RESEARCH ARTICLE

Integration of project-based learning to improve scientific process skills and conceptual understanding in the learning process of invertebrate zoology

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Abstract: Further analysis of the effectiveness of integrating project-based learning (PjBL) in Invertebrate Zoology courses to improve students' science process skills and conceptual understanding needs to be carried out. This research was aimed to analyze the integration of PjBL in the Invertebrate Zoology course on scientific process skills and conceptual understanding of student. As for seeing the effect of each indicator from each predictor, a qualitative descriptive analysis was carried out. Respondents in this study were students of the Biology Education Study Program FTTE Universitas Bengkulu. A sample of 30 respondents was taken by random sampling technique. The research instrument is a questionnaire for scientific process skills and tests for understanding concepts. The hypothesis is tested using Analysis of Variance (ANOVA). The integration of PjBL has a significant influence on the scientific skills process of 0.038 with an F value of 4.524 and also has a significant influence on concept understanding at 0.018 with an F value of 0.018. It was concluded that there was an effect of the integration of PjBL on scientific process skills and conceptual understanding of Invertebrate Zoology, with a significance level of 0.05, so that it can be taken into consideration in developing learning in the Invertebrate Zoology course.

Keywords: biology education students; conceptual understanding; PjBL; scientific process skills

Introduction

The 21st Century education aims to realize the ideals of the nation, namely a prosperous and happy Indonesian people. This concept describes Indonesian people with an honorable position and equal with other nations in the global world, through the formation of a society consisting of quality human resources, namely an independent person, willing and capable of realizing the ideals of his people (Kurniah et al., 2023; Yuliana et al., 2021). Qualified human resources have the ability to solve problems, think critically, creatively, and competitively that can express themselves in facing the times (Fajaryati et al., 2020; Lenihan et al., 2019; Rustiawan et al., 2023; Thornhill-Miller et al., 2023).
The 21st century is also known as the age of knowledge. In this era, all alternative efforts to meet the needs of life in various contexts are more knowledge based (Malik, 2018; van Laar et al., 2020). Efforts to fulfill educational needs must be knowledge-based: knowledge-based economic development, knowledge-based community development and empowerment, and knowledge-based industrial development.
In this 21st century, education is increasingly important to ensure students have the skills to learn and innovate, the skills to use technology and information media, and can work, and survive by using life skills. The 21st century is also marked by the amount of information available anywhere and can be

accessed at any time; faster computing; automation that replaces routine jobs; and communication that can be done from anywhere (Griffin et al., 2012; Saifurrahman et al., 2021; Serdyukov, 2017).

Learning in the 21st century are require students to have skills, knowledge and abilities in the fields of technology, media and information, learning and innovation skills as well as life and career skills (Partnership for 21 st Century Skills, 2015). The skills are life and career skills, learning and innovation skills, and Information media and technology skills. These three skills are summarized in a scheme called the 21st century knowledge-skills rainbow (Anggraeni et al., 2019).

The concept of lifelong learning or continuous learning is also a key to entering the 21st century in order to be able to face the challenges of the rapid changes in the world. One of the changes was the economic need to compete in global competition (Chiţiba, 2012; Elfert & Rubenson, 2023). In the global community the role of science is the most dominant, where alternative efforts to meet the needs of life in various contexts are more knowledge based. Communities whose livelihoods are based on knowledge are known as knowledge-based social empowering. Faced with this, students need to be equipped with sufficient competencies to become active students in the community (Cross et al., 2020; Whyte, 2013).

The competencies needed in the 21st century, namely "The 4Cs": communication, collaboration, critical thinking, and creativity. These competencies are important to be taught to students in the context of core subject areas and the 21st century themes (Thornhill-Miller et al., 2023). Assessment and Teaching of 21st Century Skills (ATC21S) categorizes the 21st Century skills into four categories, namely way of thinking, way of working, tools for working and skills for living in the world (Griffin & Care, 2015). Zubaidah (2019) added among the various competencies and skills that are expected to develop in students that need to be taught to students in the 21st century including personalization, collaboration, communication, informal learning, productivity and content creation.

