4.12, while the rest have scores below the Standard Score. Whereas in Basic Competency 3.13 and 4.13, there were only eleven students in Twelfth Class of Welding Engineering 1 who had scores more than Standard Score (Abdulkareem dkk., 2022; Addleman & Lee, 2021; Agustiani dkk., 2019), while the rest had scores less than Standard Score. As for Twelfth Class of Welding Technique 2, there were only four students in Twelfth class of Welding Technique 1 who had grades above the standard score in Basic Competency 3.12 and 4.12, while the rest had grades below the Standard Score. Whereas in Basic Competency 3.13 and 4.13, there were only nine students in Twelfth class of Welding Engineering 2 who had scores more than Standard Score, while the rest had scores less than Standard Score.

Based on initial interviews that have been conducted with one of the productive subject teachers in the welding engineering department, it is known that the learning process has been carried out in accordance with learning procedures in general, namely by applying the lecture method for theoretical learning and the demonstration method for practical learning, but it is still not getting maximum results (Addleman dkk., 2021; Al-Taweel dkk., 2021; Sopandi, 2019). Teachers generally use learning media in the form of videos on YouTube, which are displayed using a projector screen or seen by students on their respective smartphones. The obstacles experienced during the learning process were that when learning theory (Abuhmaid & Abood, 2020; Aguilar, 2018; Fester & Horvath, 2022), students got bored easily and lacked focus in paying attention to the theory being explained (Abramova, 2023; Akyeampong dkk., 2021; Al Ayub Ahmed dkk., 2022), and they were unable to analyze or find solutions related to the material being discussed. in

addition, students also easily experience difficulties participating in learning because there is no discussion to analyze or present related materials or assignments with their peers (Ademuyiwa dkk., 2023b; Almalki dkk., 2020; Alptekin & Temmen, 2020). However, it is different from practical learning; students are more enthusiastic about doing practical learning even though the results are not fully maximized(Ahmadipour, 2022; Ahn, 2020; Akbay & Delibalta, 2020) , and they can convey an analysis of the results of a practicum that is carried out sufficiently even though only a few students can do it (Abramova, 2023; Fülöp dkk., 2022; Georgescu dkk., 2021). This happened because, at the beginning of 2020, namely since the emergence of the COVID-19 pandemic, schools implemented a hybrid learning system. Therefore, most students do not have the ability to think critically and creatively during the learning process.

The process of forming vocational graduates who have the ability to think creatively must be carried out because their presence is so important in life in the era of advanced science and technology (IPTEK) and life in the globalization era, decorated with conditions that are always competitive (Arcoverde dkk., 2022; Ardinengtyas & Himawan, 2021; De Blaquière dkk., 2019), uncertain, and experiencing changes (Panggabean, 2017). Under John Dewey and Francis W, public schools in America used the project-based learning (PjBL) learning model for a long time (Dewey John, 1934). As a learning model, PjBL gives freedom to students in making projects, designing them, calculating them, and applying them to several subjects such as science, art, agriculture, and industry by connecting them to problems in the surrounding environment (Capraro dkk., 2013). It can be seen that PjBL will make students more flexible in their learning activities because they are given the freedom to finish making their products. From this description, the researcher wants to examine the effect of the project-based learning (PjBL) learning model on the ability to think creatively. Researchers want to do more research on the PjBL learning model with the aim of knowing the effect of the Project-Based Learning (PjBL) learning model on the creative thinking abilities of Class XII students of welding techniques at SMKS Yabhinka Cilegon.

RESEARCH METHODOLOGY

This research was conducted at Yabhinka Cilegon Vocational School located in Jombang Wetan, Kec. Jombang, Cilegon City, Banten, postal code 42411 (Ortega-Morán dkk., 2020; Xiaoyan dkk., 2019). Time This research was conducted on 3 - 31 October 2022, Odd Semester of the 2022/2023 Academic Year. This research uses quantitative research methods. Quantitative research has the goal of testing a theory, looking at the interrelationships between variables, and tracking generalizations that have predictable values. This research technique uses a quasi-experimental design (Pseudo-Experiment). The design form used is the nonequivalent control group, which is formed by dividing the samples into two groups, including the control group and the experimental group, which can be seen in Table 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment	O_1	X1	O2
Control	O3	X2	O4

Information:
O_1 = Pre-test results from the experimental class

O_2 = Post-test results from the experimental class
O_3 = Pre-test results from the control class
O_4 = Post-test results of the control class
X1 = Treatment distributed using the Project Based Learning (PjBL) learning model
X2 = Treatment distributed using the lecture method and demonstration method

Descriptive statistical techniques are used to describe how students' interest activities are after being given treatment in the form of a project based learning learning model. Analysis of student interest data by calculating the percentage of student activity in learning for each category. The percentage calculation is obtained by adding up the cognitive and psychomotor scores. Then the value is converted into a percentage rating on Table 2.

