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Project Based Learning (PLO) with a Bio-Entrepreneurship (BEP) Approach: Can it Improve Students' Science Literacy and Life Skills?

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ABSTRACT

This research aims to analyze the PjBL model with the Bio-Entrepreneurship (BEP) approach to scientific literacy abilities and life skills. The method used was quasi-experimental with a pretest posttest non-equivalent control group research design. The sample for this research consisted of 71 students consisting of experimental classes and control classes, using a purposive sampling technique. The results of research on scientific literacy abilities show that the average N-Gain in the experimental class is 0.67 with medium criteria, while the control class average N-Gain is 0.28 with low criteria. The results of life skill abilities after being given treatment in the experimental class increased higher with an average of 78.63 compared to those in the control class with an average of 51.74. Thus, this research shows significant implications for students' abilities in developing real projects by combining aspects of entrepreneurship and biological concepts in everyday life.

Project Based Learning (PJBL) with Bio-Entrepreneurship (BEP) Approach: Can it Improve Students' Science Literacy and Life Skills?

ABSTRAK: *This study aims to analyze the PjBL model with a Bio-Entrepreneurship (BEP) approach to science literacy and life skills. The method used was quasi experiment with pretest posttest nonequivalent control group design. The sample of this study amounted to 71 students consisting of experimental and control classes, with purposive sampling technique. The results of the research on science literacy skills showed that the average N-Gain in the experimental class was 0.67 with moderate criteria, while the control class had an average N-Gain of 0.28 with low criteria. The results of life skills ability after being treated in the experimental class increased higher with an average of 78.63 than in the control class with an average of 51.74. Thus, this research shows significant implications for the ability of students to develop real projects by combining entrepreneurial aspects and biological concepts in everyday life.*

INTRODUCTION

Science literacy is an important ability to increase knowledge and inquiry about natural science, improve the oral and written vocabulary needed to communicate scientifically, and improve the relationship between science, technology, and society (Rohm et al., 2021)(Kamil et al., 2020);(Putri et al., 2020). According to OECD (2021) and Putranta et al. (2020) the importance of science literacy is to identify problems by applying their knowledge, building new

knowledge, providing scientific explanations, drawing conclusions based on scientific evidence, and developing a reflective mindset to help them overcome science-related problems and ideas. This is in accordance with the conditions of the 21st century when science and information are developing very rapidly (Chusni et al., 2020);(Tohani & Aulia, 2022). So, that it raises various problems including morals in using and disseminating information, as well as the emergence of problems related to social, culture, and the environment (González-pérez & Ramírez-montoya, 2022);(Fadhilawati et al., 2023). In addition, problems in the 21st century have an impact on daily activities and the mindset of an increasingly modern society, so that science literacy is an ability that must be possessed by students in the 21st century (Mellyzar et al., 2022);(Semilarski & Soobard, 2021).

Challenges in the 21st century do not only emphasize mastery of science literacy skills (Pratama et al., 2020). However, looking at the current conditions, many fields of work such as work in assembling products have been carried out by production technology, resulting in limitations in employment (Puspita, Rakhmawati, et al., 2023);(Haka et al., 2020). According to Shaturaev (2023) the 21st century experienced a very rapid technological development and then created a new era of automation, namely technology that is more advanced and flexible to be used on a larger scale in the workplace.

Therefore, students must have life skills to be able to compete in the world of work and daily life in facing the challenges of an increasingly complex era (Rohm et al., 2021). According to the Partnership for 21st Century Learning (P21) in 2015 that González-pérez & Ramírez-montoya (2022) learning in the 21st century students are required to have life skills and careers including flexibility and adaptive, initiative and independence, social and cultural skills, productive and accountable, and leadership and responsibility (life and career skills). 21st century education not only pays attention to core subjects, but also emphasizes life skills, life skills are an innovative idea that arises because there is a need to develop proactively and creatively so that life becomes better (Oluwagbohunmi & Alonge, 2023);(Nuryanto, 2020). The importance of life skills is because it is the capital of students to become independent individuals in facing life in an increasingly modern society and increasingly competitive world of work (Puspita et al., 2023). Life skills have an urgent role in equipping students to learn to live independently. Thus, science literacy and life skills are closely related to process skills in the 21st century (Gupta, 2021);(Mayuga, 2022). This is in line with Buasuwan & Suebnusorn (2022) and Nurbatra & Nurbatra (2022) opinion that science literacy and life skills go in the same direction.