The embodiment of the 21st Century skills is science process skills and conceptual understanding which are basic abilities that are important for students to master in science learning. Science process skills not only focus on mastering scientific concepts, but also on developing critical thinking abilities, problem solving, and practical skills that are really needed in facing the challenges of the 21st century. Science process skills such as observing, classifying, predicting, interpreting data, and scientific communication is in line with 21st century skills which include critical thinking, creativity, collaboration and communication. Thus, students' mastery of science process skills can help them develop various 21st century skills necessary for success in the future (Gizaw & Sota, 2023; Turiman et al., 2012; Wola et al., 2023).

Meanwhile, conceptual understanding refers to students' ability to understand the basic concepts of a scientific discipline in depth, connect these concepts, and use them to solve problems. Conceptual understanding is closely related to 21st century skills because it is the basis for the development of higher order thinking skills (Darling-Hammond et al., 2020; Kim et al., 2019). When students have a strong conceptual understanding, they are not only able to remember facts, but can also analyze, evaluate, and create new knowledge. This skill is a core competency needed in the 21st century, where individuals are faced with complex problems that require flexible application of knowledge. In addition, good conceptual understanding also enables students to think critically, solve problems, work collaboratively, and communicate effectively – all skills that are critical for success in the 21st century (Binkley et al., 2012; van Laar et al., 2020).

The learning conditions that have taken place so far in the Biology Education Study Program FTTE Universitas Bengkulu have not fully realized the demands of the applicable regulations. One of them drawn from preliminary testing has been done on lectures Invertebrate Zoology in Biology Education Study Program Guidance and Counseling of Universitas Bengkulu. The results of a preliminary study of the academic year 2013/2014 test result data obtained 30.39% final exam excellent category, 23 53% good, 43.14% enough, 1.96% less and 0.8% less once. Ansori (2020) stated that that the cognitive analysis of science includes the domain of content, context, and process obtained by high data categories as much as 20.24%, 79.76% moderate, and low 0%. Medium scientific process skills 78.34%. The connection with scientific process skills, according to Hernawati et al (2019), the higher the score obtained by students shows that students are used to doing scientific activities about the process of scientific skills.

According to the evaluation results conducted by Service and Development of Learning Activities Unit in the Universitas Bengkulu on the invertebrate taxonomy (zoology) process in the even semester, stated in the lecture process, the method used by lecturers is the lecture method with a percentage of its use around 78.8 %, and learning media that tend to be used are visual media with Power Point devices. Based on the results of the evaluation, it can be stated that in the lecture process has not yet advanced self-autonomous learning in which students get the opportunity to develop their potential through activities of interest, and have not been fully implemented collaboratively which gives students opportunities to teach each other to improve conceptual understanding and practical skills, this is indicated by very few (0.8%) of students who choose the field of taxonomy (zoology) invertebrates for the final project (thesis).

The data from the results of the preliminary study as described above can be used as an indicator that the learning process that is taking place has not maximally explored the potential of students. A number of factors that are suspected to be the cause of the low learning outcomes in invertebrate zoology learning include: lack of high curiosity to understand concepts and analyze material, students tend to be passive to discover their own material concepts and analyze observations (science process skills), lack self-confidence and cooperation, the unavailability of teaching materials that support to train and develop scientific process skills and scientific attitudes, as well as lecturers who tend to still use learning models that are teacher centered learning .

In terms of the learning evaluation system, it has not been deliberately designed for authentic assessment to access the achievement of comprehensive learning outcomes, evaluations carried out tend to lead to low cognitive abilities (memory), and rarely do evaluations that lead to higher cognitive abilities (analysis, evaluating, and creating), affective, psychomotor, and scientific thinking. One of the reasons is the method used by lecturers in the lecture process is not yet characterized by a contextual process.