Table 2.Assessment criteria

Percentage	Criteria
81-100	Very good
61-80	Well
41-60	Enough
21-40	Not enough
0-20	Very less

Source: (Arikunto, 2006)

The normality test was used to test whether the data from the study were obtained from a normally distributed population or not, in this study the normality test used SPSS version 24.0.This homogeneity test is to find out whether the variance between the experimental class and the control class is the same or different. This test is carried out to prove whether the established hypothesis is accepted or rejected. The analysis is carried out using the t test formula, the t test formula aims to see the effect between learning using project-based learning models and conventional learning. The statistical analysis used in this study is statistical analysis. t-test.

The population in this study included all students in class XII welding techniques at SMKS Yabhinka Cilegon for the 2022/2023 academic year, a total of 47 students. For the sample, the determination of the sample was carried out using a non-probability sampling technique and the total sample used was 36 people with an average age of 17-18 years. In practice the class was divided into two groups, namely there was a control group totaling 18 students and there were 18 students in the experimental group.

RESULT AND DISCUSSION
Results
1. Description of Respondent Characteristic Data
Class XII Las 1 (with 24 students) served as the experimental group for this study, whereas class XII Las 2 (with 23 students) served as the comparison group during the 2022/2023 school year. Eighteen students from the entire class of XII Las 1 served as the study's experimental class, and eighteen students from the entire class of XII Las 2 served as the study's control class. The importance of students' ability to think creatively was measured using data from a study done on welding materials for 5F position angle joints.

2. Description of Creative Thinking Ability Data
Description of Pretest and Posttest Data Results of Experimental Class and Control Class

To find out whether the use of the Project Based Learning learning model is effective for the creative thinking abilities of class XII Las 1 students, it can be seen in the pretest and posttest results of students inTable 3.

Table 3. Statistical value data from the pretest results of the experimental class

Statistical Testing	Experimental Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Total Sample	18	18	18	18
Minimum	40	76	50	69
Maximum	79	90	76	76
Means	60	82.9	61,77	71.7
Median	58	81.5	61	71.5
Range	39	14	26	7
Standard Deviation	11.71	4.55	6,44	1.98

Source: (Primary data processed, 2022)

Statistics for a sample size of 18 students on a pretest show a mean score of 60, a median of 58, a range of 39, a maximum score of 79, a minimum score of 40, and a standard deviation of 11.71. Among the 18 students in the control group, the mean pretest score was 61.77; the median score was 61; the highest score was 76; the lowest score was 50; the range was 26; and the standard deviation was 6.44. If you look at the data above, it can be determined that these two classes have pretest scores that are still below the KKM (<75), which suggests they have not been finished. Finally, we get to the post-test significance level. There were 18 students in the experimental class, with a range of 14 and a standard deviation of 4.55. The mean score was 82.9, the median score was 81.5, the highest score was 90, and the lowest score was 76. Whereas in the control class with a total sample of 18 students obtained a mean value of 71.7, the median median value was obtained, namely 71.5, the highest value was obtained, namely 76, the lowest value was obtained, namely 69, the range (range) was obtained, namely 7, and the standard deviation was obtained, namely 1.98. Post-test results show that students in the experimental group performed significantly better after being exposed to a project-based learning model than their counterparts in the control group, who were either not exposed to the model at all or were using a lecture-based approach.

Table 4. Percentage of Pretest and Posttest Average Scores of Students' Creative Thinking Ability on Each Indicator in the Experiment Class and Control Class

Indicators	Experimental Class		Control Class	
	Pretest (%)	posttest (%)	Pretest (%)	posttest (%)
Fluency	66	67	58,8	49
Flexibility	59	75	67	65
Originality	52.5	71	58.5	64
Elaboration	50	66	49	62
Evaluation	47	64	46.5	58

Source: (Primary data processed, 2022)

