International Journal Publishing
INFLUENCE: International Journal of Science Review
Volume 5, No. 2, 2023
https://influence-journal.com/index.php/influence/index

Application of the Project Based Learning (PjBL) Model through Making Tempe to Improve Student Learning Outcomes and Creativity

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Academic Editor: Nguyen Ngoc Anh

Abstract. The aim of the research is to examine implementation, increase in learning outcomes, student creativity and student responses to Project Based Learning (PjBL) learning in making tempe. This type of research is quasi-experimental, with a non-equivalent control group design. The population of this study were all 9th grade students of SMP Darussalam Cimanggu and the samples were taken from two classes using the saturated sample technique. The experimental class was given the PjBL model treatment and the control class was treated with a scientific approach. The instruments used were observation sheets, cognitive learning outcomes tests, and student response questionnaires. The results showed that the implementation of the PjBL model was well implemented, marked by the implementation of the PjBL model by teachers, with an average of 91.6% in the very good category. The achievement of the experimental class in learning outcomes and student creativity was better based on the significance hypothesis test 0.031 < 0.05, the initial hypothesis was rejected indicating that there were differences in student learning outcomes and creativity. The learning process of implementing PjBL through making tempe shows > 80% of students responding positively to having an impact on creativity and student learning outcomes increasing because learning is more creative, innovative, and fun so that learning is in favor of students.

***Keywords**: Project-Based Learning Model (PjBL), Learning Outcomes, Student Creativity.*

A. INTRODUCTION

The science learning activities in the 2013 curriculum were designed to investigate and empower students' potentials into anticipated competencies. Students feel bored and disinterested since most schools, including the one I looked at, have not fully maximized and supported innovative learning. Lack of development of the pupils' prospective interests and skills can result in less than ideal learning outcomes. After performing a preliminary survey with a number of pupils in the school, it was discovered that they frequently felt bored and uninterested when learning when teachers employed the lecture technique, particularly in scientific sessions. This is seen in the limited development of student creativity as a result of low motivation and boring teaching techniques in which teachers only lecture students on the content.. Students still seldom engage in practical tasks, which results in inadequate learning outcomes and student innovation in science education. For instance, teachers may only teach subjects like biotechnology for human existence through lectures or homework, such as creating notes about food fermentation or memorizing the use of bacteria without putting them to use in actual experiments. There are actually numerous ways for pupils to learn about these subjects, and teachers can design more interesting courses to promote active learning, skill development, attentive observation, responsibility, and motivation, which will eventually result in the birth of creativity.

The aforementioned problems must be resolved right away. Effective learning process management requires teachers to use cutting-edge instructional design while looking for models or approaches that fit with the lessons being taught. The absence of practical activities for students to participate in, which inhibits their inventiveness and enthusiasm in producing items utilizing biotechnological processes, such as generating tempeh using microorganisms, is one of the obstacles associated with biotechnology. However, because the area where the school is located is largely agricultural, students can use a lot of soybeans to make tempeh there. Based on these concerns, teachers should design a learning activity that inspires students to come up with ideas and find solutions. Project-Based Learning (PjBL) is one of the educational strategies that can develop students' problem-solving skills. The author is encouraged to carry out additional research on "Implementation of Project-Based Learning (PjBL) Model through Tempe Making to Enhance Learning Outcomes and Creativity of 9th Grade Students at SMP Darussalam Cimanggu" in light of the issue's historical context.

The definition of the study problem is how the Project-Based Learning (PjBL) model may improve students' cognitive learning results, student creativity, and how students react to the learning process in biotechnology courses. The goals of this study are to evaluate students' responses to the implementation of the Project-Based Learning (PjBL) model through tempe making among ninth-graders at SMP Darussalam Cimanggu, to examine the application of the Project-Based Learning (PjBL) model through tempe making in improving students' cognitive learning outcomes and student creativity.

The aforementioned claims can be supported by earlier studies. One benefit of project-based learning (PjBL), for instance, is that it fosters student creativity (Sumarni, 2015). According to Pujiriyanto (2016), project-based learning (PjBL) is more effective than traditional teaching strategies at fostering creativity. The results of student learning varied significantly between experimental and control classes, according to Triani (2015), with the experimental class adopting the project-based learning paradigm achieving better results.