One model that is thought to be able to develop conceptual understanding and science process skills is project-based learning (PjBL). PjBL is learning that connects academic content with real-world contexts according to the demands of the 21st century that can involve students in learning design, arouse student enthusiasm for problem solving, and decision making. PjBL becomes one of the learning model choices that will be used to empower understanding of concepts and science process skills (Halimatusyadiyah et al., 2022; Markula & Aksela, 2022). PjBL gives a better influence and improves students' science process skills (Afifin et al., 2021). Other results conclude that the ability of self-efficacy gives significant results related to project learning (Choi et al., 2016; Shin, 2018). Furthermore, in its application the PjBL learning model can be used on a broad scale (general) for problems in several domains regardless of its content, or narrow scale (specifically) for certain domains such as classifying laboratory specimens.

The results of research conducted by previous researchers show that students who have been given PjBL training will influence students to learn more about how to solve specific problems found. Likewise with the recognition of the teachers put forward by Chiang and Lee (2016), by looking at the effect of this PjBL exercise the teachers agree that the PjBL is important to apply especially in science, because it affects the motivation to learn, the ability to solve problems. The application of PjBL especially in the field of biology, it can affect the learning outcomes of human digestive system materials, helping students understand the processes of scientists in order to obtain and use biological knowledge for scientific advancement (Nofitasari et al., 2021; Tuaputty et al., 2023).

Based on the rationality of strengths and weaknesses of PjBL, it is considered important to conduct research about its implementation in invertebrate zoology courses and influence on conceptual understanding and science process skills. This research was aimed to analyze the integration of PjBL in the Invertebrate Zoology course on scientific process skills and conceptual understanding of student.

Mastery of science process skills and conceptual understanding are key aspects in science learning, including in Invertebrate Zoology courses. Science process skills enable students to actively engage in the process of scientific inquiry, while conceptual understanding supports them in building deep and transferable knowledge. These two aspects are very important to prepare Biology Education students to face the challenges of the 21st century, which demands the ability to think critically, solve problems, and apply knowledge effectively. This research is important to analyze how the integration of PjBL activities can improve students' science process skills and conceptual understanding in the Invertebrate Zoology course. It is hoped that the results of this research will provide valuable insights for the development of science learning that is more effective and relevant to the needs of the 21st century, so that it can contribute to improving the quality of graduates of the Biology Education study program.

Method

This research was conducted for 4 months. There were nine material topics that students learned during this study, namely Porifera, Coelenterata, Ctenophora, Vermes, Mollusca, Echinoderms and Arthrophoda. The experimental class and the conventional class all study nine topics. PjBL activities are independent variables, while science process skills and concept understanding are dependent variables. Class meetings are held once a week and each lesson lasts 150 minutes.

The implementation of project activities in the experimental class was carried out in stages in accordance with the learning steps of the project referring to Grant (2002) and Sumarni et al (2016) including stage: (1) student orientation on project problems; (2) the organization of teaching and learning activities; (3) Guidance project guidance; (4) development and presentation of project results; and (5) analysis and evaluation of the learning process and reflection on project results. As for conventional classes over the past five years applying conventional learning methods/models. Application of the conventional learning models based on the instruction experimentally that complete, contains objectives, basic theory, tools and materials, working procedures and data tables, presentations.

Respondents in this study were biology education students who took the Invertebrate Zoology course in the 3rd semester year at the Universitas Bengkulu consisting of 80 students. A sample of 80 students was taken by cluster random sampling technique. The design used is quasi-experimental, only posttest control group design. The research instrument was a science process skill questionnaire and a test for understanding concepts. The process skills questionnaire consisted of 30 items that had been validated by a scientist and tested on students who were not research samples. Concept understanding tests are given in the form of essay tests (Chabalengula et al., 2012; Erkol & Ugulu, 2014; Ongowo & Indoshi, 2013).

The validity and reliability tests were determined based on the results of the trials on 32 students who were not research samples. The reliability test results with Crocbachs Alpha show the results of 0.847 for science process skills and 0.914 for self-efficacy. The problem of science process and self-efficacy has been tested for validity using the Pearson Correlation test which shows all items are valid.