From the data in table 4, it is clear that the experimental group scored 66% on the pretest's measure of creative fluency in terms of their ability to think quickly and easily. With a score of 59%, the Flexibility indicator, also known as flexible thinking skills, falls into a very original range. 52.5% of people are quite creative, indicating that they are capable of innovative thought. Ability to elaborate or consider in great detail, with a creative rating of 50% or more. The final section of the test is dedicated to gauging the candidate's ability to evaluate and think critically; this section scores 47%, placing the candidate in the quite creative category. In contrast, students in the control group scored 58.8% on the pretest and were classified as fairly creative when asked to demonstrate their facility with the "Fluency indicator," or the ability to think quickly and effectively. Indicator of cognitive flexibility or the ability to think creatively in a variety of contexts; now at a 67% clip. In terms of creativity, 58.5% of the population has a high degree of originality or the ability to think in novel ways. Skills in elaboration or detailed thinking, with 49% scoring in the quite creative range. Finally, a 46.5% evaluation of thinking talents places you in the very creative range. After implementing the project-based learning model, the post-test scores of the experimental class improved, particularly in terms of the Fluency indicator or fluent thinking skills, with 67% of students scoring above average in this area. Indicator of mental flexibility or the ability to think creatively with a 75% score. Origanility or original thinking talents with a percentage of 71% in the creative area. Capacity for elaborate or complex thought, accounting for 66% of all creative thinking. Last but not least, the evaluation or thinking skills assessment scores 64%, which places it in the inventive range.

Description of Observation Assessment Data, Projects and Feedback in the Experimental Class

Table 5. Statistical Value Data from Observation Results, Projects and Feedback in the Experimental Class

Statistical Testing	Observation	Project	feedback
Total Sample	18	18	18
Minimum	83	80	79
Maximum	89	87	84
Means	86,11	84,14	82.06
Median	86	84	82
Range	6	7,5	5
Standard Deviation	1.74	2,22	1.35

Source: (Primary data processed, 2022)

Based on the table, it can be seen that both from the assessment of observations, projects and feedback this experimental class has a high average value. This indicates that the project-based teacher learning model affects students' creative thinking abilities.

3. Normality Test

The normality test is carried out to test whether all variables are normally distributed or not. This test uses the Kolmogorov-Smirnov formula. The significance level for this test is if it is significant more than 0.05 then the data is considered normal and if it is less than 0.05 it can be said that the data is not normal. The test results can be seen inTable 5.

Table 6. Results of Normality Test for Experimental Class and Control Class

Tests of Normality

	kelas	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
hasil	Pretest Eksperimen	.125	18	.200*	.948	18	.402
	Posttest Eksperimen	.185	18	.103	.922	18	.142
	Pretest Kontrol	.145	18	.200*	.930	18	.194
	Posttest Kontrol	.152	18	.200*	.941	18	.302

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Source: (Primary data processed, 2022)

The results of the normality test showed that the calculated significance values for the pretest of the experimental class and the control class using the project-based learning model were 0.402 and 0.194 (greater than 0.05) and the values for the posttest were 0.142 and 0.302, which means greater than 0.05. So that it can be concluded that the pretest and posttest data for the experimental class and control class using the project-based learning model have data that are normally distributed.

4. Homogeneity Test

After knowing the level of normality of the data, then the homogeneity test is carried out. This test was carried out to determine the level of similarity of variance between the 2 groups, namely the experiment and control. As for this test, the significance value on Levene's statistic must be greater than 0.05 and then it is categorized as homogeneous. The homogeneity test results can be seen in Table 6.

Table 7. Results of Homogeneity Test of Experimental Class and Control Class

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Kemampuan Berpikir Krearif	Based on Mean	23.194	1	34	.100
	Based on Median	12.312	1	34	.091
	Based on Median and with adjusted df	12.312	1	22.540	.002
	Based on trimmed mean	23.114	1	34	.000

Source: (Primary data processed, 2022)

The results of the homogeneity test for the research variables obtained a significance value of 0.100, so it can be seen that the data in this study have variances that are the same or homogeneous because the significance value is > 0.05.

5. Hypothesis Test

Paired sample t test The t test was carried out to find out the difference in the means of the two paired samples. The requirements in the paired sample t test are that the data must be normal. The paired sample t test in this study was carried out to answer the formulation of the problem, namely "Is there a difference in the creative thinking abilities of Class XII students of Welding Engineering SMKS Yabhinka Cilegon using the Project

Based Learning (PjBL) learning model?". To answer the formulation of the problem, a paired sample t test was carried out on the experimental class pretest data with the experimental class posttest. Then the control class pretest data with the control class posttest data.

Table 8.Paired Sample t Test Results

Paired Samples Test

| | | Paired Differences | | | | | | | |
| | | | | | 95% Confidence Interval of the Difference | | | | |
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest Eksperimen - Posttest Eksperimen	-22.94444	11.51711	2.71461	-28.67177	-17.21712	-8.452	17	.000
Pair 2	Pretest Kontrol - Posttest Kontrol	-10.00000	7.12081	1.67839	-13.54109	-6.45891	-5.958	17	.000

Based on the results of pair 1, it obtained a significance value of 0.00, which means it is smaller than 0.05, so it can be concluded that there is a mean difference in students' creative thinking abilities for*pretest*experimental class with posttest experimental class. Furthermore, for the output pair 2, namely in the control class, the value of Sig. (2-tailed) of 0.000 <0.005, it can be concluded that there is a difference in the mean creative thinking ability of students for the pretest and posttest control class.

