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The Effect of Blended Project-Based Learning for Enhancing Student's Scientific Literacy Skills: An Experimental Study in University

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Abstract

As many studies focus on improving scientific literacy skills in students, there are still many gaps, thus an appropriate learning innovations are needed to get maximum results. This study aimed to evaluate the implementation of project-based blended learning in enhancing students' scientific literacy skills at the university. The experimental study involved 40 students of class A from the Department of Biology Education as the experimental group and 40 students of class B in the same department as the control group. The research instrument used the Economic Co-operation and Development (OECD) data. The results showed a significant increase in all aspects of scientific literacy skills after the implementation of project-based blended learning at the university such as an explaining phenomena scientifically, designing and evaluating scientific inquiry, and interpreting data and evidence scientifically. This research is beneficial for university lecturers for a solution to the problem of scientific literacy skills in students especially in university. Furthermore, there needs to be similar research at the elementary, junior high, and senior high school levels.

Keywords: project based blended-learning, scientific literacy, students

Introduction

Biochemistry learning is learning that provides direct and meaningful learning experiences to develop student competencies to better understand the natural surroundings. Broadly speaking, learning biochemistry has three main components in learning, namely scientific attitudes, scientific processes, and scientific products. In terms of learning, biology should not only focus on concepts. However, it provides direct experience in developing product, process, and scientific attitude mastery or more broadly in scientific literacy mastery (Arlis et al., 2020; Zuhara et al., 2019).

Scientific literacy or scientific literacy does not only affect the development of technology and science, but also broadly affects human life which reflects the culture of a community. For industrialized democracies, scientific literacy is very important for everyone. This is considered important because in industrial activities, most of the decision-making processes involve science and technology. Whereas in a democracy, decisions are made by the citizens themselves. So it is important that every citizen knows and understands the issue of science and technology. Therefore, scientific literacy needs to be trained through science learning activities. (NRC, 1996)

Numerous of today's most pressing societal issues are scientific and technological in nature. To address these challenges, citizens must be able to engage in conversations and decision-making processes with a firm grasp of these scientific and technological components. Thus, scientific literacy is a critical component of education in contemporary science and technology-driven cultures, and it is necessary for teaching science to all individuals, not just those who are actively involved in or interested in science as a profession (Jgunkola & Ogunkola, 2013). Scientific literacy is being a critical due to it fosters the development of critical abilities necessary for children in the twenty-first century, from elementary school to college, such as critical thinking, creativity, collaboration, and communication (Banila et al., 2021). Science educators, scientists, and policy makers agree that empowerement of students' scientific literacy is an important aim of science education (Gormally et al., 2012). Everyone must be able to understand the scientific aspects and problems in this modern era. Scientific literacy can be applied by recognizing the meaning and urgency to put all of the scientific literacy aspects as an application needed to develop student potential

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(Nainggolan et al., 2021). Scientific literacy is very important to prepare the skills that students in the 21st century must have from elementary school to college level, which include critical thinking, creative, collaborative, and communication skills (H. Lestari et al., 2021)

Science literacy is critical for students to develop as they can not only comprehend science as a subject but also used it on their daily lives. Science literacy is critical to develop because (1) it provides personal satisfaction and pleasure as a result of understanding and studying science; (2) everyone requires information and scientific thinking in order to make decisions; (3) everyone needs to engage their abilities in public discourse and debate about significant issues involving science and technology; and (4) science literacy is critical in the world (Sutrisna, 2021).

Scientific literacy is one of the required skills in the age of digital literacy, where scientific process and understanding are required in making a personal decision, participating in socio-cultural issues, and economic productivity. Scientific literacy is important for modern society since they rely heavily on technology that massively intersects with the issue of science (Turiman et al., 2012). Individuals with excellent scientific literacy can sort out more information and make more informed decisions. In a world filled with the products of scientific work (scientific inquiry), scientific literacy becomes a necessity for everyone, including the pre-service teachers who are prepared to face the educational challenges in the future. As educators, they are required to have high-level skills that enable them to learn, reason, think creatively, make decisions, and solve problems. Understanding science and its process facilitate the attainment of those skills. Countries have made a great investment to enhance scientific and technological literacy, including Indonesia (Sartika et al., 2018). As science and technology are a source of solution and risk, an individual should consider the potential benefits and risks of using science and technology. Scientific literacy requires not only knowledge about the concept and theory of science but also knowledge of the general procedures and practices related to scientific inquiry and advanced science. Therefore, scientific literacy is considered to be the essential critical competency to build human well-being in the present and the future.

PISA is a large-scale international assessment conducted in 50 countries to assess and compare students' reading literacy, mathematics, and science skills against those of other participating countries, in order to provide an overview of each country's educational system's strengths and weaknesses. Indonesian pupils' ability to read and write science is in the low or very low international benchmark group, according to PISA evaluation data (Banila et al., 2021). Indonesia ranks 74th out of 79 countries in the 2018 Programme for International Student Assessment (PISA) survey results published in March 2019 in the categories of reading ability, science, and mathematics. Indonesia is ranked ninth from the bottom (71), with an average score of 396 in the science performance category. This is a decrease from the 62nd position in 2015.

Scientific literacy can be assessed every three years through the OECD's PISA (Organization for Economic Cooperation and Development) PISA survey. The OECD is an international organization dedicated to economic cooperation and development, while PISA is a method of assessing students' competence and knowledge in reading, mathematics, and science.

Indonesian students' capacity for science literacy has remained low from 2000 to 2018, as measured by a score below the average PISA completeness score. This demonstrates that Indonesian students are incapable of comprehending scientific concepts and procedures, as well as applying their acquired science knowledge in daily life. Indonesian students have a widespread lack of science literacy as a result of learning activities that are not geared toward the development of science literacy (Sutrisna, 2021).

