



# Implementation of PjBl Model in Biotechnonology using Traditional Project of Betung Bamboo Shoot Pekasam at Senior High Scholl Bonti District

Putri Sekarayu<sup>1</sup>, Entin Daningsih<sup>1\*</sup>, Asriah Nurdini Mardiyyaningsih<sup>1</sup>

<sup>1</sup> Biology Education Study Program, Faculty of Teacher Training and Education, Tanjungpura University, Indonesia.

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Corresponding Author:

Entin Daningsih

[entin.daningsih@fkip.untan.ac.id](mailto:entin.daningsih@fkip.untan.ac.id)

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**Abstract:** Project Based Learning (PjBL) is a student-centered learning model that emphasizes the production of a final product. However, the integration of local potential into project-based learning remains limited. The production of betung bamboo shoot (*Dendrocalamus asper*) pekasam is a traditional practice not widely recognized by students, despite its potential to extend shelf life and increase economic value. Therefore, incorporating bamboo shoot pekasam into PjBL can engage students in preserving local wisdom while fostering environmental awareness. The abundance of bamboo shoots in Bonti District presents a valuable local resource that can be developed into meaningful learning projects. This study aimed to determine students' cognitive, affective, and psychomotor learning outcomes through a PjBL model based on betung bamboo shoots. The research employed a pre-experimental method with a One-Group Pretest-Posttest design. Instruments included lesson plans, pretest-posttest questions, LKPD, and validated assessment sheets using the Guttman scale. Data were analyzed using normality, homogeneity, and t-test. The results showed that the data were normally distributed and homogeneous. Cognitive scores increased from 54.26 to 78, while affective and psychomotor scores reached 84.6 and 90.02, both categorized as very good. These findings indicate that local potential-based PjBL effectively improves student learning outcomes.

**Keywords:** Bamboo Shoots Pekasam; Learning outcomes; PjBL

## Introduction

Project-Based Learning (PjBL) is a student-centered learning model that emphasizes active engagement in solving real-world problems through the creation of an authentic project or product. In the context of modern science education, PjBL is widely recognized as an effective strategy because it simultaneously enhances students' conceptual understanding, creativity, and collaboration skills. According to Ndiung & Sebastianus, (2024) the implementation of PjBL contributes significantly to the development of 21st-century competencies, particularly in fostering the communication, collaboration, and critical thinking skills needed in the global era.

The use of traditional wisdom within the PjBL framework is currently gaining increasing attention because it allows students to bridge scientific theory with cultural practices and environmental sustainability efforts in their surroundings. This integration is considered crucial for creating an educational system that is not only academically rigorous but also contextual, relevant, and sustainable for learners. Science learning becomes far more meaningful when students are connected to real-world experiences drawn from their own environment and culture, which ultimately strengthens national identity amidst the tide of modernization.

Several previous studies have demonstrated the effectiveness of this approach in science education. According to Dewi et al., (2017) a learning model based

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on local wisdom has been shown to significantly improve students' problem-solving and scientific communication skills. In line with this Annisha (2024) research indicates that integrating local values into the formal curriculum is highly effective in improving science literacy and learning motivation, as the material studied becomes more concrete and applicable to students. Furthermore, research by Afkarina et al., (2024) in the context of physics learning emphasizes that the use of local potential not only enhances cognitive understanding but also fosters "living values" and positive character traits in students. This integration is also highly relevant in biotechnology through traditional fermentation processes, where, according to Sharma et al., (2020) local communities' knowledge of processing natural resources using microorganisms serves as a real-world laboratory for students to deeply understand scientific concepts while simultaneously maintaining local food security.

The concept of sustainability in this PjBL model based on local wisdom lies in the depth of the scientific process that students undergo at each stage. In this process, students are fully and actively involved, starting from the project scheduling stage, design planning, and field observations, through to the analysis of findings and presentation of the project report. These systematic activities are crucial because they directly stimulate students' curiosity, sense of responsibility, teamwork, discipline, and attention to detail in their work. According to Zhang et al., (2023) collaborative activities in PjBL projects have been shown to strengthen individuals' sense of responsibility toward the group, while reflective activities and independent observation effectively enhance students' scientific attitudes and self-directed learning skills. Furthermore, according to Annisha, (2024), the integration of local wisdom into formal education serves as a medium for transforming noble cultural values into positive character traits that enrich students' inner experiences. Through an approach grounded in local potential, students can understand scientific concepts more concretely and deeply because such learning is directly associated with their daily activities and living environments.