Table 9.Independent Test Test Results

Independent Samples Test

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| | | | | | | | | | 95% Confidence Interval of the Difference | |
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hasil2	Equal variances assumed	23.194	.000	9.531	34	.000	11.16667	1.17164	8.78562	13.54772
	Equal variances not assumed			9.531	23.239	.000	11.16667	1.17164	8.74433	13.58900

Source: (Primary data processed, 2022)

Based on the results of the independent sample t-test, the sig. (2 tailed) of 0.000 <0.05. This means that there are differences in the creative thinking abilities of students of Class XII Welding Engineering SMKS Yabhinka Cilegon by using a project-based learning model.

Discussion

This study found that prior to implementing the project-based learning learning model, students' levels of creative thinking in Class XII Welding Engineering at SMKS Yabhinka Cilegon averaged 60 for the experimental class and 61.7 for the control class, both of which remained below the KKM (75). The post-test scores of the experimental group averaged 82.9, while the control group averaged 71.7. These data reveal that in the experimental class the average score of all students is over the KKM (<75) while the control class is still below the KKM. This indicates that students' ability to think creatively has been influenced by the implementation of project-based learning approaches in the experimental class. Due to the PBL model's incorporation of experimental group learning's stages, students are able to take an active role in the process of solving real-world problems in their environments; furthermore, the model can encourage students' curiosity and make them more eager to learn, both of which have a positive impact on their ability to think creatively and achieve their academic goals. Whereas in courses that do not employ this learning model it will have a minimal effect since during learning the students are less engaged and likely to be tired because the lecture approach is used which makes students bored to listen. Syarif Sumantri (2015)

revealed that problem-based learning (PBL) can be seen as a sequence of educational activities that places an emphasis on the scientific method. Instead of helping teachers give students as much information as possible, PBL is made to assist them learn how to think critically and creatively for themselves.

There are a variety of indicators for each of the five components of creative thinking that go into evaluating a student's aptitude for the skill: fluency (or speed of thought), flexibility (or variety of thought), originality (or depth of thought), elaboration (or breadth of thought), and evaluation (or depth of thought). observed as follows:

1. The aspect of fluency or the ability to think smoothly

There are four indicators that make up this component, and they all point to the fact that you'll be able to spot mistakes in items quickly, come up with new ideas easily while you work on your projects, and finish those projects on schedule and in good shape. Percentage-wise, students in the experimental class scored 77.25% on the fluency indicator, placing them in the good category, while the average value for the experimental class was 86.11, placing them in the above KKM category (>75). The average score from responses was 82.06. If we take a look at the mean value of pupils, we can see that this has gone up, but in reality not all measures of creative problem solving have gone up. Because of numerous issues that have an impact on kids' creative thinking abilities, this value is low in comparison to others. Students either don't pay attention while the teacher explains the project, or they waste time trying to rush through it since they don't have enough time to think of creative solutions.

Further, as is evident from students' responses during the posttest, students' ability to think fluently did not improve; only 10 of 18 students provided comprehensive and clear answers to the teacher's essay questions about welding material in the 5F corner joints. These findings demonstrate that not all students have the ability to generate possible solutions to problems and to generate alternatives to those solutions in accordance with stated learning objectives. The solution to this issue is for the teacher to encourage the students to provide other answers outside gaining fluency, as well as to set aside extra time for the content that employs a project-based learning methodology. The instructor uses questioning as a means of fostering fluency (Putri dkk., 2021)

2. Aspects of Flexibility or the ability to think flexibly

From an observational standpoint, students receive a good score of 77.75% in this area. The four indicators that students have met reveal these outcomes, most notably the students' capacity to come up with different ideas or questions for each project assignment. Second, students have multiple lenses through which they might examine a challenge inherent in each project assignment. Third, there is flexibility in how students approach each project. As a fourth benefit, students have the opportunity to offer original responses to each project brief.