National Research Council (1996) defines scientific literacy as an ability to understand the unity of concepts in science by applying science in everyday life. Someone with great scientific literacy is capable of explaining a phenomenon scientifically, evaluating and designing scientific inquiry, interpreting data, and providing scientific evidence using scientific and technological reasoning (OECD, 2019). The students' scientific literacy skills in the biochemistry course observed in this study involve understanding the principles of biochemistry knowledge and its application in reading news, discussing, seeking valid information, and interpreting tables and images. Universities also play a significant role in introducing and improving the level of science literacy in the community through the provision of guidance to apply basic science and technology knowledge in society since they are obligated to develop science and technology and apply the value of the humanities. (Singh, 2021) individual who has scientific literacy can connect science and society. However, students' difficulties in understanding and analyzing the course material indicate their low scientific literacy.

The pre-service teachers' low scientific literacy skills affect the students learning in school in the future (Fifi Khoirul Fitriyah et al., 2021; Novitasari, 2018). A previous study from (Al-Momani, 2016) reveals the importance of scientific literacy in improving the academic skills of students majoring in science and associating them with social issues. Low scientific literacy skills remain a major challenge that should be improved through an active learning model (Hidayahtika et al., 2020). A good scientific literacy also support character education in students especially in aspect believe and fear God Almighty (F. K. Fitriyah et al., 2022; Fifi Khoirul Fitriyah & Djazilan, 2020).

One of the learning model that meets the components of scientific literacy is a project-based blended learning

(PjBBL). PjBBL was introduced by the UoE. In this learning, the projects are organized based on problem solving and students' participation. This learning model prepares students to handle complex, real life, and working problems (Coto et al., 2013)Hewlett Packard, Microsoft, Fujitsu, Sykes, Amazon, Oracle, Cisco, AvVenta, Amazon, Convergys, Dell, and IBM have established operations and offices in the country. In addition, a growing number of local companies have been established to provide ICT products and services worldwide. Such development requires a large qualified workforce related to computer science and informatics, with skills in the areas of problem solving, group work, mathematics, business administration, and foreign languages. In computer engineering, teaching has traditionally been deductive, with lecturers presenting theories and general principles, illustrative examples, practical work, and at the course end tests of students' ability to do the same kind of reasoning through exams. This approach is very common in Costa Rican universities. However, many studies show that problem-based, inductive teaching that present students to real-life questions and realistic case studies is a preferable alternative. Problem-based teaching prepares better the students to complex, real-life problems and work. When students analyze the data and try to solve the problems, they create and see a need to know the principles, facts, rules and procedures. This need has a strong impact on motivation for learning, because students can understand the purpose of what they are learning. This chapter presents findings from a Costa Rican case study where the School of Informatics at the National University of Costa Rica tried out and studied how a problem-based learning approach (PBL. Learning objectives ideally aims to guide students to adapt in the real world, become critical thinkers and creative problem solvers, and decision makers. This study aims to analyze the influence of PjBBL learning model on the scientific literacy skills for student's university.

In recent years, there has been a resurgence of interest in project based blended-learning. Indonesian students' low level of science literacy is influenced by the curriculum and education system, teacher selection of teaching techniques and models, learning facilities, and instructional materials. According to (Angraini, 2014) research, the ability of students in Class X High School in Solok City to develop science literacy ability is still relatively low, owing to the fact that the evaluation material has never been studied, students are unfamiliar with working on discourse-based questions, and the learning process is less conducive to developing science literacy ability (Rizkita et al., 2016) stated the same thing, stating that Malang high school students continue to struggle with science literacy. Science literacy is low as a result of a learning process that omits science. Additionally, (Diana et al., 2015) determined that the ability of Bandung's Class X High School students to demonstrate science literacy is still very low, owing to the discrepancy between school-based learning targets and PISA requirements (Sutrisna, 2021).

Through using an appropriate methods and technology, students' science literacy abilities can be developed and enhanced (Fitriyana et al., 2020). Technology is a critical learning aid, even more so now that the Covid-19 pandemic is underway. Blended learning is an instructional method that combines in-person and online instruction (H. Lestari et al., 2020). In this new normal period, blended learning makes use of internet media and synchronous and asynchronous multimedia. Synchronous learning is an instructional method that combines direct interaction between students and teachers with the use of online tools such as conferences and chat rooms. While asynchronous learning is a form of indirect learning (learning that does not occur concurrently), self-learning is another (Borup et al., 2019; Richardson et al., 2020). Scientific literacy research based on blended learning has been conducted in Indonesia and these findings indicate that students' scientific literacy skills, after the blended learning intervention using the STEM approach, have increased (Arlis et al., 2020; Zuhara et al., 2019)..

Blended learning is a learning environment that is directly synchronous, virtually synchronous, collaboratively asynchronous, and independently asynchronous. Synchronous directly applies face-to-face learning at the same time; synchronous virtually applies direct learning but via virtual face-to-face in the same time but different locations; collaborative asynchronous is learning by collaborating with others anywhere and anytime via discussion media such as blogs, chat rooms, and whatsapp groups; and independent asynchronous applies independent juxtaposition anywhere and anytime via video, television, and radio (Chaeruman & Maudiarti, 2018). During this pandemic, only direct sync could not be deployed in the four study rooms.

Blended learning consists of three stages: (1) information seeking, which involves locating and evaluating information from various sources of information available asynchronously and independently based on its relevance, validity, reliability, and academic clarity; (2) acquisition of information, which involves locating, comprehending, and confronting it with ideas or concepts already in mind, and then interpreting information/knowledge from various sources available, until they are able to communicate back and interp Return and interpret the concepts and outcomes of their interpretations in a synchronous and asynchronous virtual environment (Chaeruman & Maudiarti, 2018; Banila et al., 2021).