Current facts show that science literacy and life skills in Indonesia are still relatively low. Based on the survey results by PISA (Program for International Student Assessment), Indonesia's average score is 396 which is still relatively low, the science literacy ranking of Indonesian students is ranked 70 out of 78 countries (OECD, 2021). The factors of low science literacy of students are influenced by students who have not been trained in solving questions with the characteristics of PISA questions (Rosana et al., 2020), the selection of an inappropriate model because the model has no continuity between science knowledge and problems in life which results in less meaningful learning and has not supported students to be actively involved (Mayasari & Usmeldi, 2023). Another factor for low science literacy is that teachers also ignore science literacy-based evaluation tools because they do not understand how to make them (Sholikah & Pertiwi, 2021). Furthermore, based on data from the Central Bureau of Statistics (PBS) in 2019 the dependency rate in Indonesia was at 5.34% with a ratio of 5 out of 100 people in

Indonesia who work, this shows that life skills in Indonesia are still relatively low (Toole et al., 2020). Then high school graduates have not produced quality human resources that can compete with other nations (Indrawati & Kuncoro, 2024). The low absorption of jobs and competitiveness is because they do not have adequate life skills to be able to face various challenges of life both in society and in the global world, as well as dependence on increasingly large jobs (Dvouletý & Blažková, 2020). This condition is influenced by learning activities that have little to do with the development of life skills, but focus on academic or professional development (hard skills) (Newman, 2020). According to Haka et al. (2022) opinion that students' life skills are still weak because they perceive the opportunity to actively participate in the learning process is still lacking so that the potential of students has not been maximized.

The solution given to overcome the low ability of science literacy and life skills of students is to integrate Project Based Learning (PjBL) with the field of entrepreneurship in biological science. Windari et al. (2023) and Handoko et al. (2024) has conducted research by integrating learning resources with approaches in one study that shows an increase in students' science literacy skills. The results of the study confirmed that the integration of entrepreneurship concepts in biological science is known as bio-entrepreneurship (BEP). Bio-entrepreneurship is a biology learning approach that directs students to have entrepreneurial skills by creating a business opportunity from a product utilizing living things (Damayanti & Ratnasari, 2021). The PjBL model is one of the most effective learning to train students' entrepreneurial skills in the 21st century (Abdullahi et al., 2020). The characteristic of PjBL is that it gives students freedom in planning projects to solve problems, the results of the planning are loaded in the form of products (Syafiq et al., 2021). Meanwhile, the characteristics of the bio-entrepreneurship approach are to explore students' creativity in entrepreneurship to make innovative and economical products (Callagher & Cullis, 2021).

Using the PjBL model with a bio-entrepreneurship approach, students can develop science literacy and life skills, through activities to apply scientific knowledge in dealing with the phenomenon of business opportunities by utilizing living things that are processed into business products to produce a productive economy (Syafiq et al., 2021). One of the appropriate biology materials to include elements of entrepreneurship is biotechnology. Biotechnology is a branch of science that studies the utilization of scientific principles that use living things to produce products and services for the benefit of humans (Utomo et al., 2020). The rapid development of science and technology makes biotechnology one of the fields of science that must be mastered by the Indonesian people, including high school students (Rudiyanto et al., 2022).