However, despite these advantages, there is a real problem in that the integration of local wisdom into PjBL is still rarely implemented consistently in schools. Many educators tend to stick to conventional methods due to limited understanding of the technical procedures of PjBL and the assessment tools that must be prepared at each stage of the project. According to Sarah et al. (2014), teachers often face significant obstacles in designing truly contextual projects and struggle to identify which local resources are most relevant for integration into the classroom curriculum. On the other hand, traditional knowledge regarding local products is often exclusive

and held only by certain community groups, so many students are actually unaware of the great potential of their own region. As a result, a knowledge gap has emerged in which students fail to realize that these traditional products are closely linked to the principles of environmental conservation and possess significant economic value that holds great potential for further development. Bamboo shoots are commonly found in the village of Bonti, and the community processes them into pekasam (fermented bamboo shoot), yet the production process for bamboo shoot pekasam is known only to certain individuals, and the younger generation (students) are unaware of how to make bamboo shoot pekasam. On the other hand, the presence of this bamboo species could serve as a unique and valuable product originating from the village of Bonti. Integrating traditional procedures for bamboo shoot pekasam into students' learning can provide insights into the natural resources around them, while also facilitating scientific inquiry- project based learning and fostering a personality that values local products. This study aims to implement a traditional project on bamboo shoot pekasam within the Project-Based Learning (PjBL) model through the practical application of biotechnology.

As a solution to this problem, this study implemented a PjBL model based on local wisdom through a project to produce fermented bamboo shoots (*Dendrocalamus asper*) in biotechnology education. The selection of this project is highly relevant because the concept of biotechnology is closely related to fermentation processes and the utilization of abundant natural resources. According to Sharma et al., (2020), microbial fermentation plays a crucial role in enhancing the nutritional quality, flavor, and extending the shelf life of food products by converting complex compounds into simpler ones. Betung bamboo shoots are a local resource in Bonti Subdistrict that are high in fiber but perishable, making their processing into pickled bamboo shoots a sustainable preservation method that also enhances their economic value. Through this project, students not only gain hands-on experience in applying biotechnology concepts scientifically but also actively contribute to preserving local cultural heritage. This research offers novelty by systematically integrating the PjBL stages—from planning to evaluation—while comprehensively measuring project outcomes that encompass cognitive, affective, and psychomotor aspects to foster students' holistic scientific character.

## Method

### Research Design

This study used a pre-experimental method with a One-Group Pretest-Posttest Design, which compares learning outcomes before learning (pretest) and after learning (posttest). The experimental method used was a one-group pretest-posttest Design referring to Sugiyono, (2016) with a design that can be seen in Table 1.

**Table 1.** Research design

Treatment	Learning outcomes	
	Pretest	Posttest
X	O <sub>1</sub>	O <sub>2</sub>

Description:

O<sub>1</sub> = Pretest score before learning

X = Treatment with the PjBL model for the production of *D.asper* betung bamboo shoot pekasam

O<sub>2</sub> = Posttest score after learning

### Population and Samples

The population in this study was class XII science students of Senior High School 1 Bonti for the 2023/2024 school year. The sample in this study was 34 students from class XII Science of Senior High School 1 Bonti. In this study, treatment was given in the form of learning activities using the PjBL model by making *D.asper* pekasam (Schultes f.) *Backer ex Heyne* bamboo shoot pekasam.

During learning activities, an assessment of attitudes and skills was also carried out for students. Attitude assessment included aspects of curiosity, discipline, responsibility, and cooperation. The skill assessment included the aspects of collecting tools and materials that were used to make products, used tools and materials according to their functions, carried out work steps systematically; compiled observation data.

### Instrument

The instruments used in this study were test instruments in the form of a pretest and posttest and observation instruments consisting of affective and psychomotor aspects. The test used in this study was a multiple-choice test with four alternative answers. The test given before the learning activity (pretest) aimed to determine the ability to know before the implementation of the PjBL model learning. The test given after the learning activity (posttest) aimed to find out the development of students' knowledge after the implementation of the PjBL model learning.

The learning tools used in this study consisted of pretest and posttest questions, student worksheets (LKPD), power points slides (PPT), attitude and skill assessment sheets. The used of instruments was in the

form of learning tools that are validated by two biology education lecturers who was experts in their fields. Testing the validity of learning instruments and tools used the guttman scale to obtain a firm answer to a stated problem, namely "Yes" (1) and "No" (0), the gutman scale was used in the form of a checklist, the answer Yes is given a score of 1 and No is given a score of 0 (Sudaryono, 2016). The Assessment Category on the Guttman scale can be seen in Table 2.

**Table 2.** Guttman Scale Review Category

Number	Score	Information
1	1	Yes
2	0	No

### Procedure

The implementation of PjBL went through six stages, namely; determining basic questions, made project planning, compiling a project schedule, monitoring project progress, assessing results, and evaluating experiences. The data in this study was obtained from the learning outcomes before learning (pretest), as well as the learning outcomes after learning (posttest) using PjBL to made *D.asper* bamboo shoot pekasam During learning activities, an assessment of students' attitudes and skills was also carried out.