Learning in scientific literacy emphasizes on the achievement of the students' scientific attitude. Meanwhile, the enhancement of students' scientific literacy requires attitude development, the expansion of the idea, and science process skills through scientific inquiry activities. One of the learning models that potentially improve scientific literacy is problem-based learning. Problem-based learning is expected to increase scientific literacy as its model provides the opportunity for students to solve a problem scientifically using science and technology and apply the concepts and principles of science (Sibarani et al., 2019). This study aimed to evaluate the implementation of project-based blended learning in enhancing students' scientific literacy skills at the university.

Some researchs about improving scientific literacy skills through project based blended learning have been conducted, such as (H. Lestari et al., 2021) that showed the average scientific literacy skills of students from the application of the blended learning model with the STEM approach had an average score of 85.50 in the good category. Several models have been applied, such as the project-based learning model assisted by blended learning. The results can make the learning atmosphere in the classroom fun and meaningful because it involves students actively and creatively in finding problems and how to solve them so that students are successful in learning.

The gap of the previous studies and in this study is the using of Edlink and in the biochemistry topics. The program Edlink create a framework to think more organized, contains the task, zoom, project assignments, videos, links youtub, the poster of the worksheet student during the practicum, as well as tasks assigned to students can be conceptualized. On the program Edlink consists of some of the menu there are class information, discussion, learning sessions, assignment, quiz, file, class members and reports. On the session menu of learning lecturers can share materials, lesson plans, learning videos, and even a virtual lab.

Therefore, based on the background that has been described, This study aimed to evaluate the implementation of project-based blended learning in enhancing students' scientific literacy skills at the university. Given the importance of mastering scientific literacy by students, it is necessary to have a biokimia learning pattern that is oriented towards the active paradigm, namely project-based learning technology that allows students to get information widely so that students can be more proficient in their fields, more critical, have the ability to think logically, think creatively, be able to solve problems, and master technology.

Literature

Project-Based Blended Learning

Project-based learning and Blended Learning have been widely used in universities. Similarly, studies on Project-based learning in the Blended Learning environment for some specific courses have been widely carried out, but a combination of Project-based learning and Blended Learning teaching models have not been identified (Tong et al., 2020). Originally, blended learning used a combination of learning media, such as audio-visual media and blackboard (Jannah et al., 2021; Kusumaning Ayu et al., 2019). In recent technology advancement, blended learning is defined as the combination of face-to-face and online learning (Garrison & Kanuka, 2004). A combination between blended learning and project-based learning emerges as they have many common elements. In Project-based learning, students are self-taught and are divided into groups to identify and solve problems. Similar to blended learning, project-based learning also involves assignment, self-study, face-to-face teaching, and the learning examination and evaluation through the teaching platform (Tong et al., 2020).

Scientific Literacy Skills and Its Aspects

Scientific literacy skills refer to students' scientific competencies that involve knowledge of science and understanding of the science characteristics as a way of acquiring knowledge. It signifies that scientific literacy mastery depends upon an individual's attitudes towards science and their willingness to engage in science-related issues (Kogure, 2010). Scientific literacy greatly helps everyone to address problems critically, particularly related to science and technology. Someone with good scientific literacy has proper life in this current era of science and technology (Toharudin, et al., 2011). In contrast, without scientific literacy, a person faces difficulty to make decisions on various phenomena and is left behind in this modern technology era. Without scientific literacy, both the younger generation present and future are unable to compete on a global scale (Novitasari, 2018). Holbrook & Rannikmae (2009) define scientific literacy as the ability to apply science concepts in everyday life, solve science problems, and associate science concepts in solving social, economic, technological, and cultural issues. Furthermore, enhancing scientific literacy through science education develops creative use of evidence-based scientific knowledge and skills, relevance for everyday and career life, in solving personally challenging and meaningful scientific problems with responsible socio-scientific decisions (Holbrook & Rannikmae, 2009).

According to PISA (2010), three dimensions of scientific literacy are the science content, science process, and scientific context. Science content refers to the key concepts needed to understand the nature and environmental changes caused by human activity (Ratnasari et al., 2022). Meanwhile, the process of science refers to the students' involvement in solving a problem or question, analyzing, and formulating the conclusion. This process requires students to categorize the questions that can be solved by science and require investigation of science. This dimension indicates students' communication, problem-solving, and critical thinking competence so that students are obligate to communicate the results of their scientific process. The context of science represents the conditions in everyday life that can be a reference to understanding the concept of science. In this dimension, students' scientific creativity is enhanced by creating and modifying the scientific objects in daily life based on the prior scientific concept (Sibarani et al., 2019).

Method

Research Design

This quasi-experimental research used a non-equivalent control group design. This design involved an experimental and control group. Both experimental and control group received a pretest. After that, the experimental group attended class using PjBBL, while the control group used PjBL. In the end, both classes attended a posttest to identify the effect of the treatment on the experimental group. The population in this research was the students of biology education academic year of 2020. The dependent variable is skills.

Available in the form of a platform namely zoom and edlink which are packaged in it materials related to the Project based blended learning model that interactive activities such

Table 1: Differences in the Implementation of project-based blended learning from the Lecturer and Student Side

		Learning Activities	
No	*Syntax*	*Lecturer*	*Student*
1.	Asking essential questions *(Start With the Essential Question)*	Introducing the topic and providing essential questions, namely questions that can assign students to carry out an activity, Take topics that are in accordance with real-world reality and begin with an in-depth investigation. *(FTF, online and Offline)*	Express opinions, ideas, ideas, and formulate essential problems. *(FTF, online and Offline)*
2.	Designing a project plan *(Design a Plan for the Project)*	Facilitate project planning by inviting collaboration to solve problems through projects. *(FTF, online and Offline)*	Planning the project, by compiling the things needed for project activities, both tools and materials. *(FTF, online and Offline)*
3.	Schedule *(Create a Schedule)*	Collaborate to develop a schedule of activities in completing the project. *(FTF, online and Offline)*	Develop a schedule of implementation and completion techniques. *(FTF, online and Offline)*
4.	Monitor students and project progress *(Monitor the Students and the Progress of the Project)*	Monitor every project process. *(FTF, online and Offline)*	Report the progress of the project being implemented. *(FTF, online and Offline)* .
5.	Results Assessment *(Assess the Outcomes)*	Measuring the achievement of project standards implemented, evaluating student progress, providing feedback on what has been achieved. *(FTF, online and Offline)*	Presenting project work, written reports and products. *(FTF, online and Offline)*
6.	Evaluate *the Experience*	Guiding students to reflect on activities and project results that have been implemented. *(FTF, online and Offline)*	Reflect yourself by keeping a journal reflecting project activities and results. *(FTF, online and Offline)*