Research data were statistically tested using ANOVA which aims to explain the difference between more than two groups of samples with a significance level of 5% ($p < 0.5$) (Mertler & Reinhart, 2016). The data obtained were first tested in the analysis prerequisites including the Kolmogorov-Smirnov normality test and the homogeneity of variance using the Levene-Test. The hypothesis being tested is that there is no influence on the integration project activities to improve science processes and self-efficacy skills. All data testing was performed using the SPSS Program version 23.0 for windows.

Results and Discussion

Implementation of PjBL

Descriptive data analysis about the integration of PjBL in the learning process presented in Table 1. The learning process by integrating project activities gives good results when viewed from the data presented in Table 1. Projects carried out by students in some activities still require direction and guidance during the process learning. Students are still less critical in investigating and analyzing the data needed to complete a project, therefore, it must be stressed repeatedly. In addition, with various activities and repetitive emphasis can improve student skills. Students can also work cooperatively and collaboratively with their groups that projects created during several activities can produce the expected product. To be accustomed to exploring through investigative learning, organizing problems, organizing data, making hypotheses, it is necessary to increase reflection during project activities.

Table 1. Results of Analysis of PjBL Integration

PjBL Syntax	Activity (value in %)						
	1	2	3	4	5	6	7
Student orientation to problems	66.67	77.78	88.89	77.78	77.78	77.78	88.89
Arrange students to study	88.89	66.67	77.78	77.78	77.78	88.89	88.89
Guide students to carry out project activities	83.33	83.33	83.33	83.33	83.33	66.67	66.67
Develop and present project results	66.67	66.67	83.33	83.33	66.67	83.33	83.33
Analyze and evaluate process activities	66.67	66.67	66.67	83.33	83.33	83.33	83.33
Average	74.45	72.22	80.00	81.11	77.78	80.00	82.22

Integration of PjBL with Scientific Process Skills

Data analysis was carried out to explain the effect of the integration of PjBL on the scientific process skills of Biology Education Study Program students in the Invertebrate Zoology course. The results are presented in Table 2. ANOVA test results show that the effect of the integration of PjBL on students' scientific process skills in the Invertebrate Zoology course is very significant. That can be seen from the calculation results (0.038) with an F value of 4.524.

Table 2. Summary of the integration analysis of PjBL in the scientific process skills of prospective biology teachers

	Number of Squares	Df	Mean Square	F	Sig.
Between groups	35.267	1	35.267	4.524	0.0038
In Group	452.133	58	7.795		
Total	487.400	59			

This result is in agreement with many previous researchers who have investigated the relationship between PjBL as a learning model or strategy and scientific process skills. PjBL serves a feasible way to incorporate classroom learning activities. A literature study shows that PjBL can promote the development of higher cognitive levels and offer various forms of performance appraisal (Guo et al., 2020; Yu, 2024). Other results show that students who experience difficulties in conventional learning gain significant benefits through PjBL experiences (Cooper & Kotys-Schwartz, 2013). Thus, PjBL can develop better performance skills (Sumarni et al., 2016). More important when students do project work, their abilities increase because of experience in performing complex skills (Artama et al., 2023; Guo et al., 2020). This finding becomes even more important for students learning through PjBL. Therefore, this learning strategy can be an alternative to place them as students in a better position.

PjBL shows positive results with the creation of active learning that is interesting and meaningful. Mastery of science process skills enables students to conceptualize at a deeper level. In addition, he also classified these scientific process skills into information processing skills, reasoning, inquiry, and creative thinking skills (Opateye, 2012). PjBL is learning in which students respond to questions around the real world or solve problems through inquiry processes, develop thinking skills, creativity and encourage them to work together as a team (Fatimah, 2018; Issa & Khataibeh, 2021). PjBL can also create an environment that helps students to build meaningful knowledge and become active in student-centered learning, and encourage them to collaborate and solve problems on relevant knowledge and skills (Chiang & Lee, 2016).