### Data Analysis Techniques

The data analysis used in this study was descriptive quantitative data analysis. The data collected was in the form of cognitive, affective, and psychomotor assessment data of students. The knowledge (cognitive) aspect was combined between pretest, posttest and knowledge from the results of student worksheets, the attitude aspect (Affective) was based on the results of attitude assessment, and the skill aspect (psychomotor) was based on the results of skill assessment and presentation evaluation as well as the activity.

The data obtained from the pretest and posttest knowledge were first tested through normality and homogeneity tests. The normality test of the lilivors test and the homogeneity test using the F test were carried out used SPSS 26. After the assumption test was carried out, it was followed by a t-test used a paired sample t test to compare learning outcomes before and after learning (posttest)

## Result and Discussion

### Validation

Validation of learning instruments consisting of lesson plans, student worksheets, test questions, affective and psychomotor sheets was carried out first. The validation of the learning implementation plan (RPP) has been revised based on the validation of two

validators who are experts in their fields. The results of the validation test of learning tools in the form of lesson plans are shown in Table 3.

**Table 3.** Results of Validation of PjBL Learning Implementation Plan (RPP)

Aspects	Average	Category
Identity of RPP	100%	Highly valid
Competency	100%	Highly valid
Achievement Indicators		
Learning Objectives	100%	Highly valid
Learning Materials	100%	Highly valid
Learning activities	100%	Highly valid
Suitability of learning activities with the project-based learning model	100%	Highly valid

The results of the RPP validation showed an average score of 100% with a highly valid category used the guttman scale referring to Akbar (2013). Thus, the implementation of teaching can be carried out in accordance with the lesson plan that has been prepared. The validation of the learning tools was followed by the validation of the student worksheets PjBL. Student worksheets PjBL has been tested for feasibility and revised based on two validators who are experts in their fields. The results of the student worksheets PjBL validation can be seen in Table 4.

**Table 4.** Results of the Validity of the Student Worksheet PjBL

Aspects	Average	Category
Material/content eligibility	100%	Highly valid
Display	100%	Highly valid
Language Compatibility	100%	Highly valid

The results of the validation of the student worksheets showed an average score of 100% with a highly valid category, referring to Akbar (2013). Validation was then continued with the validation of pretest and posttest question instruments. The pretest and posttest questions were tested for feasibility and revised by two validators who are experts in their fields. The validated pretest and posttest questions amounted to 15 questions. The validated questions include 11 criteria, namely: [1] the formulation of the questions was in accordance with the learning outcomes, learning objectives and indicators of the questions, [2] the formulation of the questions has been made in accordance with the material, [3] the content of the material asked was in accordance with the learning objectives, [4] the formulation of the question items has been accompanied by an answer key, [5] the formulation of the questions was free from questions that are SARA, [6] the question had a similar distraction, [7] the answer

choice does not used the question "all the above answers are true/false", [8] pictures/graphs/tables/diagrams/the like can help students in answering questions, [9] the formulation of question items already used simple and communicative language, [10] the questions used good and correct Indonesian, [11] the formulation of question items does not cause double interpretation or misunderstanding. The validation results show that the pretest and posttest questions can be used but need to be improved according to comments from validators.

*Implementation of D.Aasper Pekasam*

After the validation of learning tools and instruments for pretest and posttest questions, it was followed by the implementation of learning activities using the PjBL model to made *D.asper* pekasam. The learning outcomes were in the form of cognitive, affective, and psychomotor assessments using learning with the PjBL model by relating the *D.asper* bamboo shoot pekasam as one of the used of local wisdom in Bonti District.

The PjBL learning process began with a pretest. Pretest was used to know initial knowledge skills in students. Then continued with the PjBL learning process. In the first stage of the PjBL model, students determined the basic questions or formulation of problems to be solved regarding the abundance of *D. asper* bamboo shoots in Bonti District [Figure 1], as well as the relatively short post-harvest shelf life of *D. asper* bamboo shoots. After reading the article Naulandari et al., (2023) about lactic acid bacteria in apus bamboo shoots that have been read, students also read and discuss theoretical studies about the abundance of bamboo shoots in Bonti District. *D. asper* bamboo shoots have a short shelf life after harvest so they were prone to spoilage. Therefore, *D. asper* bamboo shoots need to be further processed to extend the shelf life and add nutritional value and taste to the bamboo shoots. The teacher showed a picture of *D.asper* bamboo shoot pekasam that had been made at the Biology Education Laboratory, Tanjungpura University [Figure 2], starting from the necessary tools and materials, how to make it, chemical physics tests, and organoleptic tests carried out on *D.asper* bamboo shoot pekasam using a power point. Teachers used power points so that all students can observe it more clearly. The used of power points was the implementation of learning used technology according to the demands of 21<sup>st</sup> century education. The integration of technology such as power points in teaching helps facilitate active and collaborative learning, which was an approach that was more in line with the demands of the 21<sup>st</sup> century. This approach encouraged students to actively participate in the learning process, develop critical thinking skills, and

work together in solving problems (Ramaila & Molwele, 2023).