Table 2: Differences in the Implementation of Project Based learning from the Lecturer and Student Side

Phase First	Project Determination In this phase, students describe the objectives of the project will be executed or assigned then given knowledge about the problem to be solved in the project
Phase Second	Project Planning In this second phase, students given the freedom to seek and creativity in searching, compiling and design a project that will carried out according to the purpose there is
Phase Third	Project Scheduling and Execution In the third phase, it is only in the form of writing experimental project data obtained which is then entered in the table and analyzed according to existing theory
Phase Fourth	Monitoring the progress of the project Held Lecturers monitor the student activities during complete the project. Monitoring done by facilitating students in each process. Lecturer role as mentor for activities student.
Phase Fifth	Project Result Report Assessment and Presentation In this fifth phase consists of conclude the results of projects that have been done and communicated to other groups of students
Phase Sixth	Evaluation of learning experience At the end of the learning process, the lecturer and students reflect on project activities and outcomes already executed. Reflection process done well individually as well as groups. At this stage students are asked to express feelings and experience while completing project. Lecturers and students develop a discussion in order to improve performance during the process learning, so that in the end found a new finding inquiry) to answer the problem submitted in the first stage learning

as narrated PPT, learning videos, Project Student Worksheets, project results in the form of Project Student Worksheet reports and posters.

The implementation of learning is carried out face-to-face in class, monitoring is only carried out during face-to-face learning and working on student worksheets, the final results are student worksheet reports and posters.

Population and Sample

The following is a display of Table 3 which offers information about the semester 1 student population. The reason of the sample determination is that the biochemistry material very difficult to understand and necessary a learning model that can bridge the abstract material into real with the application of real life learning material. Subjects are selected according to the level of material Class taken in the even semester. Biochemistry material needs a learning models that brings students to do a lot of experiments and needed answers through scientific literacy that invites students to often observe, reading references and finally can fully understand the concept.

Table 3 shows that the total participants were 80, with 25 male and 55 female students.

The participants were selected using random sampling. Samples were obtained by randomly selecting two classes, the 2020A as the experimental class and class 2020B as the control class. The design of the study is presented in Table 4.

Research Instrument

The research instruments in this study were in the form of scientific literacy skills tests. Researchers developed the scientific literacy skills instruments to assess the content of scientific literacy abilities in biochemistry. The measurement instrument is a 20-item scientific literacy test. The description that has been created is in reference to the Test of Scientific Literacy (TOSLS).

The scientific literacy skills data consisted of three aspects, namely explaining phenomena scientifically, designing and evaluating scientific inquiry, along interpreting data and evidence scientifically. The indicators of each aspect are presented in Table 5.

Measurement

The test will be given at the time of pretest and posttest. Before the instrument is used, the validity and reliability of the instrument is first tested so that it can be known whether the instrument is suitable to be used to measure the variables studied. Pretest is given to students with the aim of equating students' perceptions and prior knowledge. After doing the pretest, then the homogeneity test is then carried out. Next, a posttest will be carried out to find out how much the results of the treatment in the control class and experimental class.

For concept comprehension performance, the instrument validation result was > 0.044. As a result, authenticity is asserted. Prof Sri Rahayu Lestari, M.Si of the State University of Malang's Biology department validated the assessment instrument as well. The reliability test was used to determine the level of trust and consistency, with the goal of minimizing measurement errors. IBM SPSS Statistics 23 reported a reliability score of 0.790 for concept understanding performance, indicating a high level of dependability > 0.06.

Table 3: Subject Characteristic

Respondents' Gender	*N (%)*	*Mean*	*Median*
Male	25 (31.25)	1.00	1.00
Female	55 (68.75)	2.00	2.00

Table 4: Research Design

Group	*Pre-test*	*Treatment*	*Post-test*
Experimental Class	O1	X	O2
Control Class	O3	-	O4

(Keterangan: O1= Early ability of Experimental Class, O2= Later ability of Experimental Class, O3= Early ability of control class, O4= Later ability of control class, X= Treatment for Experimental Class)

Table 5: The scientific literacy skills instruments

Scientific Literacy Aspect	*Indicators*
Explaining phenomena scientifically	Remembering and applying proper scientific knowledge tools.
	Identifying, using, and generating the model with a clear representation.
	Explaining the potential implications of scientific knowledge on society.
Designing and evaluating scientific inquiry	Proposing how to explore a question scientifically.
	Evaluating how to explore a question scientifically.
	Describing and evaluating various methods used by scientists to determine the validity and objectiveness of the data as well as the generality of explanation.
Interpreting data and evidence scientifically	Transforming data from one representation to the other representation.
	Analyzing and interpreting the data and drawing appropriate conclusions.

(OECD, 2013)

In the analysis, one of the requirements is carried out to detect the data obtained can meet the requirements for analysis through testing using analytical techniques that are planned according to the research objectives.

Data Analyzing Technique

Data were collected using a pretest and posttest. the indicators used to measure students' scientific literacy are presented in Table 3. The data analysis was carried out using preconditions and hypotheses tests, while for the prerequisite test, this study adopted normality and homogeneity test. A normality test was conducted to determine whether the obtained data were normally distributed or not. The standard norm distribution is data that has been transformed into a Z-score form and will be assumed to be in normal form. The application of the Shapiro-Wilk test is that if the significance is 0.05, that is, there are two data to be tested and have differences where one has a significant characteristic with the standard normal data, which means this data indicates that it is not normal. The normality test results were analyzed using the Shapiro-Wilk test through SPSS version 23. The homogeneity test was completed using the Variance test to determine the homogeneity of the population and sample used in the study. Once the prerequisite test was carried out, a hypothesis test was completed.