Research on the use of bio-entrepreneurship as a learning approach has been conducted by other researchers before. Achmad et al. (2024) has conducted research on the effect of learning with a bio-entrepreneurship approach on life skills and students' entrepreneurial interests but has not used a project-based model in the learning process and has not measured science literacy skills. Sukma & Shiyamsyah (2024) and Handayani et al. (2022) have conducted research on the use of bio-entrepreneurship-based teaching materials in learning but the abilities measured are still focused on students' entrepreneurial skills and have not measured other life skills and students' science literacy. Agustiani et al. (2022) has conducted research on the use of bio-entrepreneurship-oriented PjBL models on entrepreneurial interest and creativity but has not measured science literacy skills. From various existing studies,

the researcher believes that it is necessary to conduct new research by integrating Project Based Learning with bio-entrepreneurship (BEP) to measure science literacy and life skills simultaneously in learning.

The implication of the bioentrepreneurship-based PPA model is that learners not only learn about biological concepts theoretically, but are also invited to develop real projects that combine aspects of entrepreneurship and applications of biological science in everyday life (Shea et al., 2021). Through these activities, learners are challenged to think critically and creatively in solving problems, as well as developing skills such as teamwork, time management, effective communication, and decision making. In addition, the bioentrepreneurship-based PPA model facilitates more relevant and contextualized learning, thus increasing learners' motivation and interest in learning, as well as preparing them with practical skills that are useful in the world of work and daily life.

METHODS

The research was conducted at SMA Negeri 1 Bandar Lampung on biotechnology material for class X even semester of the 2022/2023 school year. The type of research used is quasi experiment with pretest posttest nonequivalent control group design. The population in this study were all X MIPA class students totaling 329 students. The sample of this study amounted to 71 students consisting of class X MIPA 9 as the experimental class and class X MIPA 7 as the control class, with *purposive sampling* technique.

Data on students' science literacy skills were obtained from pretest and posttest scores in experimental and control classes, then the results of pretest and posttest scores were calculated normalized - gain (N-Gain) test. After obtaining the pretest and posttest scores, as well as the average N-Gain, a prerequisite test is carried out, namely the normality test and homogeneity test. The prerequisite test aims to determine the statistical test in proving the research hypothesis. Then to determine the effect of the application of PjBL with a bio-entrepreneurship approach to the science literacy skills of students using the effect size test. To calculate the effect size, Cohen's formula is used as follows: (Avakiat & Roopsuwankun, 2021)

$$d = \frac{\bar{X}_t - \bar{X}_c}{S_{pooted}}$$

Description:
d : Effect size value
$\bar{X}_t$: Mean score of experimental class
$\bar{X}_c$: Mean score of control class
S_{pooted} : Standard deviation

The interpretation of the effect size results follows table 1

Table 1. Effect Size Interpretation Criteria

Effect Size	Interpretation of Effectiveness
0 < d < 0,2	Small
0,2 < d < 0,8	Medium
d > 0,8	Great

Table 2. Lattice of Science Literacy Instrument in the Aspect of Science Competence

No.	Aspects	Indicator
1.	Identifying scientific issues	(1) Recognize issues that may be investigated scientifically (2) Identify key words for scientific information (3) Recognize key features of scientific inquiry
2.	Explaining scientific phenomena	(1) Apply science knowledge in a given situation (2) Describe or interpret phenomena and predict changes (3) Identify appropriate descriptions, explanations and predictions.
3.	Using scientific evidence	(1) Interpret scientific evidence and draw conclusions (2) Identify the assumptions, evidence and reasoning behind

No.	Aspects	Indicator
		the conclusions drawn.
		(3) Provide reflections based on the social implications of scientific conclusions.

Furthermore, data on the ability of students' life skills is obtained from the results of observation sheets conducted by observers in each class. The results of the observation sheet illustrate how much the percentage of students' life skills in experimental and control classes. Calculate the percentage of each indicator based on the (Sugiyono, 2015).

$$P = \frac{\sum xi}{n} \times 100\%$$

Description:
P : Percentage of *students' life skills* assessment
$\sum xi$: Number of scores obtained
n : Maximum number of scores

Then determine the percentage of assessment of students' *life skills* according to the following interpretation.