The average value of the pupils in the experimental class was 86.11, which placed them in the above KKM group (75), and a score of 77.75% on the flexibility indicator placed them in the good category. The average score from responses was 82.06. A total of 70.25 percent is calculated based on the indicators' percentage scores for the adaptability factor. This number indicates an improvement in creative problem solving as a result of employing the project-based learning approach. Research confirmed that students were able to propose a wide range of options for completing their upcoming tasks. In agreement with the view expressed by (Noor & Asiskawati, 2015), which states

that indications of flexibility in creative thinking are linked to the amount of ideas students can propose and that these replies must change. According to the data gathered, only 13 of the 18 students who participated in the exercise provided a thorough and coherent analysis of the steps used to prepare for and carry out the welding of the 5F corner joint. The findings of this study are consistent with those of (Liliawati, 2011), which found that students' ability to think creatively was boosted when they were given more leeway in how they approached a specific assignment. According to the data gathered, only 13 of the 18 students who participated in the exercise provided a thorough and coherent analysis of the steps used to prepare for and carry out the welding of the 5F corner joint. The findings of this study are consistent with those of (Liliawati, 2011), which found that students' ability to think creatively was boosted when they were given more leeway in how they approached a specific assignment. According to the data gathered, only 13 of the 18 students who participated in the exercise provided a thorough and coherent analysis of the steps used to prepare for and carry out the welding of the 5F corner joint. The findings of this study are consistent with those of (Liliawati, 2011), which found that students' ability to think creatively was boosted when they were given more leeway in how they approached a specific assignment.

3. Aspects of originality or original thinking skills

This aspect has four indicators, namely thinking about unusual ways of completing each project task, making unusual combinations related to each project task, enriching and developing an idea or product related to each project task and adding details of an object. related. Based on the observations, it was obtained that the average score of the experimental class students in this aspect was 86.11, this value was included in the above KKM category (<75) and for the percentage score on the originality indicator, a score of 77.25% was included in the good category. . In the feedback results obtained a mean of 82.06. Based on the percentage score per indicator for the originality aspect, the percentage is 70.50%.

Even though they are in a good category, students are not yet very capable of developing a pre-existing product, the products made by students are almost the same as pre-existing products. This was also shown from the answers to essay questions about different ideas from other students regarding the solutions given in the 5F position angle joint welding material that 13 out of 18 students answered completely and clearly but were less relevant. This is in line with research that has been conducted by (Luthvitasari dkk., 2012) concluded in his research that this is possible because the ability of students to imagine and also innovate to create something new is still weak. The development of the originality aspect is closely related to the fluency and flexibility aspects.

4. Aspects of elaboration or detailing thinking skills

This aspect has four indicators, namely interpreting problems in the surrounding environment in accordance with project assignments, making new understandings regarding problems in the surrounding environment, taking new steps to carry out project tasks in detail and taking new steps to carry out project tasks in small quantities. Based on the observation results, the average value of the experimental class students in this aspect was 86.11, this value was included in the above KKM category (<75) and the percentage score on the elaboration indicator obtained a value of 78.25% which was included in the good category . In the feedback results obtained a mean of 82.06. Based

on the percentage score per indicator for the elaboration aspect, it obtained a percentage of 78.25%.

These results can also be seen from the students' answers to the essay questions in a complete and clear manner, besides that during the project the students did not experience any problems in elaborating an idea or describing in detail an experiment to make a product resulting from welding a 5F angle joint. In addition, students can also give ideas for projects made by other friends. This skill can be identified from the way students answer a question in detail and can expand an idea (Febrianti et al., 2016).

5. Aspects of evaluation or assessing thinking skills

This aspect has four indicators, namely providing unique responses related to problems in the surrounding environment, responding to problems in the surrounding environment, considering new solutions related to problems in the surrounding environment and having solutions that are commonly used to overcome problems in the surrounding environment. Based on the observation results, the average score of the experimental class students in this aspect was 86.11, this value was included in the category above the KKM (<75) and the percentage score on the indicator evaluation obtained a value of 77% which was included in the good category. In the feedback results obtained a mean of 82.06. Based on the percentage score per indicator for the evaluation aspect, it obtains a percentage of 80%.

During the research, in this aspect students have been able to determine the truth of the questions given by the teacher and make plans to solve problems that occur in projects that are made. In addition, students are also able to give ideas to solve problems correctly. Based on the results of observations of 14 out of 18 students, they were able to give opinions regarding the results of the products that their friends wanted to make completely and clearly. This shows that students are able to make an assessment of the product they want to make and the reasons for making the product. The results of this assessment will be used to carry out evaluations whose results can be in the form of pass or fail status, classification needs or does not need improvement, or a certain level.