**Figure 1.** Bamboo Shoot *Dendrocalamus asper*



**Figure 2.** Pekasam bamboo Shoot *Dendrocalamus asper* which was made at the Biology Education Laboratory, Tanjungpura University.

To complete the first stage, namely determining the basic question or formulation of the problem to be solved regarding the abundance of *D.asper* bamboo shoots in Bonti District, students then answered the formulation of the problem, namely by making a good *D.asper* bamboo shoot pekasam. The making of bamboo shoot pekasam has never been done in schools before. This would indirectly make students conduct an in-depth investigation about *D.asper* bamboo shoots which will be valuable for attention and efforts to find information for students, students also gain knowledge through reading and apply problems to real-world reality. According to Ndiung & Sebastianus, (2024) stated that PjBL can improve students' critical thinking, problem-solving, and creativity skills through contextual and real-world problem-based project completion. Thus, the PjBL model allows students to develop creative ideas and work collaboratively, thereby strengthening learning outcomes and skills. This was

also supported by Trianto, (2014) stating that PjBL was learning that involves students in learning activities both in solving a problem and providing opportunities for students to express their creativity more so that it can improve learning outcomes and students' creativity. Students also related the direct experience gained in the home environment when utilizing the abundance of *D. asper* bamboo shoots to be processed into pekasam, with project-based learning creating a learning environment approach that encourages learning to construct knowledge, as well as skills through direct experience. The integration of local wisdom in learning not only teaches students about relevant materials, but also introduces and preserves local culture. This was also in line with the research of Sardjono, (2018) which states that it was possible for students to see the direct relevance of what students learn in the context of daily life.

In the second stage, namely the design of the project stimulus, in this phase students discussed with the group to design the project to be made, namely a good *D.asper* bamboo shoot pekasam, *D.asper* bamboo shoots used from the surrounding environment. The planning carried out by the students was in the form of determining tools and materials as well as how to make good bamboo shoot pekasam, then written in the student worksheets. Even though the making of *D. asper* bamboo shoot pekasam has never been done at school, some students have done making bamboo shoot pekasam at home taught by their parents. With PjBL, students can collaborate to exchange knowledge that may not have been known by other students. This is in line with Fahadah et al.,( 2021) who stated that the implementation of PjBL can train students to be more independent, skilled in collaborating, and conducting experiments. To help students in designing projects, they can use articles or journals as the information needed. According to Zhang et al., (2023) showed that PjBL improves students' skills in collaboration and real problem-solving, with group responsibility as the main factor affecting learning success.

In the third stage was the project pumping schedule. Students determine the schedule for making *D.asper* bamboo shoots, starting from collecting tools and materials, making *D.asper* bamboo shoots, to testing the results. In this phase, it can encourage students to be more active and more involved in group discussions in designing the project schedule to be made, namely the making of *D.asper* bamboo shoot pekasam to estimate the time used in each stage of making *D.asper* bamboo shoot pekasam. The project-based learning process can make it easier for students to understand the material, because students directly apply their knowledge to a project that they compile Apriany & Muktadir, (2020) Schedule stimulation is also coordinated with teachers

to plan activity schedules. This was supported by Kosasih, (2016) stating that under the guidance of the teacher, students schedule according to the activities that have been designed.

The fourth stage was that the teacher monitors the progress of the project carried out by the students. students bring the tools and materials needed to made *D.asper* bamboo shoot pekasam. Teachers conduct monitoring to observe the extent of the project to be carried out. The implementation of making *D.asper* bamboo shoot pekasam was carried out at school on weekdays. However, observations were not made at school, because the school did not facilitate laboratory activities at school during holidays, so students brought the project home to their respective homes so that it was easy to observe, as proof of observation students provided photos/videos when making observations through the Whatsapp grub. This also aimed to monitor the progress of the project that has been carried out by the students, as well as open discussions between researchers as teachers and students in completing the project. With the used of the whatsapp grub, it made it easier to carry out monitoring during the implementation of the PjBL project.

According to Sanita & Saparia,(2023) technological developments have made the learning process easier and the search for learning resources, because today's learning was no longer limited by space and time. In making pekasam, students also write down project observations consisting of bamboo shoot colors and events during observation. At this stage, the teacher conducts the PjBL assessment using the help of the whatshap grub. In this PjBl assessment, teachers used affective and psychomotor assessment sheets for students.