Table 3. Interpretation of the Percentage of Life Skill Assessment for Students

Value	Category
86% ≤ A ≤ 100%	Very good
76% ≤ B ≤ 85%	Good
60% ≤ C ≤ 75%	Simply
55% ≤ D ≤ 59%	Less
E ≤ 54%	Less than Once

The application of the PjBL model with a bio-entrepreneurship approach (BEP) is said to have an effect if the average value of students' *life skills* in the experimental class is higher than in the control class.

Table 4. Life Skill Instrument Lattice

Aspects	Indicator
Personal Skills	(1) Self-awareness as a servant of God, a social creature, and a creature of the environment
	(2) Awareness of self-potential and the drive to develop it
	(3) Exploration and discovery skills
	(4) Information processing skills
	(5) Decision-making skills
	(6) Problem-solving skills.
Social Skills	(1) Oral and written communication skills
	(2) Cooperation and participation skills
Academic Proficiency	(1) Proficiency in identifying variables
	(2) Ability to explain the relationship to a particular phenomenon
	(3) Ability to formulate a hypothesis for a series of events
	(4) Ability to plan and carry out research to prove a problem
Vocational Skills	(1) Proficiency in a specific field of work
	(2) Proficiency in creating or manufacturing products
	(3) Entrepreneurial Skills

RESULTS AND DISCUSSION

The results showed that the science literacy skills of students showed that at a significance level of 0.05 obtained Sig. (2-tailed) 0.000 <0.05. Based on table 5, it is known that the test results of the average N-Gain score in the experimental class were 0.67 with a medium category, while in the control class the average N-Gain obtained was 0.28 with a low category. This shows that there is a significant increase in the science literacy skills of high students in the experimental class compared to the control class.

Table 5. Science Literacy Skills of Learners

Value	Class	$\bar{x} \pm$ Sd	Normality Test	Homogeneity Test	Independent Sample T-Test
Pretest	E	47,36 ± 7,70	Sig. 0,090 > 0,05	Sig. 0.232 > 0.05 (Homogeneous)	Sig. (2-tailed) 0.000 < 0.005
	K	41,14 ± 13,47	Sig. 0,057 > 0,05		

Value	Class	$\bar{x} \pm$ Sd	Normality Test	Homogeneity Test	Independent Sample T-Test
Posttest	E	83,05 ± 9,36	Sig. 0,077 > 0,05	Sig. 0.553 > 0.05 (Homogeneous)	
	K	57,57 ± 13,47	Sig. 0,200 > 0,05		
N-Gain	E	0,67 ± 0,18	Sig. 0,200 > 0,05	Sig. 0,186 > 0,05 (Homogeneous)	
	K	0,28 ± 0,15	Sig. 0,109 > 0,05		

Notes: E = Experiment, K = Control, Sd = Standard Deviation, $\bar{x}$ = Mean

The difference in the average N-Gain between the experimental class and the control class is supported by the results of the calculation of the average N-Gain for each indicator of science literacy in the experimental class. Aspects of science competence in experimental and control classes (Figure 1).