The learning process by integrating project activities gives good results when seen from Table 1 of the data presentation. Projects undertaken by students in several activities still require direction and guidance during the learning process. Students are still less critical in investigating and analyzing the data needed to complete a project, therefore, it must be stressed repeatedly. In addition, with various activities and repetitive emphasis can improve student skills. Students can also work cooperatively and collaboratively with them that projects created during several activities can produce the expected products. To achieve habituation to be explored through learning inquiry, organizing problems, organizing data, making hypotheses, and reflection during project activities need to be improved.

These results are consistent with a number of previous researchers who have studied the relationship between project-based learning as a learning model or strategy and scientific process skills and self-efficacy. PjBL serves a feasible way to incorporate classroom learning activities. A literature study shows that PjBL can promote the development of higher cognitive levels and offer various forms of performance appraisal (Almulla, 2020; Ngereja et al., 2020; Zhang & Ma, 2023). Other results indicate that students are experiencing difficulties in conventional learning significant benefits are obtained through PjBL experiences (Cooper & Kotys-Schwartz, 2013). Thus, PjBL can develop better performance skills (Guo et al., 2020). This finding becomes even more important for students learning through PjBL. Therefore, this learning strategy can be an alternative to place them as students in a better position.

Based on research conducted by See et al (2015) it is explained that PjBL shows positive results with the creation of active learning that is interesting and meaningful. Opateye (2012) explains that mastery of science process skills enables students to conceptualize at a deeper level. In addition, he also classified these scientific process skills into information processing skills, reasoning, inquiry, and creative thinking skills. Chiang and Lee (2016) explain that PjBL can also create an environment that helps students to build meaningful knowledge and become active in student-centered learning, and encourage them to collaborate and solve problems on relevant knowledge and skills.

In general, Shin (2018) revealed that PjBL can increase student motivation in learning science, the ability to solve problems and improve learning achievement. A recent study from Picard et al. (2022) that a well-designed project process can help students to achieve knowledge and skills better than lecturing in engineering education. Other findings in the work of laboratory work projects can help students visualize abstract concepts become real, develop student performance directions and are easily understood by students (Elmoazen et al., 2023; Shana & Abulibdeh, 2020).

This finding confirms that scientific process skills can be trained and developed through the integration of projects in the learning process, project-based learning, or a combination of PjBL with other learning strategies. Further explanation regarding the position of each indicator in scientific process skills is shown in Figure 1.

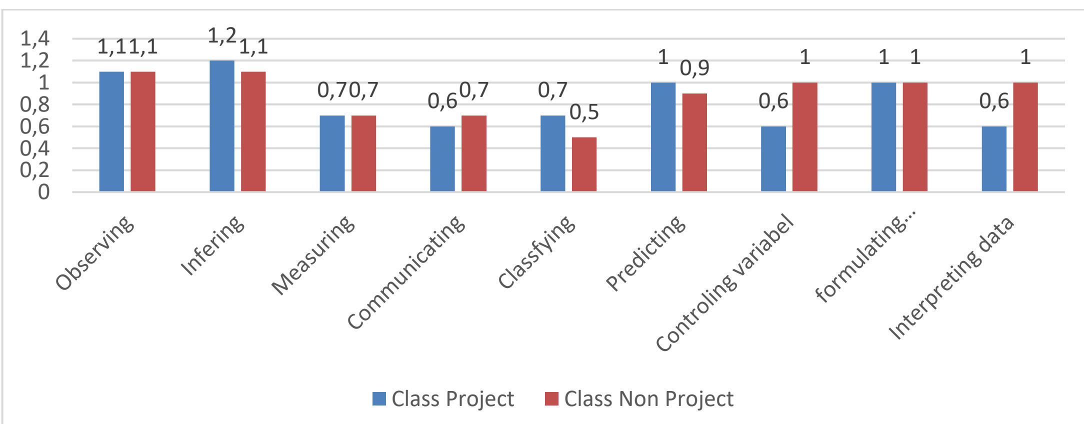

Figure 1. Average score of scientific process skills in project and non-project classes

Based on the results of the study, the project class and non-project class have the same ability in observing, measuring, and making operational definitions. Observation is the most basic process in science (Agustiani et al., 2022; Hardianti & Permatasari, 2023). Measurement is a quantitative representation of observations, which can be done by making operational definitions for variables, which will vary according to facts, phenomena, and related variables that cannot be measured directly. This measurement can be done using standard and non-standard measurements to describe each dimension (Ongowo & Indoshi, 2013).