In the next stage, namely the fifth stage, students tested the project that had been made, namely *D.asper* bamboo shoot pekasam, after making a project for 5 days, the testing stage was carried out at the next meeting. Students are directed by the researcher as a teacher, to prepare 5 samples from the project that has been created, including sample codes for each sample made to facilitate assessment [Figure 3]. In this phase, students are also invited to become panelists in providing assessments on products from other groups using line scale test sheets that have been given for each test parameter consisting of color, aroma, texture. In testing the pH parameters, students were invited to used a simple laboratory tool, namely the pH paper indicator, which was assisted by the use of mortal and pestle in smoothing the sample, which had never been used by the students before, so as to arouse the curiosity of the students [Figure 4] and several other materials such as aquades. Students' curiosity about the material they learn by themselves or by the teacher can cause their

knowledge to be much more and easier for students to understand, compared to students who are just silent and waiting for the teacher's explanation. Students who have a sense of curiosity will have high motivation to learn something. This was in line with Wade, (2019) explained that curiosity was related to learning outcomes, this was influenced by students' curiosity to be able to generate impulses that can maximize actions and learning outcomes. This was also supported by Eliza et al., (2022) stating that project-based learning was important for students because students can explore knowledge with their curiosity to find solutions to the problems students face. Then students recapitulate the results of the group sample assessment using a line scale test given by other groups and write it down in the student worksheets. Students gained a basis of knowledge from preliminary research on the influence of water ratio on physicochemical properties and organoleptic tests on bamboo shoot pekasam which was used as a learning resource on biotechnology materials. Making *D. asper* bamboo shoot pekasam was not only a project for students but students are also given experience and learning to be panelists in testing organoleptics and chemical physics. Students was introduced to organoleptic testing, as one of the steps in food testing when a food product was about to be marketed. This organoleptic test is one of the processes in PjBL, before a product was sold, it was necessary to carry out an organoleptic test to determine the acceptance of food products. Through organol testing, students were taught to measure, and interpret responses to a product based on capturing product characteristics using the human senses Mahadewi & Suastuti, (2022) The senses used in organoleptic testing consist of sight/eyes, smell/nose, taste/tongue, and touch/hand. In this study, the sense of taste/tongue was not used, because the students were undergoing fasting.



Figure 3. Students Prepare Samples Used in Organoleptic Testing.



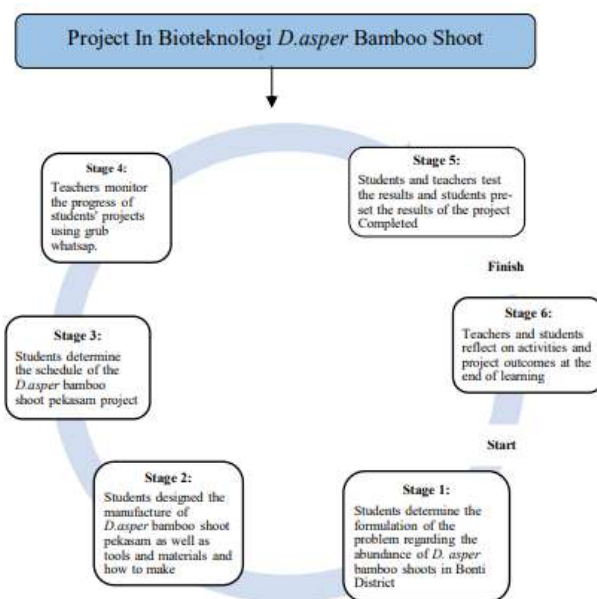
**Figure 4.** Students Given Experience and Learning to Become Panelists in Testing Organoleptics and Chemical Physics

At this stage, the teacher also assesses the project made, namely *D. asper* bamboo shoot pekasam. Then students made a presentation of the product that has been made. Of the six groups, there were 3 groups that scrambled to advance first because the enthusiasm of the students was very good. then the remaining 3 groups advance according to the order of the groups. During the presentation, students experience problems in displaying power points because the lights are off, and the solution that can be done was to display the power point through a laptop that was directed to students. Even though there were obstacles in the presentation, all students still paid attention to the group that was making a presentation explaining the project that had been carried out. Other students also play an active role in listening and comparing with the project they are doing, and responding when the presentation takes place. Presentations are one of the project-based learning products that can run in multiple directions and all members are actively involved and enthusiastic so that they can develop communication skills and student engagement.