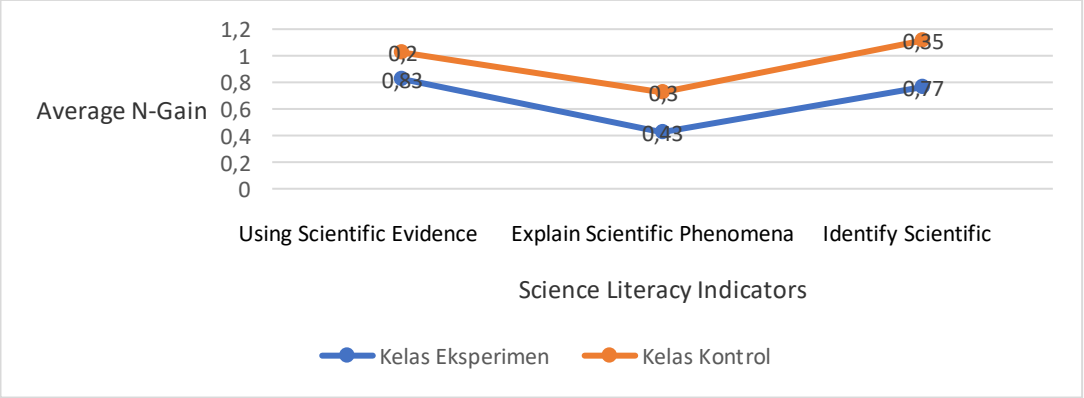

Figure 1. Average N-Gain Calculation Results of each Science Literacy Indicator on the Science Competency Aspect

Then to determine the magnitude of the effect of PjBL learning with a bio-entrepreneurship approach (BEP) on students' science literacy skills using the effect size test. The acquisition of the effect size test of science literacy skills can be seen in the following table.

Table 6. Effect Size Test Results of Science Literacy Ability

Class	Average N-Gain	Standard Deviation	Effect Size	Interpretation
Experiment	0,67	0,18	2,349	Great
Control	0,28	0,15		

Table 6. shows that the acquisition of the effect size value of 2.349> 0.8 then the interpretation of effectiveness is large. This shows that the use of the PjBL model with a bio-entrepreneurship (BEP) approach has a major influence in improving students' science literacy skills. The increase in science literacy skills is evidenced by the indicator of identifying scientific issues getting an average increase in N-Gain of 0.77 with a high category (Figure 1). The increase in indicators of identifying scientific issues can be seen from students in the step of determining fundamental questions, students can analyze problems based on phenomena that occur in everyday life, namely the drop in tomato prices in the market, besides that students can provide solutions by making projects to solve the problems presented. This is in accordance with the research of Adiwiguna et al. (2019) that the stage of determining fundamental questions can train students' thinking skills and interest in participating in the learning process, which is the initial stage for developing students' literacy skills at the

functional stage. Shofawati et al. (2023) in his research also states that in the early stages of learning by asking basic questions about the phenomena that occur can improve students' science literacy skills.

The increase in science literacy skills in the experimental class is also supported by the results of the highest increase in indicators using scientific evidence with an average N-Gain of 0.83 (high category). This increase is evidenced by students being able to analyze their findings by using scientific evidence as a foundation (Lockman & Schirmer, 2020). Then during learning activities students can make clear and relevant evaluations based on scientific evidence to objectively evaluate the success and unsuccessfulness of the product. Increasing students' science literacy skills through scientific work to solve a problem and produce a product so that learning is maximized, then the results of the highest science literacy skills on indicators using scientific evidence to solve problems that occur by applying scientific knowledge owned by students (Sholahuddin et al., 2021).

The indicator of explaining scientific phenomena in science literacy skills gets the lowest N-Gain average in the experimental class with a value of 0.43 (medium category). This happens when the project monitoring stage students are not optimal in applying their scientific knowledge to explain phenomena scientifically, so educators still guide and motivate students. Shohib et al. (2021) in her research also obtained the results of indicators explaining scientific phenomena in the low category, indicated by the low ability to apply the scientific knowledge they have understood in solving science literacy questions on material concepts. Then research conducted by Az et al. (2023) explains that one of the factors that cause the low level of science literacy of students is because students are not accustomed to working on questions that demand analytical skills.

In the control class, there was also an increase in science literacy skills but not as significant as in the experimental class. The highest indicator of science literacy skills in the control class was the indicator of identifying scientific issues with an average N-Gain of 0.35 (medium category). Learners in the control class were able to know and understand questions based on phenomena that occurred, and could identify keywords from phenomena to solve problems. While the lowest results were shown by the indicator of using scientific evidence with an average N-Gain of 0.2 (low category). This happens when the learning process students have not been able to draw conclusions scientifically, besides that students have not been able to communicate evidence scientifically.