B. LITERATURE REVIEW

1. Project-Based Learning Model

According to Joyce & Weil (1980), a learning model is a plan or pattern that can be used to shape the curriculum (long-term instructional plan), design learning materials, and guide classroom or other forms of learning. A learning model is a method or approach used by educators to deliver instructional material. A project serves as the focal point of the classroom in the project-based learning methodology (Thomas, 2000). Project-Based Learning (PjBL), according to the NYC Department of Education (2009), is a project-based learning technique where students create their own subject-matter knowledge and exhibit new understanding through a variety of representations.

Project-Based Learning (PjBL) is not a label that can be applied to all active learning activities that involve projects. A learning strategy must satisfy a number of requirements to qualify as project-based learning (PjBL). Centrality, driving questions, constructivist investigation, autonomy, and realism are the five requirements for a learning strategy to be deemed Project-Based Learning (PjBL). (Thomas, 2000; Kemdikbud, 2014).

The George Lucas Education Foundation and Dopplet, two specialists, created the stages of PBL. According Kemdikbud (2014) the syntax of project-based learning includes: identifying key questions, designing the project, and evaluating the project. Making a schedule, tracking the progress of the project and the students, evaluating the results, assessing the experience.

2. Cognitive Learning Outcomes

As defined through evaluation instruments expressed as letters, words, or symbols and referred to as achievement, cognitive learning outcomes are the skills that a student possesses after engaging in learning (Sudjana, 2014). The abilities and skills that a person has acquired as a result of taking part in learning activities are therefore represented by learning outcomes. The three components of student learning outcomes cognitive, emotional, and psychomotor are what teachers aim to achieve when they conduct lessons. Six degrees or levels of competency exist for cognitive learning outcomes: C1 (remembering), C2 (understanding), C3 (applying), C4 (analyzing), C5 (evaluating), and C6 (creating).

Factual, conceptual, procedural, and metacognitive knowledge are the learning outcomes that instructors are expected to test for in the knowledge dimension (kemdikbud, 2014). Knowledge of categories, classifications, links between categories, causal laws, definitions, and theories is referred to as conceptual knowledge. Technical terms like algorithms, approaches, methods, and standards for judging whether a procedure should be used appropriately are all examples of procedural knowledge. Knowledge of how to learn, how to distinguish between significant and unimportant knowledge, knowledge applicable to certain circumstances, and self-knowledge are all examples of metacognitive knowledge.

3. Creativity

Muhammad Asori (2011) defines creativity as the capacity that exhibits originality, fluency, and flexibility in thinking and idea development. Novelty or fresh approaches to completing tasks are associated to creativity. Therefore, innovation and creativity go hand in hand. Additionally, creativity must be of a high caliber for something new. Although it is exceptional and of high quality, creativity requires consistency.

Sulaeman, Liliasari, Redjeki, & Sawitri (2014) list the following as indications of creativity: 1) Fluency, which is the capacity to produce several accurate, original, and fascinating ideas; 2) Flexibility, or the capacity to create exhaustive, thorough, and in-depth content about a certain biology topic; 3) Originality, which is the capacity to articulate one's own thoughts or viewpoints on a novel subject; 4) Problem-solving sensitivity, which is the capacity to recognize the main problems associated with a subject with clarity and accuracy.

4. Biotechnology

A technology known as biotechnology uses organisms (living things) to create useful goods and services for people. Microorganisms that carry out fermentation are closely tied to biotechnology. One illustration is the fermented traditional dish called tempeh. Proteins, carbs, and lipids undergo metabolic modifications by fungus during the fermentation process of tempeh, increasing the digestibility of the soybean components.

5. Hypothesis

Ha: At SMP Darussalam Cimangu, there is a difference in the learning results and creativity of ninth-grade students between the experimental class using the Project Based Learning (PjBL) model and the control class using the scientific approach model.

C. METHOD

The 9A class served as the experimental group for this study, while the 9B class served as the control group, both of which were students at SMP Darussalam Cimanggu. This study compared two distinct treatments given to the research volunteers using a quasi-experimental approach. The non-equivalent control group research design was employed. All ninth-graders at SMP Darussalam Cimanggu made up the population of this study, and the sample consisted of two classes chosen using the saturated sample technique, in which every member of the population was included in the sample. This was due to the fact that the purposive sampling technique was only used to select two 9th grade classes as the sample. A researcher who uses a purposeful sampling strategy has chosen the sample after taking into account a number of factors (Ansori, 2009).

Table 1 Research Design

Group	Pre test	Treatment	Post test
Experiment	O1	X1	O2
Control	O3	X2	O4

Source: Sugiyono (2010).