The next and final phase was evaluation. In this phase, students and researchers as teachers reflect on the activities and project results at the end of learning. The reflection process is carried out both individually and in groups. Students were asked to discuss their thoughts and experiences after working on the *D. asper* bamboo shoot pekasam project. According to Thomas & Brown (2021) reflection is an important element in project-based learning. Reflection helps students relate project experiences and concepts learned by students, deepen understanding, and encourage the development of critical thinking skills. In this phase evaluation *D. asper* bamboo shoot pekasam, individual discussions in groups after the project learning made students internalize the learning that has been carried out, identify the difficulties they face. This was also supported by a study by Huang, Cheng, & Wang, (2022)

showing that group reflection not only functions to evaluate cognitive understanding, but also students' collaborative skills. Students who were active in the reflection process tend to have a better understanding and are more durable with the material taught (Lopez & Martin, 2023).

Briefly, the implementation of PjBL used *D. asper* bamboo shoot pekasam as a project can be seen in Figure 5.



**Figure 5.** Implementation of PjBL Used *D. asper* Bamboo Shoot

*Students' Learning Outcomes*

Students' learning outcomes were in the form of cognitive, affective, and psychomotor assessments of students. Cognitive learning outcomes consist of pretest learning outcomes, posttest and student worksheets assessment. Affective learning outcomes were obtained from affective assessment sheets, and psychomotor learning outcomes were obtained from psychomotor assessment sheets and presentation assessment sheets. The results of the students' cognitive assessment based on the pretest and posttest scores of the average scores of students before learning (pretest) and after (posttest) can be seen in Table 5.

**Table 5.** Assessment Score of Students' Knowledge Before and After Learning to Made Bamboo Shoots *D. asper*.

Knowledge Assessment	Score
	Mean ± St. Deviasi
Pretest	54,26 ± 11,94
Posttest	78,53 ± 12,03

The results of the assessment of students' knowledge increased from before the treatment (pretest) with an average score of 54.26 and after the treatment

(posttest) with an average of 78.53. The pretest and posttest values showed that the normally distributed data was shown with a pretest kurtosis value of  $-0.102$ , and a posttest kurtosis value of  $-0.486$ . This difference in scores shows that the learning provided had succeeded in improving students' understanding. The achievement of a fairly good score indicates that the implementation of biotechnology learning using the PjBL model, namely *D.asper* bamboo shoot pekasam enlightened cognitive insights so that it made it easier for students to understand biotechnology material. According to Anderson et al., (2015) stated that the higher the cognitive achieved, the higher the level of understanding of the concept of the students. Overall, these results show that learning using PjBL *D.asper* bamboo shoot pekasam was effective in increasing students' knowledge.

Statistical test analysis was carried out to see if there was a significant difference between the results of cognitive assessment before (pretest) and after learning (posttest) using the t-test. However, before the t-test was carried out to see the difference in the learning outcomes of the pretest posttest, the normality and homogeneity test was carried out first. The results of the normality test can be seen in Table 6.

**Table 6.** Results of the Normality Test of Pretest and Posttest Knowledge Assessment Data

	Statistics	Sig.	Result	Description
Pretest	.139	.092	.092 > 0.05	Normally distributed
Posttest	.137	.107	.104 > 0.05	Normally distributed

The results of the normality test of the pretest and posttest knowledge assessment data showed a pretest significance value of  $0.092 > 0.05$  and a posttest significance value  $0.104 > 0.05$ , so that the pretest and posttest data were normally distributed. The analysis was then continued with a homogeneity test used the f test. The results of the homogeneity test was seen in Table 7.

**Table 7.** Results of Homogeneity Test of Pretest and Posttest Knowledge Assessment Data

	Statistics	Sig	Result	Description
Pretest	0.41	.839	.839 > 0.05	Data Homogen
Posttes			0.05	

The results of the homogeneity test of the pretest and posttest knowledge assessment data showed a significant value of the pretest posttest  $0.839 > 0.05$ , so that the data was homogeneous. After the data was declared homogeneous, it was followed by the T test

(Paired sample t-test). The analysis of the t-test can be seen in Table 8.

**Table 8.** Test Results (Paired Sample T Test) Pretest and Posttest Knowledge Assessment Data

Variables	Mean	Std. Deviasi	sig	Result	Description
Pretest	65.41	17.15	.000	.000 < 0.05	There is a significant difference
Posttest				0.05	

The results of the t-test (Paired Sample T test) data for the assessment of pretest and posttest knowledge showed a significance value of pretest and posttest  $0.00 < 0.05$ , so that there was a significant difference in the value of pretest and posttest learning knowledge.