The use of the Project Based Learning (PjBL) model with a bio-entrepreneurship approach (BEP) can also improve life skills. shows that the average life skills of students after being treated in the experimental class increased higher than in the control class (Table 7). The increase in science literacy and life skills of students in the experimental class was due to the learning process using the PjBL model with a bio-entrepreneurship approach (BEP). This situation is in line with the results of research by Anas and Murti (2016: 113) that project-based learning can improve students' life skills. In addition, in the research of Ghosheh et al. (2021) that PjBL is a learning strategy that can develop students' life skills, this can be seen from the involvement of students in solving problems.

Table 7. Results of Life Skill Assessment

Aspects	After Treatment					
	Control Class			Experiment Class		
	$\bar{x} \pm$ Sd	(%)	Criteria	$\bar{x} \pm$ Sd	(%)	Criteria
Personal Skills	2,42 $\pm$ 0,98	60,47%	Simply	3,11 $\pm$ 0,59	77,66%	Good

Aspects	After Treatment					
	Control Class			Experiment Class		
	$\bar{x} \pm$ Sd	(%)	Criteria	$\bar{x} \pm$ Sd	(%)	Criteria
Social Skills	2,21 $\pm$ 0,68	55,35%	Less	3,22 $\pm$ 0,68	80,55%	Good
Academic Proficiency	1,98 $\pm$ 0,83	49,46%	Less than Once	3,05 $\pm$ 0,55	76,21%	Good
Vocational Skills	1,67 $\pm$ 0,47	41,66%	Less than Once	3,20 $\pm$ 0,65	80,09%	Good
Average	**2,07 $\pm$ 0,74**	**51,74%**	**Less than Once**	**3,15 $\pm$ 0,62**	**78,63%**	**Good**

Based on the results of the observation sheet assessment of students' life skills abilities after being treated in the experimental class in table 7, it shows an increase in the average life skills ability of 78.63 with a good category. Increased life skills ability. This is because students have the skills needed in everyday life and the world of work, such as personal skills, social skills, academic skills, and vocational skills. Based on the results of research by Nurtanto et al. (2020) and Almulla (2020) also explained that project-based learning contributes to improving personal skills, social skills, academic skills, and vocational skills.

The high increase in life skills in the experimental class is supported by the results of the average value in each aspect of life skills (Table 7). The aspect of personal skills received an average increase of 77.66 with a good category. The increase in personal skills seen during the learning process is that students can develop their ability to explore and find information on problems that occur scientifically. In addition, students have an innovative and creative attitude in determining business opportunities to create processed tomato fruit products with the help of living things that attract consumers (Chen et al., 2019). They are also able to provide logical arguments related to decisions in determining business opportunities to solve problems systematically, so that learners have the awareness to always develop their potential. Dewi & Mashami (2019) state that the life skill that is most developed by students is personal skills, it can be seen that students are very enthusiastic about cooperating with their group friends during the activity process. Then Ghavifekr (2020) state that students can develop their potential through interpersonal interactions collaboratively to produce a product so that students' personal skills increase.

Furthermore, in the aspect of academic skills in the experimental class, the average increase was 76.21 with a good category. This is shown when students can think scientifically in identifying variables and explaining their relationship. In addition, students prepare the tools and materials to be used when making products and carry out the manufacture of products as planned systematically, this can be seen in Figure 2. According to Han & Son (2020) in his research that increasing students' academic skills is able to plan and carry out research according to previously designed work steps to prove a problem.