Finding

The Data used in this study were obtained from the results of the pretest and posttest. Before testing the hypotheses, the data were analyzed Shapiro-Wilk Test and Levene's Test of Equality of Error Variances. The test results show that all the data is not normally distributed but homogeneous, except for the data on aspect three of scientific literacy.

The results of the normality and homogeneity tests show that the obtained data is not normal but homogeneous, so a non-parametric hypothesis test was carried out to see the learning model's effects on the three aspects of scientific literacy skills. Summary of the hypothesis test results is shown in Table 8.

Table 6: The Summary of Normality Test Results

		Kolmogorov-Smirnova		
Data Group	*Class*	*Statistic*	*Df*	*Sig.*
Pretest scientific literacy aspect 1	Control_class	0,177	40	0,000
	Experiment_class	0,224	40	0,003
Postes scientific literacy aspect 1	Control_class	0,232	40	0,000
	Experiment_class	0,284	40	0,000
Pretest scientific literacy aspect 2	Control_class	0,295	40	0,000
	Experiment_class	0,255	40	0,000
Postes scientific literacy aspect 2	Control_class	0,257	40	0,000
	Experiment_class	0,193	40	0,001
Pretest scientific literacy aspect 3	Control_class	0,269	40	0,000
	Experiment_class	0,451	40	0,000
Postes scientific literacy aspect 3	Control_class	0,485	40	0,000
	Experiment_class	0,343	40	0,000

Table 9 shows that the highest mean value is observed in explaining phenomena scientifically aspect (93.50), on both in the control and experiment class, followed by the aspects of designing and evaluating scientific inquiry then interpreting data and evidence scientifically. It signifies students' great understanding of scientific statements and actions for formulating decisions in social life since science learning deals not only with scientific concepts, but also their applications in society. Science literacy represents students' scientific knowledge as well as their ability to implement the knowledge in their life. Designing and evaluating scientific inquiry attains a lower score, leading to students' difficulty in interpreting data and evidence scientifically. Thus, improvement in this aspect is required, such as by asking students to provide support statements with evidence and reasoning, the question to defend the idea, and revise the statement, if necessary. A person with excellent argumentation skills understands the phenomenon, expresses his understanding, and convinces others to accept his ideas. Further, the students also have low skills in evaluating the validity of the source indicating

Table 7: The Summary Homogeneity Test Result

	Levene Statistic	*df1*	*df2*	*Sig.*
Pretest scientific literacy aspect 1	0,079	1	78	0,780
Postes scientific literacy aspect 1	2,079	1	78	0,153
Pretest scientific literacy aspect 2	0,459	1	78	0,500
Postes scientific literacy aspect 2	1,177	1	78	0,281
Pretest scientific literacy aspect 3	16,842	1	78	0,000
Postes scientific literacy aspect 3	35,084	1	78	0,000

Table 8: The mean score from the experimental and control groups' pre-test

	Mean value	
Scientific Literacy Aspect	*Control Class*	*Experiment class*
Explaining phenomena scientifically	83.26	81.53
Designing and evaluating scientific inquiry	57.43	57.36
Interpreting data and evidence scientifically	45.94	49.58

Table 9: The mean score from the experimental and control groups' post-test

	Mean value	
Scientific Literacy Aspect	*Control Class*	*Experiment class*
Explaining phenomena scientifically	92.01	93.50
Designing and evaluating scientific inquiry	60.90	68.54
Interpreting data and evidence scientifically	50.73	55.10

Table 10. Summary of hypothesis test results

No	*Variables*	*Nilai Sig.*
1	Explaining phenomena scientifically	0,000
2	Designing and evaluating scientific inquiry	0,000
3	Interpreting data and evidence scientifically	0,000

* Significant at level 5%

students difficulties analyzing the statements and the accuracy of the scientific data and evidence.

Discussion

Table 10 shows that PjBBL carries a significant effect on students' scientific literacy skills. To improve the students' scientific literacy skills, their knowledge should be enhanced since the scientific explanation requires scientific knowledge. Meanwhile, for the second and third aspects of scientific literacy, students should master procedural and epistemic knowledge. Procedural knowledge is the standard procedure underlying the diverse methods and practices used to build scientific knowledge. Epistemic knowledge refers to an understanding of the special role in constructing and defining the important elements of building knowledge in science. Moreover, the learning design and procedure have to emphasize the use of science and its application in everyday life. (Gherardini, 2016) stated has identified the influence of teaching methods and critical thinking skills on scientific literacy skills, therefore policymakers need to adopt appropriate learning methods. Generally, students' final literacy skills can be categorized as good. Initially, this study should be carried out in normal face-to-face learning, but the rapid infection of Covid-19 had forced the study to be carried out online. Online lectures online faced several obstacles, ranging from students' internal conditions such as their learning motivation to external factors such as the learning environment conditions. Students should have high curiosity about their surrounding problems, as the problems are the learning source. Further, students' scientific literacy can be enhanced through reading scientific articles, research, and participation in scientific activities such as seminars, workshops, training, or organization related to biochemistry and its application. Scientific activities improve students learning experience, curiosity, and interest in the subject. In the forum which discusses issues related to biochemistry, the student will be actively looking for information and trying to find the ideas and innovation, as a form of problem-solving. The knowledge they gained from the lectures serves as a basis to develop a wider knowledge in the conceptual implementation.