The ability to make conclusions, classify, and predict the project class higher than the class of non-projects. The ability to make conclusions refers to the development of observation and previous knowledge, express ability to classify. One can categorize an object of course based on similarities, differences, and relationships between objects. Therefore, classification has an exclusive role in developing various conceptions. This is because facts and generalizations must be collected and arranged to form concepts. Predicting is an important part of science, which refers to how someone makes a specific statement about what will happen. Accurate predictions need thorough observations and correct measurements. The prediction also states the statement of the event's future results based on the pattern of evidence (Chabalengula et al., 2012; Ongowo & Indoshi, 2013).

The results also showed that non-project class students have higher communication skills, control variables, make hypotheses, and interpret data than project class students. Communication is important as a basic human effort in making arguments. Communication can be done by using words or symbols to describe an action, object or event. Control variable also the skills necessary to improve the data validity and reliability and manage scientific investigation (Chabalengula et al., 2012; Ongowo & Indoshi, 2013).

Making a hypothesis or statement about possible variable relationships is another basic skill based on observation. Data interpretation is related to the analysis of organized data, inferred from data and making sense of data. Therefore, one can easily find patterns that lead to conclusions or hypotheses (Erkol & Ugulu, 2014; Ongowo & Indoshi, 2013). When examined from the standpoint of behavior theory, Schunk (2012) state that learning behavior can influence the learning process. Some things suggested in behavioral learning theory include emphasizing stimulus presentation and response reinforcement (Thorndike's learning theory), habituation (Pavlov's Theory), and reinforcement (Skinner's theory) not yet attached to several indicators in the project class.

The ability of students to explore themselves is still lacking so meaningful learning concepts as in Ausubel theory need to be emphasized as challenges and have positive opportunities to become better. A number of research findings support that scientific process skills are strongly related to cognitive development, support thinking, reasoning, inquiry, evaluation, student problem solving skills, and creativity (Almulla, 2023; Hacıeminoğlu et al., 2022; Mayer et al., 2014; Özgelen, 2012; Sholahuddin et al., 2020). In addition, there is a strong relationship between student achievement and learning (Figure 1). Average score of scientific process skills in the project class and non-project class process skills. Previous studies have shown that scientific process skills are another important factor required for problem solving and direct functionality (Hernawati et al., 2019; Ilma et al., 2020; Prayitno et al., 2017).

The researchers believe that a positive attitude towards science makes students more interested in focusing the science process. In other words when students understand science process skills, it becomes more attractive to them, so as to increase positive attitudes towards science (Hofstein & Mamlok-Naaman, 2011; Tytler & Osborne, 2012). Researchers investigate the acquisition of science process skills by teachers. The results showed that they had moderate scientific skills acquisition and did not show differences in results by sex (Wola et al., 2023; Zeidan & Jayosi, 2014).

Integration of PjBL on Conceptual Understanding

Analysis of PjBL on understanding the concepts of Biology Education students is shown in Table 3 and Table 4. In Table 3, the results of descriptive analysis are related to the project's effect on understanding the concepts of Biology Education students. The experimental class average pre-test concept comprehension was 75.14 and post-test was 79.17 while the control class was average pre-test concept comprehension by 76.09 and post-test by 75.26. Thus, the effect size or d-value for the PjBL model on concept understanding in the experimental class is 0.71, it can be concluded that it has a big effect, while for the control class, 0.11, it can be concluded that it has a moderate effect.