Hypothesis testing using the (Yhoky dkk., 2018)paired sample t test and the independent sample t-test yields a significance level of 0.000 (higher than 0.05). via an approach centered on working on actual projects. This study's findings corroborate those of (Yulianti dkk., 2014), who found that using a project-based learning approach significantly improved students' capacity for higher-level reasoning. More results from(Yulianti dkk., 2014) shows that the project-based learning model has a substantial effect on the ability to think at a higher level in the material temperature and heat. This study's findings are consistent with the literature. According to findings from a study conducted by (Amin, 2019), the project-based learning model significantly increases students' capacity for original thought. This is seen based on the results of descriptive and inferential analysis which reveal that there is an influence of the project-based learning approach on students' creative thinking abilities. The results of the study (Irwanto, 2020) suggest that learning outcomes and students' capacities enhance by implementing the PJBL approach.

Project-based learning methods, according to the literature (Sopandi, 2019), can help students develop higher-order thinking and problem-solving abilities(Assaf, 2018). Project-based learning strategies have been found to significantly improve students' ability to engage in higher-order thinking(Anazifa & Hadi, 2016). That's because problem-raising, planning, scheduling, monitoring, assessing, and reflecting on project

activities all play a role in the project-based learning approach(Ashfahani, A., Haryono, H., & Kustiono, 2020). In the action phase of this project-based learning strategy, students have been provided a stimulus to optimize their existing higher-order thinking skills.

CONCLUSION

Based on the results and discussion described above, it can be concluded that based on the research results, the test scores for students' creative thinking abilities in class XII Las 1 by applying the Project Based Learning (PjBL) learning model, namely a posttest score of 82.9, observation is 86.11 and the value of the project is 84.14. Whereas class XII Las 2 who did not apply the Project Based Learning (PjBL) learning model obtained a posttest score of 71.7, an observation of 74.56 and a project of 49.83. The results of hypothesis testing with the Independent t-test statistic showed a significant value of 0.000 or less than 0.05 so that it could be concluded that from the results of the pottest, observation.

ACKNOWLEDGEMENT

REFERENCES

Abdekhoda, M., Dehnad, A., & Zarei, J. (2022). Factors influencing adoption of e-learning in healthcare: Integration of UTAUT and TTF model. *BMC Medical Informatics and Decision Making*, *22*(1), 327. https://doi.org/10.1186/s12911-022-02060-9

Abdulkareem, Z. O., Abdulkareem, S. A., & Mustapha, I. B. (2022). Engineering Students' Perception of Online Learning During the Emergency Nationwide Lockdown in Nigeria. *SN Computer Science*, *3*(4), 288. https://doi.org/10.1007/s42979-022-01196-9

Abram, K. J., & McCloskey, D. (2022). A Comprehensive Evaluation of Metabolomics Data Preprocessing Methods for Deep Learning. *Metabolites*, *12*(3), 202. https://doi.org/10.3390/metabo12030202

Abramova, T. A. (2023). The Historian of Everyday Life and Household Activities, Organizer of Science and University Education: On the 85th Anniversary of V. A. Balashov. *Economic History*, *18*(4), 352–363. https://doi.org/10.15507/2409-630x.059.018.202204.352-363

Abuhmaid, A., & Abood, M. (2020). The impact of flipped learning on procrastination and students' attitudes toward it. *Universal Journal of Educational Research*, *8*(2), 566–573. Scopus. https://doi.org/10.13189/ujer.2020.080228

Addleman, D. A., & Lee, V. G. (2021). Simulated central vision loss does not impair implicit location probability learning when participants search through simple displays. *Attention, Perception, & Psychophysics*, *84*(6), 1901–1912. https://doi.org/10.3758/s13414-021-02416-9

Addleman, D. A., Legge, G. E., & Jiang, Y. V. (2021). Simulated central vision loss impairs implicit location probability learning. *Cortex*, *138*, 241–252. https://doi.org/10.1016/j.cortex.2021.02.009

Adefuye, A. O., Adeola, H. A., & Busari, J. (2021). The COVID-19 pandemic: The benefits and challenges it presents for medical education in Africa. *The Pan African Medical Journal*, *40*, 42. https://doi.org/10.11604/pamj.2021.40.42.28489

Ademuyiwa, I. Y., Ayamolowo, S. J., Oshinyemi, T. E., & Oyeku, K. J. (2023a). Knowledge and attitude of sex education among secondary school students in south-western Nigeria: A cross-sectional study. *Dialogues in Health*, *2*, 100085. https://doi.org/10.1016/j.dialog.2022.100085

Ademuyiwa, I. Y., Ayamolowo, S. J., Oshinyemi, T. E., & Oyeku, K. J. (2023b). Knowledge and attitude of sex education among secondary school students in south-western Nigeria: A cross-sectional study. *Dialogues in Health*, *2*, 100085. https://doi.org/10.1016/j.dialog.2022.100085

Aguilar, J. (2018). Exemplar variability facilitates retention of word learning by children with specific language impairment. *Language, Speech, and Hearing Services in Schools*, *49*(1), 72–84. https://doi.org/10.1044/2017_LSHSS-17-0031