As described in educational psychology, online learning is using the type of condition learning of verbal information. The lectures are delivered verbally, while students learn to present ideas from the verbal information. Verbal information is commonly used to associate concepts so that students acquire a set of theoretical and practical knowledge. In biochemistry lectures, theoretical and practical knowledge attainment is already facilitated through discussions, presentations, and tasks in the form of a written report. However, the provision of new information and knowledge should be related to the students' existing information, therefore verbal information needs to be contextualized in everyday situations. Besides, images or other instructions stimulate students' memorization, accompanied by repetition and reinforcement. Scientific literacy skills consist of three aspects, namely explaining phenomena scientifically, designing and evaluating scientific inquiry, and interpreting data and evidence scientifically. In the first aspect, students are expected to capture the essential concepts so that student can apply their knowledge that is relevant to daily life context. The research results suggest that students have a low ability to identify and imply problems with real-world examples. Learning based on constructivism facilitates the students to be able to construct their own knowledge concerning the real world. In the second aspect, students are expected to evaluate the essential concepts relevant to daily life context, while the third aspect contains the highest where the students can use scientific evidence to identify the assumptions, evidence, and reason. The students ' ability in identifying scientific issues is closely related to the scientific aspects associated with the concepts of biochemistry. The research results show that students attain the highest score in the first aspect, as they can freely express their ideas with a variety of examples relevant to daily life aspects. Higher education institutions have adjusted and used e-learning for the blended learning approach for the delivery of the courses, while also accepting and supporting the use of e-learning in the traditional approach (Cabauatan et al., 2021).

In accordance with this research finding, previous research indicates that the Project-Based Blended Learning model is extremely effective in providing excellent learning experiences for students, and hence should be adopted frequently. Integrating technology into the classroom is extremely beneficial for facilitating student learning (Sophonhiranrak et al., 2015). Because it teaches and delivers learning experiences relevant to 21st-century concerns, the usage of Project-Based Blended Learning has a major impact on students' knowledge and competencies (Bell, 2010). These learning experiences promote the development of conceptual and technical knowledge and professional skills while also motivating, assisting, and creating a comfortable environment, as well as coping with the large number of students who cannot be served effectively (Putra, 2021). Students actively construct their knowledge by comparing newly acquired knowledge to previously acquired knowledge.Project Based Blended Learning facilitates students to better understand the material taught by giving students the task required in thinking to solve various problems in the classroom by way of groups, so students have knowledge the wider. Students find concepts and construct their knowledge through projects that have been given. In its application students are invited to optimize group activities with the ease of online literacy to complete projects through experiments related to the surrounding environment. Students have the freedom to search for information sources online or ask face to face (blended) at the lecturer (Ngussa et al., 2021). Students discuss and work together in completing projects. This can be seen that Project Based Blended Learning is an active learning model both in individuals and in groups so that it can develop the ability to think productively in solving real problems in the environment.

The effect of the PjBBL model is to improve the teaching effects, which is due to the rich network learning materian diverse teaching activities, scientific and convenient communication methods and network-based process evaluation method. The advantages of the PjBBL teaching model to enhance students abilities are embodied in the following aspects: 1) PBBL model can improve students' practical and application ability more effectively, 2) PBBL model can improve students' self-learning ability and inquiry ability more effectively and 3) PBBL model can cultivate students' teamwork ability more effectively (Tong et al., 2020).

Further, blended learning efficiency comes from its ability to facilitate a community of inquiry. This community provides the stabilizing, cohesive influence that balances open communication and limitless access to information on the Internet. They also provide the condition for free and open dialogue, critical debate, negotiation, and agreement, as the hallmark of higher education. Blended learning facilitates these conditions and adds an important reflective element with multiple forms of communication to meet specific learning requirements. For example, in the beginning, it may be advantageous to have a face-to-face class to meet and build community. In contrast, discussing a complex issue that requires reflection may be better accomplished through an asynchronous Internet discussion forum (Garrison & Kanuka, 2004). The student's scientific literacy skills can be empowered through learning activities such as identifying scientific questions, providing an explanation of phenomena scientifically, and using scientific evidence. This activity can happen in the classroom (Lestari et al., 2021), but also through activities in the laboratory and field practice that encourage a culture of literacy in the family and society. In the end, scientific literacy is capable of forming a social community that is literate to science (Dewantari & Singgih, 2020).

Conclusion

The findings suggest that the implementation of Project-Based Blended Learning significantly increases three aspects of scientific literacy skills such as an explaining phenomena scientifically, designing and evaluating scientific inquiry, and interpreting data and evidence scientifically. Learning with the project-based blended learning model helps students become independent learner in the network and outside the network in the era of global computing. Students will make strong relationship between concepts and facts learned so that students actively work to find information and produce a product learning, not only as passive learners who only receive information.

Suggestion

Further research can be conducted in the elementary, junior high, and senior high school levels. The further research can be conducted to investigate every aspect of scientific literacy skliss and how to improve it well. The universities are recommended to implement learning media and resources in improving student scientific literacy. Furthermore, researchers and lecturers need to do similar research on different learning materials and levels of education to measure the influence of the learning model related to other dependent variables. Scientific literacy has a very important role for students in facing the 4.0 industry. Scientific literacy allows students to achieve competence in the 4.0 industry, consisting of critical thinking, problem-solving, creativity, communication skills, and the ability to work collaboratively. In enhancing students' scientific literacy skills, educators can use learning models and media that accelerate students' scientific literacy by utilizing Project-Based Blended Learning on a variety of materials in order to examine additional samples. For optimal results, combine research and development (R&D) models such as developing a biochemical practicum guide with a Project-Based Blended Learning model or experimental research with other types of research such as a Pre-test-Post-test one control group design.

Limitation

The limitation of this research is the research design which only uses the Pre-test-Post-test one group design. In addition, biochemical material used in research, biochemistry in everyday life which contains a small part of the more complex biochemical theory.

References

Al-Momani, F. N. N. (2016). Assessing the Development of Scientific Literacy among Undergraduates College of Education. *Journal of Studies in Education*, *6*(2), 199. https://doi.org/10.5296/jse.v6i2.9405

Angraini, G. (2014). Analisis Kemampuan Literasi Sains Siswa Sma Kelas X Di Kota Solok. *Prosiding Mathematics and Sciences Forum 2014*, 161–170.