Figure 2. Activities to Make Conventional Biotechnology Products Can Train Learners' Academic Skills

Then in the experimental class, the highest increase in life skill aspects was also obtained, namely the vocational skills aspect with an average of 80.09 (good category) and the social skills aspect with an average of 80.55 (good category). Based on the results of the assessment of the life skills observation sheet, the high vocational skills aspect can be seen in presentation activities, namely students giving pamphlets they made to the target market to convey information directly about the benefits and uniqueness of the products made. Presentation activities as a way to market their processed products to the target market. During the presentation, students looked enthusiastic to contribute to selling and marketing the biotechnology products they made to the target market. In addition, this activity provides learners with the expertise to use methods and tools in working on relevant projects, one of which is a market survey, so that the products made by learners are very creative and have an economic selling value. The conventional biotechnology products made include variations of tomato yogurt and tomato pizza (shown in Figure 3). This is in line with Idawati et al., (2020) that producing products or services is a vocational skill possessed by students. Research by Chusni et al. (2020) suggests, that the implementation to improve vocational skills is that students can recognize a tool or material, use tools, and operate tools that have been made.

The increase in social skills aspects is evidenced when learners are able to cooperate and participate with group members collaboratively during project work. In addition, this increase is also evidenced by the oral and written communication skills of learners in project work. Learners can explain the duties and roles of fellow group members, and carry out projects according to the deadline that has been written before. This is in line with Kamil et al. (2020) that project-based learning can improve oral and written communication skills and arouse students' enthusiasm to participate in learning activities so that social skills increase. Lovakov & Agadullina (2021) in their research also that PjBL can improve social interaction, collaboration, and communication in learners to solve problems that occur.

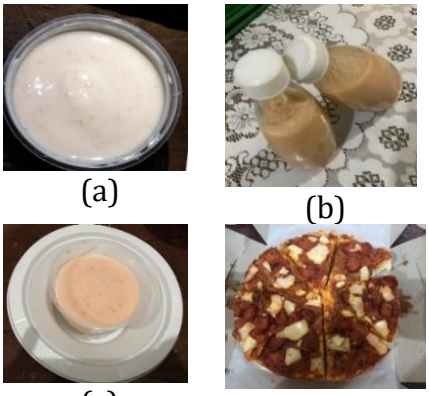

Figure 3. The results of processing tomato fruit into conventional biotechnology products (a, b, and c) variations of tomato yogurt, and (d) tomato pizza**.**

In the control class after treatment there was an increase in life skills, the increase in life skills in the control class was not as significant as in the experimental class, as can be seen in table 7. The results of the highest increase in the aspect of personal skills with an average value of 60.47 which is included in the sufficient category. Students in the control class have self-awareness to maintain cleanliness and order during the learning process and students can also provide arguments to solve problems.

While the lowest results in the aspect of vocational skills with an average of 41.66 which is included in the very poor category. This happened in the control class because during the learning process students were lacking in developing skills in the field of work such as entrepreneurship, besides that students did not have the skills to recognize and operate tools to make biotechnology products.

Based on the results of the study, the PjBL model with a bio-entrepreneurship

approach has a positive impact on improving students' science literacy and life skills. Through learning activities that combine theoretical biology concepts with entrepreneurial skills, it provides a deeper and more practical understanding of how biology concepts can be applied in real life. Then, learners are directly involved in projects that require them to conduct research, experiments and data analysis (Ramli et al., 2022). This process enriches learners' science literacy which requires them to understand and apply biology concepts to complete the project (Safitri et al., 2022). It also makes learning more contextual and relevant to everyday life, creating a rich and diverse learning environment and helping learners to develop a holistic understanding of complex issues.

CONCLUSIONS AND SUGGESTIONS

Based on the results of research and discussion, it can be concluded that the application of the PjBL model with a bio-entrepreneurship (BEP) approach has an effect on improving the ability of science literacy and life skills of students. Then further suggestions in the research that has been done, the application of this learning, educators must increase motivation and direct students to be more enthusiastic and directed in participating in learning and working with groups to be more effective and efficient.

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