Explanation:
X1 = Treatment of project-based learning model
X2 = Treatment of lecture-based method in science teaching
O1 = Pretest administered to the experimental group
O2 = Posttest administered to the experimental group
O3 = Pretest administered to the control group
O4 = Posttest administered to the control group

Table 2 Data Collection Techniques

Target	Data Source	Instrument	Data Collection Time
Student Creativity	Students	Observation sheet in the form of a creativity assessment rubric	During the Learning Process
Observation of the Implementation of PjBL Model	Students	Observation sheet for monitoring the implementation of PjBL model	During the Learning Process
Achievement of Students' Cognitive Learning Outcomes	Students	Written test	After the Learning Process
Students' Response to Project Based Learning Model	Students	Questionnaire	After the learning process

The information to be gathered is quantitative and includes questionnaires from students about how the Project Based Learning teaching model is being implemented as well as observation sheets from other teachers about how the Project Based Learning (PjBL) model is being implemented in teaching and learning activities. A 15-item multiple-choice question test on biotechnology content will be used to gather data from pre-test and post-test regarding the achievement of student learning outcomes. With indications including fluency, adaptability, elaboration, originality, and evaluation, a creativity assessment rubric in the form of an observation sheet will be used to gather data on student creativity. The goal is to evaluate student creativity by using the Project Based Learning (PjBL) approach to create biotechnology-related prototypes.

D. RESULTS AND DISCUSSION

1. Implementation of Project Based Learning (PjBL) Model through Tempe Making in Grade 9 of SMP Darussalam Cimanggu

The monitoring and recording of teacher actions during the learning process using the Project Based Learning (PjBL) model are outlined in the following table in order to evaluate the implementation of the PjBL model:

Table 3 Summary of Observation Results on the Implementation of PjBL Model in Tempe Making as a Biotechnology Teaching Material

No	Learning Activities	Average	Percentage (%)	Category
1	Introductory Activities	3,79	94,8	Excellent
2	Main Activities	3,47	86,6	Excellent
3	Closing Activities	3,75	93,4	Excellent
Total Average		**3,67**	**91,6**	**Excellent**

According to the justification in Table 3 above, teachers are able to carry out the teaching process in an excellent category based on the observation results of their activities in putting the Project Based Learning (PjBL) model into practice. This is predicated on the teacher implementing every syntactic indication of the PjBL model, with an average implementation rate of 94.8% for introduction activities, 86.6% for main activities, and 93.4% for closing activities. The overall average implementation of the teaching process, taking into account all three stages of the learning process, is 91.6%, falling into the outstanding category.

Meanwhile, the information gathered by monitoring students' Project Based Learning (PjBL) model of learning activities is shown in the table below:

Table 4 Summary of Percentage Results of Observing Students' Activities in the PjBL Model of Tempe Making

No	Stage of Activities	Observed Aspects of Activities	Average Aspect	Percentage	Category
1	Introduction Activity	Active and Paying Attention to Teacher's	3,4	85,0	Good
2	Core Activity	Stage 1 Presence of Fundamental Questions	3,3	83,3	Good
		Stage 2 Designing Product Planning	3,4	84,4	Good
		Stage 3 Compiling Production Schedule	3,3	81,3	Good
		Stage 4 Monitoring Activity and Project	3,4	87,5	Very Good
		Stage 5 Testing Results	3,5	87,5	Very Good
		Stage 6 Evaluation and Learning Experience	3,5	87,5	Very Good
3	Closing Activity	Drawing Conclusions	3,3	87,5	Good
Average: Overall Student Learning Activities			**3,5**	**85,9**	**Very Good**

Based on Table 4, it is clear that students engaged in productive activities when the Project Based Learning (PjBL) paradigm was being implemented. This is as a result of the instructor's ability to facilitate and design introductory learning exercises with a variety of intriguing questions as an apperception and the usage of examples of conventional biotechnology products. This is demonstrated by the fact that, according to activity observations, the overall result of student learning activities was 85.9%. Siregar (2011), who asserts that active learning encompasses a variety of practical techniques to foster students' active learning capacities and explore the potential of students and teachers to build and exchange information, skills, and experiences, supports this viewpoint.