Based on the results of the study, there was an increase in learning outcomes in the posttest. The sample used came from a normally distributed population, as shown by the normality test with a  $p > 0.05$ . The data was also proven to be homogeneous with a  $p > 0.05$ . In addition, there was a significant influence of project-based learning (PjBL) on the results of the pretest and posttest, which was shown by a significant value (sig) of  $< 0.05$ . which meaning that there was a difference before and after the treatment was given. This result was supported by research conducted by Warmadewi et al., (2024) which stated that there was a difference in pretest and posttest scores so that it was concluded that there was a difference in student learning outcomes. Phyllis C Blumenfeld et al., (1991) found that PjBL encourages learners to actively participate in the learning process, improve critical thinking skills, and produce a deeper understanding of materi material studied. Research by Gallagher & Gallagher, (2013) shows that PjBL integrated with local or cultural contexts, such as in the case of bamboo shoot pekasam, increases learning relevance for learners, resulting in more significant learning outcomes. This was in line with the principle that learning that contextual and relevant to students' daily lives tends to be more effective and has a long-term impact. According to Bransford et al., (2000) stated that in biotechnology involving many abstract concepts, learning media that utilizes local wisdom, in this case *D. asper* bamboo shoot pekasam which was concrete and based on real experience can make the concept of biotechnology easier to understand.

Learning outcomes were the final results after experiencing the learning process, where behavior was seen in the form of changes that ware observed and measured. Learning outcomes were in the form of cognitive, affective, and psychomotor assessments. Sudjana, (2016) which states that learning outcomes were essentially changes in a person's behavior that

include cognitive, affective, and psychomotor abilities after participating in a certain teaching and learning process. Learning outcomes were the abilities that students have after they have had their learning experience. Learning outcomes can also be said to be an indicator of the learning process. The average score of students' learning outcomes can be seen in Table 9.

**Table 9.** Average Learning Outcomes of Students After Treatment

Group	Cognitive	Affective	Psychomotor
1	88.3	88.5	89.9
2	78.5	83.7	76.6
3	87.0	87.4	90.2
4	85.2	83.7	98.3
5	89.0	86.4	91.0
6	88.0	82.2	93.0
Average	86.46	85.4	90

The average learning outcomes of students after the treatment obtained an average score 86.46, 85.4, and 90 for cognitive, affective, and psychomotor, subsequently. Students' cognitive learning outcomes consist of the results of pretest, posttest and student worksheets assessment. The results of the cognitive assessment obtained an average of 86.46 with the category of very good. Evaluation questions and student worksheets have a close connection. In the student worksheets, there are questions related to what students do during the biotechnology learning process used the PjBL model, namely making *D.asper* bamboo shoot pekasam. student worksheets was done in groups so that students can discuss with their group members to answer questions. The display of student worksheets as a learning medium also affects students' understanding of biotechnology materials. According to Manda & Arifin, (2024) Students who take part in learning through experimental activities had better cognitive values compared to only using the lecture method, because in the practicum students were not only given material but also practice so that students can directly practice the theories obtained. In PjBL *D.asper* bamboo shoot pekasam was a scientific approach that had stages such as observing, asking, collecting data, analyzing, and attracting curiosity, which was also used in practicum activities. This showed that the application of PjBL with local wisdom-based materials, namely *D.asper* bamboo shoot pekasam, had a significant positive impact on learning outcomes. Thomas & Brown, (2000) in his review of PjBL, showed that the PjBL learning model, showed that the project-based learning model not only improves cognitive learning outcomes, but also increases student engagement and interest, which can be seen in affective and psychomotor aspects.

The results of the analysis of *D. asper* bamboo shoot pekasam in the affective assessment of students were obtained by making observations during the practicum which was assisted by observers. The affective score of students obtained a score of 85.45 including the very good category. Student assessment was divided into four aspects, namely cooperation, discipline, curiosity, and responsibility. The high average score of students was due to the implementation of learning with PjBL in the making of making *D.asper* bamboo shoot pekasam can foster scientific attitudes such as cooperation, discipline, curiosity, and responsibility which can be seen in phases one to five in PjBL. In the *D.asper* bamboo shoot pekasam making activity, students maintained, worked, and followed directions according to a sense of responsibility. This was also supported by Bendah (2022) stating that the project-based learning model also helps students in creating better relationships between students, as well as facing others and having a great sense of responsibility, both to the group and to the students themselves. Interaction in groups can train students to discuss and cooperate with group friends based on curiosity such as by asking questions, being enthusiastic, and paying close attention to directions. The value of cooperation was important for students where students need to know how to compete and work independently, because in many fields the world of work and society requires cooperation. Students who are involved in cooperation through learning such as the *D.asper* bamboo shoot pekasam project activities Students work together in determining the formulation of the problem to test the results. Thus, the value of cooperation for students provide benefits both in the world of work on a small and large scale. In addition, the making of pekasam bamboo shoots trains students to attend according to the predetermined time so as to foster a disciplined attitude, do tasks in accordance with the steps and obey the directions in the student worksheets. This was also supported by Railsback (2002) stating that PjBL can increase students' sense of responsibility for learning Learners become motivated when learners have control over the project, as well as the project was relevant to their daily lives. Affective learning outcomes are related to cognitive and psychomotor learning outcomes. Liawati & Rahayu, (2017) stated that students who have good affective have good cognitive and psychomotor learning outcomes. Bell (2010) found that through PjBL it can increase students' emotional engagement by making learning more relevant and interesting. This had a positive effect on students' attitudes towards learning and active participation of students in the classroom.