Arlis, S., Amerta, S., Indrawati, T., Zuryanty, Z., Chandra, C., Hendri, S., Kharisma, A., & Fauziah, M. (2020). Literasi Sains Untuk Membangun Sikap Ilmiah Siswa Sekolah Dasar. *Jurnal Cakrawala Pendas*, *6*(1), 1–14. https://doi.org/10.31949/jcp.v6i1.1565

Banila, L., Lestari, H., & Siskandar, R. (2021). Penerapan blended learning dengan pendekatan STEM untuk meningkatkan kemampuan literasi sains siswa pada pembelajaran biologi di masa pandemi covid-19. *Journal of Biology Learning*, *3*(1), 25. https://doi.org/10.32585/jbl.v3i1.1348

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *83*(2), 39–43. https://doi.org/10.1080/00098650903505415

Borup, J., Chambers, C., & Srimson, R. (2019). Online teacher and on-site facilitator perceptions of parental engagement at a supplemental virtual high school. *International Review of Research in Open and Distance Learning*, *20*(2), 79–95. https://doi.org/10.19173/irrodl.v20i2.4237

Cabauatan, R. R., Uy, C., Manalo, R. A., & Castro, B. de. (2021). Factors Affecting Intention to Use Blended Learning Approach in the Tertiary Level: A Quantitative Approach. *Higher Education for the Future*, *8*(2), 239–255. https://doi.org/10.1177/23476311211011934

Chaeruman, U. A., & Maudiarti, S. (2018). Quadrant of Blended Learning: a Proposed Conceptual Model for Designing Effective Blended Learning. *Jurnal Pembelajaran Inovatif*, *1*(1), 1–5. https://doi.org/10.21009/jpi.011.01

Coto, M., Mora, S., Lykke, M., & Georgsen Zander, Pär-Ola, M. (2013). Developing the Qualifications of the ICT Workforce through problem-based learning. *Changing Education Through Ict in Developing Countries*, *August 2017*, 33–59.

Dewantari, N., & Singgih, S. (2020). Indonesian Journal of Natural Science Education (IJNSE). *Indonesian Journal of Natural Science Education (IJNSE)*, *03*(2), 366–371.

Diana, S., Rachmatulloh, A., & Rahmawati, E. S. (2015). Profil Kemampuan Literasi Sains Siswa SMA berdasarkan Instrumen Scientific Literacy Assesments (SLA). *Prosiding Seminar Nasional XII Pendidikan Biologi FKIP UNS*, 285–291.

Fitriyah, F. K., Hidayah, N., Muslihati, M., & Hambali, I. (2022). Analysis of Character Values in the Indonesian Nation ' s Motto " Bhinneka Tunggal Ika " through An Emancipatory Hermeneutical Study. *Pegem Journal of Education and Instruction*, *12*(1), 1–9. https://doi.org/10.47750/pegegog.12.01.01

Fitriyah, Fifi Khoirul, & Djazilan, M. S. (2020). Kontekstualisasi Nilai Pendidikan Karakter dalam Sirah Nabawiyah. *Journal of Islamic Civilization*, *2*(2), 80–89. https://doi.org/https://doi.org/10.33086/jic.v2i2.1734

Fitriyah, Fifi Khoirul, Hidayah, N., Muslihati, M., Hambali, I., & Ibad, M. (2021). The Role of Demographic Characteristics and Spiritual Dimensions in Predicting Empathy: A Study in Muslim Pre-Service Teachers. *Islamic Guidance and Counseling Journal*, *4*(2). https://doi.org/https://doi.org/10.25217/igcj.v4i2.1553

Fitriyana, N., Wiyarsi, A., Ikhsan, J., & Sugiyarto, K. H. (2020). Android-based-game and blended learning in chemistry: Effect on students' self-efficacy and achievement. *Cakrawala Pendidikan*, *39*(3), 507–521. https://doi.org/10.21831/cp.v39i3.28335

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *Internet and Higher Education*, *7*(2), 95–105. https://doi.org/10.1016/j.iheduc.2004.02.001

Gherardini, M. (2016). TERHADAP KEMAMPUAN LITERASI SAINS Monalisa Gherardini Mahasiswa S2 Pendidikan Dasar Universitas Negeri Jakarta Sains sebagai bagian dari pendidikan pada umumnya berpikir berperan kritis , logis , untuk dan menyiapkan peserta didik yang mampu kreatif , ber. *Jurnal Pendidikan Dasar*, *7*(2), 253–264.

Gormally, C., Brickman, P., & Lut, M. (2012). Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments. *CBE Life Sciences Education*, *11*(4), 364–377. https://doi.org/10.1187/cbe.12-03-0026

Hidayahtika, F., Suprapto, P. K., & Hernawati, D. (2020). Keterampilan Literasi Sains Peserta Didik dengan Model Pembelajaran Reading, Questioning, and Answering (RQA) dalam Pembelajaran Biologi. *Quagga: Jurnal Pendidikan Dan Biologi*, *12*(1), 69. https://doi.org/10.25134/quagga.v12i1.2123

Holbrook, J., & Rannikmae, M. (2009). The meaning of scientific literacy. *International Journal of Environmental and Science Education*, *4*(3), 275–288.