Due to the fact that students gained new knowledge and experiences through the biotechnology process of creating tempeh, there has been an increase in positive student activities since the Project Based Learning approach has been implemented. For instance, when creating tempeh, students must comprehend the right procedures, be aware of the necessary components, and utilize convergent thinking when combining the yeast and packaging the finished product, which encourages creativity. Project-based learning (PjBL) can enhance cognitive learning outcomes by exposing students to new information (Afriana, 2015), Promote effective learning (Afriana, 2015) and environmental care attitudes and behaviors (Afriana, 2015). With an average competence test score of 67% and a satisfactory understanding assessment through oral questioning of students, Miswanto in Kristanti (2016) further showed that student learning outcomes in his research were very good when using a project-based learning model. These findings had an effect on student learning activities in the classroom.

2. Student Learning Outcomes in Implementing the Project Based Learning (PjBL) Model through Tempeh Making

An overview of the post-test student learning outcomes in the experimental and control classes is presented in the following table:

Table 5 Analysis of Post-test Learning Outcomes Data

No	Class	Total Score of Students	Score Average	Learning Completeness
1	Control	1253	70	44,44%
2	Experiment	1387	77	77,77%

Table 5 shows that the experimental class achieves a higher level of learning completion than the control group. This is due to the fact that the experimental class uses the Project Based Learning (PjBL) model, which emphasizes learning that is student-centered, whereas the control class uses lecture techniques that pay less attention to the requirements of the students. The Project Based Learning (PjBL) approach also integrates real-world projects with high motivation and difficult questions, tasks, or issues in order to foster competency mastery through group problem-solving (Baron, 2011). The graph below shows how the percentages in the cognitive aspect are distributed:

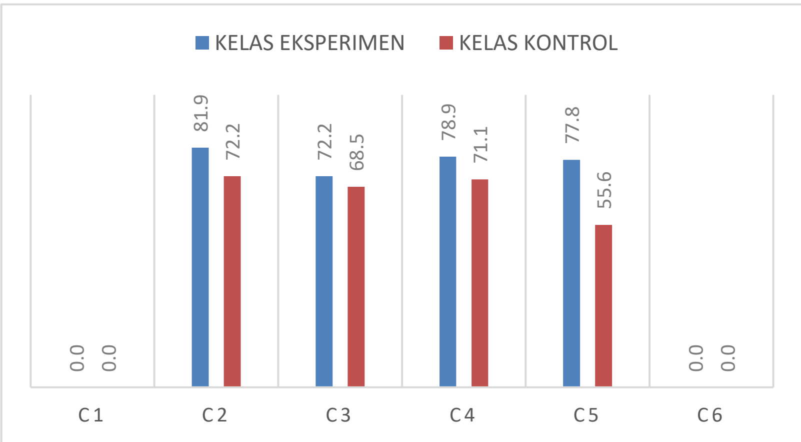

Figure 1 Percentage Distribution of Posttest Learning Outcomes in Cognitive Aspect

The above graph explains why aspects C1 and C6 were not employed. Aspect C1 (remembering) was not used because the cognitive level was insufficient to measure the indicator of creativity. Aspect C6 (creating) was not used since students' thought processes at this grade level were not yet able to measure the indicator of creation. The experimental class's performance on the cognitive aspect revealed that aspect C2 had the highest performance compared to the other cognitive aspects. This was due to the fact that the majority of students were able to comprehend how to make tempe in the biotechnology course, which is cognate at level C2. However, because students had to employ their creative thinking skills to discover the right answers during the application process, cognitive element C3 success was the lowest.

This is consistent with the creative side, where original thought had the narrowest range of scores.

Due to the teacher's excellent facilitation skills, the ratings for components C4 and C5 were extremely high. The ninth-grade students' analytical and evaluative thinking skills were also better, which made it possible to use the Project Based Learning (PjBL) model to develop their scientific reasoning and problem-solving abilities. This is consistent with Ngalimun's assertion in Triani (2015) that the benefits of the project-based learning paradigm include improved motivation, problem-solving abilities, teamwork, and resource management abilities. Additionally, ideas that assert that the project-based learning approach affects students' learning results are in favor of this idea.

According to the average percentage of learning results from aspect C2 to C5, the graph shows that the Project Based Learning (PjBL) model's adoption at each stage has improved students' average cognitive learning outcomes. The Project Based Learning (PjBL) paradigm. According to Kemendikbud (2014) encourages students to actively participate in problem-solving while also fostering the growth of their higher-order cognitive abilities and enhancing learning outcomes. Given that farming is the area's primary source of income, students are introduced to the use of supporting materials in tempe production through the practical activity of creating tempe in the traditional biotechnology course. Additionally, by cooperating in their groups to complete simple projects, share ideas or thoughts, and participate in group discussions, students are required to have a creative mindset and ideas. Their ability to think critically and solve problems scientifically is fostered by the tempe-making practicum they do in their groups.