Table 3. Average Pre-test, Post-test, and effect size on Conceptual Understanding

Treatment class	Pre-test average	Post-test average	Effect Size
Project class	75.14	79.17	0.71
Non-project class	76.09	75.26	.11

Table 4. Summary of ANCOVA Understanding Test Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	118.350 *	2	59.175	12.517	.000
Intercept	1269.431	1	1269.431	268.951	.000
Group	64.309	1	64.309	13.625	.000
Pretest_Concept_Deepening	19.935	1	19.935	4.224	.044
Error	316.236	67	4.720		
Total	9877.000	70			
Corrected Total	434.586	69			

Table 4 shows the significance value in the corrected model with the conclusion that there is a significant effect of the learning model on the understanding of concepts in signification 0.000 with an F value of 12.517. While the significance for the concept understanding variable is 0.044 with a Sig value <0.05 and an F value of 4.224. The PjBL model has a significant effect on the understanding of concepts with pre-tests as covariates at the 0.05 significance level. The significance value obtained is 0.000.

The data in Table 4 indicates that the learning model applied has a significant impact on students' conceptual understanding in the Invertebrate Zoology course. These results also show that the PjBL has a significant influence on students' conceptual understanding at the 0.05 significance level, with the pre-test score as a covariate. The significance value obtained is 0.000, which means the PjBL model significantly increases students' conceptual understanding in learning Invertebrate Zoology.

The integration of PjBL in science learning, especially in Invertebrate Zoology courses, can be an effective approach to facilitate the development of students' conceptual understanding. PjBL encourages students' active involvement in the process of scientific inquiry, enabling them to connect theoretical concepts with practical applications, as well as encouraging critical thinking, problem-solving and collaborative skills (Almulla, 2020; Issa & Khataibeh, 2021; Markula & Aksela, 2022). Feedback and reflection during and after project activities also provide opportunities for students to improve their conceptual understanding, so that the understanding developed becomes deeper and longer lasting (Hartmann et al., 2023; Veine et al., 2020).

Based on the results of data analysis, PjBL also influences Biology Education Students' conceptual understanding. PjBL has advantages that make it stand out among other models. PjBL engages students, improves cooperative skills (de la Torre-Neches et al., 2020; Grant, 2002), improves academic achievement (Zhang & Ma, 2023), develops HOTS (Khafah et al., 2023), motivation (Wijnia et al., 2024), and builds positive relationships between students and teachers. A number of research findings reveal that significant learning outcomes have a direct relationship to project experience and demonstrate the development of conceptual understanding. The project experience process can help students improve their understanding of concepts and continuous learning processes (Almulla, 2020; Zhang & Ma, 2023).

Conclusion

Based on the research above, it can be concluded that the integration of pJbl has a significant effect towards the scientific skills process at 0.038 with an F value of 4.524 and also has a significant effect on self-effectiveness at 0.018 with an F value of 0.018. Based on the analysis, the integration of teaching Invertebrate Zoology and the learning process of students study biology can improve the scientific process skills and conceptual understanding, with a significance level of 0.05. The integration of PjBL in the learning process tends to have a higher potential in improving science process skills and conceptual understanding of biology education students. Statistical analysis shows the PjBL significantly influence science process skills and understanding of biology education student concepts. It believes that the integration of PjBL has the right learning stages that are needed by students in increasing their achievement. Students engage in a variety of skills and foster their self-efficacy.

This research contributes to biology education students and lecturers to implement project integration in involving many skills in training and developing science process skills and conceptual understanding. Another thing of self-efficacy is strengthening during the learning process. The implications of this research education curriculum should pay more attention to small research activities, especially those that have a direct impact on improving teaching practices and improving the performance of biology education students in science learning. PjBL can be taken into consideration in developing learning in the Invertebrate Zoology course

The limitation of this study is the number of samples which are less representative in representing the research. Another problem is the concept of limited discussion in research on Arthropod material lack of original specimens as samples during the learning process. For further research it is recommended to add a number of samples and expand research material.

Conflicts of Interest

The author stated has no conflicts of interest in this paper.

Author Contributions

A. Abas: analysis of data and writing, original draft preparation, revision; **M. Amin:** methodology, data checking and data validation; **I. Ibrohim:** methodology and data review; and **S. E. Indriwati:** methodology and data review.

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