Agustiani, M., Ningsih, S., & Muris, A. A. (2019). RESPON MAHASISWA TERHADAP PEMBELAJARAN BAHASA INGGRIS BERBASIS BLENDED LEARNING MELALUI EDMODO DI UNIVERSITAS BATURAJA. *PEDAGOGIA*, *17*(2), 108–119. https://doi.org/10.17509/pdgia.v17i2.18528

Ahmadipour, H. (2022). Online learning self-efficacy: A necessity for virtual education. *Journal of Education and Health Promotion*, *11*, 113. https://doi.org/10.4103/jehp.jehp_848_21

Ahn, M. Y. (2020). Four domains of students' sense of belonging to university. *Studies in Higher Education*, *45*(3), 622–634. https://doi.org/10.1080/03075079.2018.1564902

Akbay, S. E., & Delibalta, A. (2020). Academic risk taking behavior in university students: Academic procrastination, academic locus of control, and academic perfectionism. *Eurasian Journal of Educational Research*, *2020*(89), 159–178. Scopus. https://doi.org/10.14689/ejer.2020.89.8

Akyeampong, K., Carter, E., Rose, P., Ryan, J., Sabates, R., & Stern, J. M. B. (2021). The effects of language preference and home resources on foundational literacy retention during school holiday closures in Ghana: Lessons from the Complementary Basic Education Programme. *PROSPECTS*, *52*(1–2), 115–136. https://doi.org/10.1007/s11125-021-09590-6

Al Ayub Ahmed, A., Hassan, I., Pallathadka, H., Keezhatta, M. S., Haryadi, R. N., Al Mashhadani, Z. I., Attwan, L. Y., & Rohi, A. (2022). MALL and EFL Learners' Speaking: Impacts of Duolingo and WhatsApp Applications on Speaking Accuracy and Fluency. *Education Research International*, *2022*. Scopus. https://doi.org/10.1155/2022/6716474

Almalki, K., Alharbi, O., Al-Ahmadi, W., & Aljohani, M. (2020). Anti-procrastination online tool for graduate students based on the pomodoro technique. Dalam Zaphiris P., Ioannou A., & Ioannou A. (Ed.), *Lect. Notes Comput. Sci.: Vol. 12206 LNCS* (hlm. 133–144). Springer; Scopus. https://doi.org/10.1007/978-3-030-50506-6_10

Alptekin, M., & Temmen, K. (2020). Gamification in an Augmented Reality Based Virtual Preparation Laboratory Training. Dalam Tsiatsos T. & Auer M.E., *Adv. Intell. Sys. Comput.* (Vol. 916, hlm. 578). Springer Verlag; Scopus. https://doi.org/10.1007/978-3-030-11932-4_54

Al-Taweel, F. B., Abdulkareem, A. A., Gul, S. S., & Alshami, M. L. (2021). Evaluation of technology-based learning by dental students during the pandemic outbreak of coronavirus disease 2019. *European Journal of Dental Education*, *25*(1), 183–190. https://doi.org/10.1111/eje.12589

Amin, M. (2019). Penerapan Model Project Based Learning untuk Meningkatkan Hasil Belajar Siswa di SMK Negeri 1 Bireun pada Materi Teknik Pengelasan Busur Manual. *Jurnal Pendidikan, Sains, dan Humaniora*, *7*(4), 503–511.

Anazifa, R. D., & Hadi, R. F. (2016). *Pendidikan Lingkungan Hidup Melalui Pembelajaran Berbasis Proyek (Project- Based Learning) Dalam Pembelajaran Biologi*. 453–462.

Arcoverde, Â. R. dos R., Boruchovitch, E., Góes, N. M., & Acee, T. W. (2022). Self-regulated learning of Natural Sciences and Mathematics future teachers: Learning strategies, self-efficacy, and socio-demographic factors. *Psicologia: Reflexão e Crítica*, *35*(1), 1. https://doi.org/10.1186/s41155-021-00203-x

Ardinengtyas, A., & Himawan, A. N. (2021). Enhancing ELT Classroom Using Moodle E-Learning During the Pandemic: Students' and Teachers' Voices. *IJEE (Indonesian Journal of English Education)*, *1*(1), 24–39. https://doi.org/10.15408/ijee.v1i1.20220

Arikunto, S. (2006). *Metode Penelitian Kualitatif*. Bumi Aksara.