3. Student Creativity in Implementing the Project Based Learning (PjBL) Model through Tempe Making in 9th Grade at SMP Darussalam Cimanggu

An overview of the analysis of student creativity data in the experimental and control classes is presented in Table 6:

Table 6 Analysis of Student Creativity Data

No	Indicators of Creativity	Control group	Experimental
1	Fluency	80,6	83,3
2	Flexibility	75,0	81,9
3	Elaboration	69,4	80,6
4	Originality	66,7	75,0
5	Evaluation	76,4	80,6
Average		**73,6**	**80,3**
Category		**Good**	**Good**

Based on the information in Table 6 above, it can be concluded that using the project-based learning approach to teach students about the traditional biotechnology issue of tempe production has a favorable effect on the students' ability to be creative. The control group's average creativity score, which is 73.6 and is considered good, and the experimental group's average creativity score, which is 80.3 and is considered very good, both reflect this. According to Kusumawati, Sudarisman, and Maridi (2014), students' cognitive and affective learning outcomes are affected by their level of creativity because the learning models they use call for it. Finding a problem to solve is the first step in encouraging creativity. Once students are aware that a problem exists, they will examine it and use convergent and divergent thinking to integrate prior knowledge with the current issue. By introducing fresh ideas or concepts, this integration process will inspire a variety of ideas and alternate methods to problem-solving, developing the abilities and capabilities of the pupils.

Both the experimental and control groups performed well in terms of meeting the Fluency criteria. This can be linked to the teacher's stimulation of creative thinking, nurturing of students' creativity, and encouragement to seek pertinent solutions to practical issues by engaging in tempe-making activities to comprehend the function of traditional biotechnology. The experimental group scored 81.9%, compared to the control group's score of 81.5% for the flexibility indication. The percentage between the control and experimental groups differs significantly. Each group in the experimental group had diverse (various) ideas about the choice of primary ingredients for tempe manufacturing from the start of their learning process during the practical process of making tempe.

Scores have increased in relation to the Elaboration indicator. The experimental group outperformed the control group in achievement, scoring 80.6% versus 69.4%. In the experimental group, the teacher oversaw and assisted students as they went through the exercise of manufacturing tempe. In order to complete their group assignments, students worked cooperatively with their peers. In terms of the Originality indicator, the experimental group scored 75%, compared to the control group's proportion of 66.7%. These findings demonstrate that the experimental group performed better on the originality index. Each group gave presentations, and this practice encouraged students to actively learn new information that their group had not considered, fostering the growth of original ideas.

The Fluency indicator has the highest achievement out of all the creativity indicators in the experimental group. This is due to the fact that the teacher constantly supervises and supports the learning process in order to develop creativity and encourage students to use model making to seek solutions to pertinent real-life situations, which helps them grasp the function of conventional biotechnology. Furthermore, students' capacity for fluent thinking emphasizes their capacity for conceptual knowledge of the content they have studied as demonstrated by their ability to articulate their thoughts clearly. On the other hand, the smallest achievement in the experimental group is in the Originality indicator. This is because the tempe-making learning process is perceived by students as something new, requiring adaptation in the practical implementation.

These justifications lead to the conclusion that students' creativity has been fostered, developed, and enhanced through the Project Based Learning (PjBL) paradigm. Due to its own learning syntax and student-centered approach, the project-based learning model efficiently fosters students' creativity, which is a feature that cannot be found in other teaching methods. Project-based learning, according to Rohana (2016), is a method of learning that starts with problems and then searches for and gathers data and information from a variety of sources to solve the problems, integrating students' prior knowledge, making decisions from a variety of alternative problem-solving solutions, and participating in practical tasks to produce creative products.