The analysis results student psychomotor assessment obtained an average score of 90.02 with the category of very good. The psychomotor average score

obtained the highest average score. The high psychomotor value of students was due to the PjBL model that emphasized more on active student learning by paying attention to skills. Project-based learning outcomes can improve students' problem-solving skills that will later be applied to the real world, achieve learning goals, and increase students' learning motivation. Psychomotor assessment of students was also divided into 4 aspects, namely collecting tools and materials that will be used to made products, using tools and materials according to their functions, carrying out work steps systematically, and compiling data from the observation of made *D.asper* bamboo shoot pekasam. The psychomotor aspect was also supported by the existence of student worksheets that was attractive and meets learning criteria, which was very necessary to make students active in learning in the classroom (Ulfah & Arifudin, 2021).

Psychomotor learning outcomes were also a continuation of cognitive and affective learning outcomes. Psychomotor assessment and presentation value have a close relationship in the learning process, psychomotor assessment was used to determine the extent to which students determine the learning outcomes that had been obtained, including psychomotor and physical abilities. The results of this study were also in accordance with the results of Warmadewi et al.,( 2024) which stated that the Project Based Learning model had an effect on students' science process skills in science learning. This can happen because the PjBL model emphasizes more on active student learning by paying attention to science process skills. This can happen because the PjBL model emphasizes more on active student learning by paying attention to science process skills. Teachers were no longer tasked with providing knowledge, but rather facilitating and preparing situations that attract students to ask questions, prepare schedules, and design, complete projects, and present project results through experiments that had been carried out, as well as evaluate project results.

Based on the six student groups in cognitive, affective, and psychomotor research, it was seen that Group two obtained lower learning outcomes compared to the overall average in all aspects assessed. In the cognitive aspect, which assessed the level of understanding and knowledge of the material taught, student group two accepted a score of 78.5, which was below the average of 86.46. In the affective aspect, which includes students' attitudes during learning activities, group two obtained a score of 83.7, slightly lower than the average of 85.4. Meanwhile, on the psychomotor aspect, which assessed psychomotor and physical skills, group two obtained a score of 76.6, which was the lowest score among all groups and well below the overall

average of 90.0. These results suggest that group two may needed special attention or adjustments in learning methods to improve their performance in all three aspects. Briefly, the learning results used *D.asper* bamboo shoot pekasam can be seen in Figure 6.

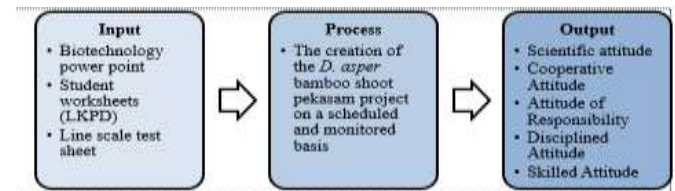


Figure 6. Summary of Input, Proses and Output Using PjBL by *D.asper* Pekasam

## Conclusion

The implementation of the project-based learning model (PjBL) by utilizing local wisdom through the manufacture of *Dendrocalamus asper* bamboo shoots at State High School 1 Bonti improved student learning outcomes for cognitive, affective, and psychomotor aspects with the category of very good. The application of PjBL also helped students develop critical thinking skills, collaboration, creativity, and the ability to solve real-world problems. The *D.asper* bamboo shoot pekasam project was an innovation based on local wisdom, successfully providing a new learning experience for students, as well as increasing students' involvement and interest in learning. Among the aspects of learning outcomes, the psychomotor aspect was higher than other aspects with excellent results, which supports the successful implementation of the PjBL model, this happens because students were directly involved in the stages of the PjBL process, starting from collecting tools and materials, processing, to observing fermentation results which results in improving students' skills

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## Author's Contribution

Entin Daningsih designed the study, analyzed the data, provided part of the research Facilities, developing instruments and validation sheets, and wrote the manuscript. Putri Sekarayu designed and conducted the study, developing instruments and validation sheets, and wrote the manuscript. Arsiyah Nurdini wrote the manuscript.

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## Conflicts of Interest

The authors declare no conflict of interest.

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