Artobatama, I., Hamdu, G., & Giyartini, R. (2020). Analisis Desain Pembelajaran STEM berdasarkan Kemampuan 4C di SD. *Indonesia Journal of Primary Education*, *4*(1), 76–86. https://ejournal.upi.edu/index.php/IJPE/article/view/24530/12110

Ashfahani, A., Haryono, H., & Kustiono, K. (2020). The Effectiveness of Project Based Learning and Discovery Learning with Modul to Improve Learning Outcome for AutoCAD Subject. *nnovative Journal of Curriculum and Educational Technology*, *9*(2), 72–77.

Assaf, D. (2018). *Motivating Languange Learners during Times of Crisis through Project-Based Learning: Filming Activities at The Arab International University, Theory and Practice in Languange Studies*.

Capraro, R. M., Capraro, M. M., & Morgan, J. R. (2013). *STEM Project-Based-Learning (An Intergrated Science, Technology, Engineering, and Mathematics (STEM) Approach)*.

De Blaquière, G., Nolan, J. E., & Wray, K. (2019). Joining up the dots: Telling the story of skills. How can students in Higher Education be supported to better understand and articulate their employability? *Journal of Teaching and Learning for Graduate Employability*, *10*(2), 15–35. https://doi.org/10.21153/jtlge2019vol10no2art699

Derebew, B., Mola, M., Kalyankar, V. B., Padwal, N. D., Chauhan, N. M., Humbe, A. S., & Hajare, S. T. (2023). Determination of knowledge, attitude and practice of voluntary counseling testing on HIV among youths from Tepi Town, Ethiopia. *PEC Innovation*, *2*, 100102. https://doi.org/10.1016/j.pecinn.2022.100102

Dewey John. (1934). Comments and criticsm by some educational leaders in our universities. *IL : Public School Publishing Company*, *Part II*(The Thirty-third yearbook of the National Society for the Study Education), 77–103.

Fester, A., & Horvath, G. (2022). Instant messaging and the facilitation of collaborative, student-led learning and teacher-support: The NZCEL EAP scenario. *TESOL Journal*, *13*(4). https://doi.org/10.1002/tesj.691

Fülöp, M. T., Breaz, T. O., He, X., Ionescu, C. A., Cordoş, G. S., & Stanescu, S. G. (2022). The role of universities' sustainability, teachers' wellbeing, and attitudes toward e-learning during COVID-19. *Frontiers in Public Health*, *10*, 981593. https://doi.org/10.3389/fpubh.2022.981593

Georgescu, M.-I., Duţă, G.-E., & Ionescu, R. T. (2021). Teacher–student training and triplet loss to reduce the effect of drastic face occlusion. *Machine Vision and Applications*, *33*(1), 12. https://doi.org/10.1007/s00138-021-01270-x

Irwanto, I. (2020). Model pembelajaran pendidikan vokasional yang efektif di era revolusi industri 4.0. *Taman Vokasi*, *8*(1), 58. https://doi.org/10.30738/jtv.v8i1.7265

Noor, F., & Asiskawati, E. (2015). Kemampuan Berpikir Kreatif Siswa Dalam Pembelajaran Matematika Menggunakan Pendekatan Pendidikan Matematika Realistik di SMP. *EDU-MAT Jurnal Pendidikan Matematika*, *3*(2).

Nurullah, M. (2021). Efektivitas Pemanfaatan Model Pembelajaran Project Based Learning Di Sman 10 Banjarmasin. *JPG (Jurnal Pendidikan Geografi)*, *8*(1), 37–42. https://doi.org/10.20527/jpg.v8i1.11599

Ortega-Morán, J.-F., Pagador, B., Maestre-Antequera, J., Arco, A., Monteiro, F., & Sánchez-Margallo, F. M. (2020). Validation of the online theoretical module of a minimally invasive surgery blended learning course for nurses: A quantitative research study. *Nurse Education Today*, *89*, 104406. https://doi.org/10.1016/j.nedt.2020.104406

Sopandi, M. (2019). Penerapan Model Pembelajaran Project Based Learning (Pbl) Pada Mata Pelajaran Pemrograman Desktop Untuk Meningkatkan Hasil Belajar Peserta Didik Kelas Xi Rpl B Smk Negeri 2 Karanganyar. *Jurnal Ilmiah Pendidikan Teknik dan Kejuruan*, *11*(2), 59. https://doi.org/10.20961/jiptek.v11i2.24218

Xiaoyan, G., Qian, L., Zhigang, W., JianPing, L., & Dengsheng, W. (2019). Multi-agent nomadic routes network planning considering grassland-livestock balance. *7th International Conference on Information Technology and Quantitative Management (ITQM 2019): Information technology and quantitative management based on Artificial Intelligence*, *162*, 704–711. https://doi.org/10.1016/j.procs.2019.12.041