Jannah, Z., Fauziah, N., Ningsih, T. N., Kusumaning, R. F., Suryadi, D. A., Putri, R., Budiarti, N., & Fitriyah, F. K. (2021). Planetarium Glass Based on Augmented Reality to Improve Science Literacy Knowledge in Madura Primary Schools. *Child Education Journal*, *3*(1), 19–29. https://doi.org/https://doi.org/10.33086/cej.v3i1.1768

Jgunkola, B. J., & Ogunkola, B. J. (2013). Scientific Literacy: Conceptual Overview, Importance and Strategies for Improvement. *Journal of Educationai and Sociai Research*, *3*(1), 265–274. https://doi.org/10.5901/jesr.2013.v3n1p265

Kogure, Y. (2010). Dense beds of Ophiura sarsii limited by food supply in the Sea of Japan. In *Echinoderms: Durham - Proceedings of the 12th International Echinoderm Conference*. https://doi.org/10.1201/9780203869543-c92

Kusumaning Ayu, R. F., Puspita Sari, S., Yunarti Setiawan, B., & Khoirul Fitriyah, F. (2019). Meningkatkan Kemampuan Berbahasa Daerah Melalui Cerita Rakyat Digital pada Siswa Sekolah Dasar: Sebuah Studi Pengembangan. *Child Education Journal*, *1*(2), 65–72. https://doi.org/10.33086/cej.v1i2.1356

Lestari, H., Rahmawati, I., Siskandar, R., & Dafenta, H. (2021). Implementation of Blended Learning with A STEM Approach to Improve Student Scientific Literacy Skills During The Covid-19 Pandemic. *Jurnal Penelitian Pendidikan IPA*, *7*(2), 224. https://doi.org/10.29303/jppipa.v7i2.654

Lestari, H., Setiawan, W., & Siskandar, R. (2020). Science Literacy Ability of Elementary Students Through Nature of Science-based Learning with the Utilization of the Ministry of

Education and Culture's "Learning House." *Jurnal Penelitian Pendidikan IPA*, *6*(2), 215. https://doi.org/10.29303/jppipa.v6i2.410

Lestari, Y. N., Farida, E., Amin, N., Afridah, W., Fitriyah, F. K., & Sunanto, S. (2021). Chia seeds (Salvia hispanica l.): Can they be used as ingredients in making sports energy gel? *Gels*, *7*(4), 1–14. https://doi.org/10.3390/gels7040267

Nainggolan, V. A., Pramana, R., & Pudji, S. (2021). JPBI (Jurnal Pendidikan Biologi Indonesia) Learning Bryophyta : I mproving students ' scientific literacy through problem-based learning. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *7*(1), 71–82.

Ngussa, B. M., Fitriyah, F. K., & Diningrat, S. W. M. (2021). Correlation Between Facebook Use, Mental Health And Learning Engagement: A Case Of Universities In Surabaya City, Indonesia. *Turkish Online Journal of Distance Education*, *22*(1), 229–245. https://doi.org/10.17718/TOJDE.849912

Novitasari, N. (2018). Profil Kemampuan Literasi Sains Mahasiswa Calon Guru Biologi. *Biosfer : Jurnal Tadris Biologi*, *9*(1), 36. https://doi.org/10.24042/biosf.v9i1.2877

Putra, A. K. (2021). *The Effect of Blended Project-Based Learning with Stem Approach to Spatial Thinking Ability and Geographic Skill*. *14*(3), 685–704.

Ratnasari, A., Syafiuddin, A., Budiarti, R. P. N., Bistara, D. N., Fitriyah, F. K., & Mardhotillah, R. R. (2022). Mass transfer mechanisms of water pollutions adsorption mediated by different natural adsorbents. *Environmental Quality Management*. https://doi.org/https://onlinelibrary.wiley.com/doi/epdf/10.1002/tqem.21849

Richardson, J. W., Lingat, J. E. M., Hollis, E., College, R., & Pritchard, M. (2020). Shifting teaching and learning in online learning spaces: An investigation of a faculty online teaching and learning initiative. *Online Learning Journal*, *24*(1), 67–91. https://doi.org/10.24059/olj.v24i1.1629

Rizkita, L., Suwono, H., & Susilo, H. (2016). Analisis Kemampuan Awal Literasi Sains Siswa Sma Kota Malang. *Prosiding Seminar Nasional II*, *2*, 771–781.

Sartika, D., Kalsum, U., & Arsyad, A. A. (2018). Analisis Kemampuan Literasi Sains Mahasiswa Program Studi Pendidikan Fisika Universitas Sulawesi Barat. *WaPFi (Wahana Pendidikan Fisika)*, *3*(2), 8. https://doi.org/10.17509/wapfi.v3i2.13722

Sibarani, R. A. M., Afandi, & Andi Besse Tentiawaru. (2019). *Pentingnya literasi sains bagi siswa di era revolusi industri 4.0*. *Oktober*, 214–221.

Singh, M. N. (2021). Inroad of Digital Technology in Education: Age of Digital Classroom. *Higher Education for the Future*, *8*(1), 20–30. https://doi.org/10.1177/2347631120980272

Sophonhiranrak, S., Suwannatthachote, P., & Ngudgratoke, S. (2015). Factors Affecting Creative Problem Solving in the Blended Learning Environment: A Review of the Literature. *Procedia - Social and Behavioral Sciences*, *174*(1982), 2130–2136. https://doi.org/10.1016/j.sbspro.2015.02.012

Sutrisna, N. (2021). Analisis Kemampuan Literasi Sains Peserta Didik SMA di Kota Sungai Penuh. *Jurnal Inovasi Penelitian*, *1*(12), 2683.

Tong, Y., Kinshuk, & Wei, X. (2020). Teaching design and practice of a project-based blended learning model. *International Journal of Mobile and Blended Learning*, *12*(1), 33–50. https://doi.org/10.4018/IJMBL.2020010103

Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21st Century Skills through Scientific Literacy and Science Process Skills. *Procedia - Social and Behavioral Sciences*, *59*, 110–116. https://doi.org/10.1016/j.sbspro.2012.09.253

Zuhara, E., Jufri, A. W., & Soeprianto, H. (2019). Kemampuan Literasi Biologi Berdasarkan Gender Pada Siswa Peminatan Mipa Di Sma Negeri Kabupaen Lombok Barat. *Jurnal Penelitian Pendidikan IPA*, *5*(1), 115–119. https://doi.org/10.29303/jppipa.v5i1.234