4. Student Response to the Project Based Learning (PjBL) Model through Tempe Making in 9th Grade at SMP Darussalam Cimanggu

Through the use of task creation in biotechnology-related material, this study also investigated the students' responses to ascertain their attitudes and interests toward the Project Based Learning (PjBL) model. The following graph gives a description of the student response data:

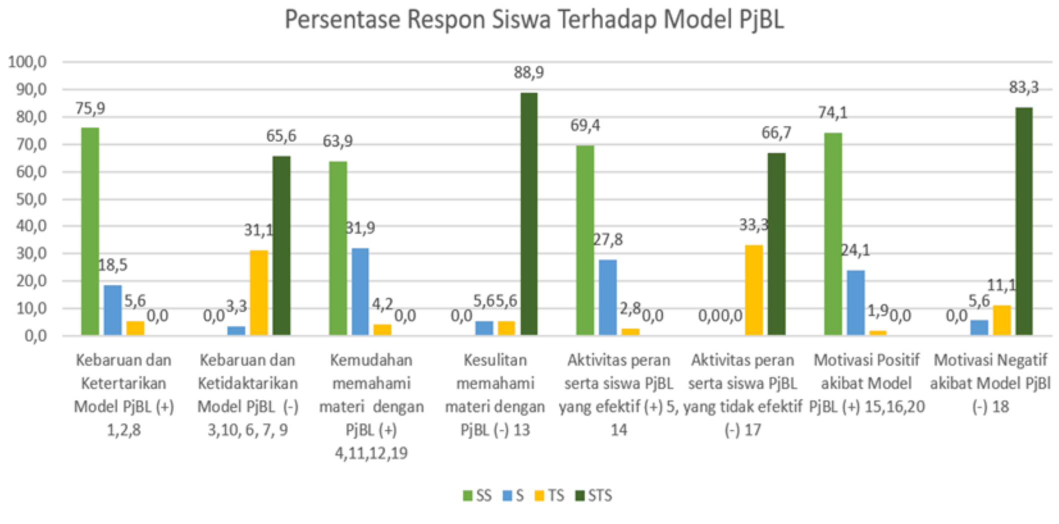

Figure 2 Percentage of Students' Response to PjBL Learning Model

According to the graph above, 75.9% strongly agree, 18.5% agree, and 5.6% disagree with the first indicator (positive) regarding students' novelty and interest in the Project Based Learning (PjBL) model. Regarding the PjBL model's novelty and lack of interest among students, the second indicator (negative) reveals that 3.3% agree, 31.1% disagree, and 65.6% strongly disagree. According to the PjBL model's third indicator, which is positive, 63.9% of respondents strongly agree, 31.9% agree, and 4.2% disagree with the statement that the material is easy to understand. According to the PjBL model's fourth indicator, which is negative, it is difficult to understand the material, 5.6% of respondents agree, 5.6% disagree, and 88.9% strongly disagree. Regarding students' active participation in successful PjBL learning activities, the fifth indication (positive) reveals that 69.4% strongly agree, 27.8% agree, and 2.8% disagree. 33.3% of students disagree and 66.7% strongly disagree with the sixth indicator (negative) evaluating students' ineffective engagement in PjBL learning activities. Regarding positive motivation, the PjBL model's eighth indicator (positive) reveals that 74.1% strongly agree, 24.1% agree, and 1.9% disagree. Regarding negative motivation brought on by the PjBL model, the eighth indicator (negative) reveals that 5.6% agree, 11.1% disagree, and 83.3% strongly disagree.

Students' learning outcomes are improved by using the Project Based Learning (PjBL) model in the learning activities because it makes them feel pleased, engaged, and makes the subject simple to understand. It also encourages students' creativity and learning motivation. The PjBL approach gives students the chance to refine their thought processes, learn to find and create their own concepts, and eventually improve their cognitive capacities. The Project Based Learning (PjBL) model is deemed to be a very ideal method for teaching conventional biotechnology subject since it allows students to freely express their own ideas and opinions as well as recognize issues in their environment. Through the process of creating products, they get the ability to define challenges and even learn to create alternate solutions. This is what distinguishes the PjBL model from other learning models, leading to students actively engaging in the PjBL learning process with high motivation, enthusiasm, and a passion for learning, ultimately realizing independent learning through quality learning that prioritizes student-centered education.

E. CONCLUSION

With a success rate of 91.6%, the Project Based Learning (PjBL) model implementation through template-making qualifies as excellent and leads to better learning outcomes and student creativity. This is corroborated by the outcomes of t-test hypothesis testing, which reveal that the initial hypothesis was rejected because neither student creativity nor learning outcomes have a significance value greater than 0.05. This indicates that there is a difference between the experimental and control groups' average creativity and learning outcomes, with the experimental group outperforming the control group. Additionally, students are responding favorably to the application of the project-based learning approach.

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