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Learning the Discovery Learning Model How to Blended Learning in Practicum Using a Simple Volumetric Gasometer to Support Scientific Literacy

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Abstract: Education in the 21st century requires innovation and creativity as well as skills including scientific literacy skills and numeracy literacy, one of which is experimental learning. Often experiments are constrained by insufficient learning time so that learning becomes less meaningful. The purpose of this study was to determine the effect of applying the discovery model using the blended learning method using a simple volumetric gasometer in supporting scientific literacy. This research is an experimental research conducted in February 2023 at a Bandung high school. The research population was 432 students of class X at a senior high school in Bandung, which were divided into 12 classes. The sampling technique used simple random sampling so that 70 students were obtained consisting of 35 people from one control class and 35 people from one experimental class. The instrument used is a PISA question with the theme of innovation in alcoholic fermentation technology. Instruments were in the form of multiple choice questions and true wrong choice questions to measure scientific literacy profiles. Based on the results of the research, it was found that the learning outcomes of the discovery model by means of blended learning with practical methods using a simple volumetric gasometer can support scientific literacy.

Keywords: Blended learning; Discovery learning; Experiments; Scientific literacy; Simple volumetric gasometers

Introduction

Education in the 21st century requires innovation and creativity including 21st century learning skills, namely skill innovation in learning. Literacy skills can enable students to create significant contexts full of interpretations of descriptive language and interesting characters (Magulod, 2018). With the rapid development of technology, the literacy culture in Indonesia is very concerning because in terms of information technology where everything is instantaneous so that students prefer to listen rather than read and put it in written form (Hapsari et al., 2023). In OECD data, PISA 2019 results for Indonesian students that literacy skills is still low in literacy with the results of an assessment of the literacy skills of Indonesian students ranked 72 out of 78 countries. Students' low literacy is because they are not used to solving everyday life problems based on real phenomena so that their reasoning and creativity skills are not honed (Miralda et al., 2022; Rakhmawati & Mustadi, 2022).

Scientific literacy is the ability to observe scientific phenomena based on scientific laws and theories that are later needed to make decisions in everyday life (Dragoş & Mih, 2015; Čipková et al., 2020). According to AAAS, scientific literacy is the ability to use scientific knowledge to identify questions and draw conclusions based on experimental evidence to make a decision (Shaffer et al., 2019). Scientific literacy is not only about understanding the basic concepts of knowledge, but also

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modifying scientific theories and hypotheses through scientific investigations and problem solving (Zen, 1990). Scientific literacy is important because it provides a context for addressing societal problems, and because scientifically literate populations are able to better address many problems and make informed, intelligent decisions that will impact their quality of life and that of their children. Chiappetta says that the nature of science itself is a way of thinking, a way of investigating and a body of knowledge (Fatonah & Prasetyo, 2014).

Biology is a part of science that plays a role in supporting and developing scientific literacy, because biology, which is the science of plants and animals, contains many difficult-to-observe concepts that are used to uncover some basic problems. To be able to uncover difficult concepts, one of the methods used in real learning through proving is to do practicum. To be scientifically literate one must be able to understand facts, concepts and explanations of science by understanding how science works.

Abrahams et al. (2012) said that practicum can be a bridge, between previously taught scientific concepts and subsequent observations. Högström et al. (2010) argues that practicum in science is important because students can be involved in training skills in scientific investigation and problem solving so that students have real work experience in learning scientific concepts and can increase interest, motivation, practical skills, and students' problem solving abilities. Practicums can give students real experiences that move from memorizing to deeper understanding of concepts and applications and can develop students' intellectual abilities, such as critical thinking, scientific inquiry, and practical skills (Byukusenge et al., 2022).

In the Merdeka curriculum on Phase E Learning Outcomes, students are expected to have the ability to be responsive to global issues and play an active role in providing problem solving, one of which is in the material of biological technology innovation. The material for technological innovation in the biology of alcoholic fermentation is a material that is quite difficult, so it requires proof of scientific phenomena to support the theory, one of which is by measuring the reaction rate of alcoholic fermentation using a simple volumetric gasometer. According to research studies Weinberg (2018) that a simple water displacement volumetric gasometer made from a plastic water bottle, a plastic tube, and a measuring cylinder is used to measure the product of the yeast fermentation reaction, namely carbon dioxide. The resulting quantitative data can be graphed to display events such as reaction time lag, fermentation optimum, and nutrient depletion, and can be used to show the effect of various conditions (such as carbohydrate type and concentration, inhibitors, pH, and temperature) on yeast fermentation rates. Advanced students can use the gasometer to calculate kinetic parameters such as the Michaelis constant, maximum velocity and activation energy. The gasometer can be a versatile tool for exploring the principles of fermentation and enzyme kinetics in science laboratories ranging from elementary school through high school advanced placement chemistry and freshman year college chemistry, and can be used to demonstrate the effect of various conditions (such as carbohydrate type and concentration, inhibitor, pH, and temperature) on yeast fermentation rates.

To do scientific work, one of the learning models that can be used is the discovery learning model (Meliyanti et al., 2018; Pursitasari et al., 2019). The discovery learning model is a learning process that uses the principles of a scientific approach that allows students to acquire new conceptual knowledge by discovering some or all of this knowledge themselves (Nurhamidah et al., 2022). The discovery model can help students improve and enhance cognitive skills and processes, strengthen memory, concepts and knowledge transfer, and encourage student independence and active learning (Sartono, 2019).

There are obstacles in learning Biology at school, namely limited learning time, while doing practicum takes quite a long time so efforts are needed to improve learning outcomes of scientific literacy and interaction between teachers and students or between fellow students, one of which is with learning facilitated by technology so that can be done anytime and anywhere. One solution that can be used to overcome limitations in biology learning time is by learning the blended learning method. Blended learning is an online learning activity combined with face-to-face learning in class (Burhendi et al., 2019).

Based on the explanation of the background, there is a formulation of the problem, namely: "How is the ability of scientific literacy after applying the discovery learning model of blended learning using a simple volumetric gasometer?"

Method

This research is an experimental research conducted in February 2023 at a Bandung high school. This study used the Non-Equivalent Pre-Test Post-Test Control Group Design. The research population was 432 students of class X at a senior high school in Bandung, which were divided into 12 classes. The sampling technique used simple random sampling so that 70 students were obtained consisting of 35 people from one control class and 35 people from one experimental class. The experimental class was treated with discovery learning using a blended learning method using a simple volumetric gasometer, while the control class was given discovery learning using a simple volumetric gasometer in full offline. In the experimental class, the online learning process is carried out via WhatsApp.

The data collection instrument used the PISA framework scientific literacy questions with the theme Alcohol fermentation biotechnology in the form of multiple choice and true-false choices to measure the profile of scientific literacy in aspects of competency and content knowledge developed based on indicators in Table 1.

Table 1. OECD Science Literacy Indicator

Aspects of Scientific Literacy	Indicator	No Question
Competence	Explain the scientific phenomena in the process of alcoholic fermentation	1
Competence	Evaluating and designing scientific investigations in alcoholic fermentation processes	2
Knowledge content	Describe the chemical changes in the material in the fermentation reaction on bread	3, 4
Knowledge content	Explain the physical changes of matter in the fermentation reaction on bread	5

The test was given to students after learning Biotechnology using a practical guideline based on discovery learning with a simple volumetric gasometer. The results of students' scientific literacy and numeracy tests will be analyzed based on the final test scores. The final value is calculated using the formula:

$$\text{Final value} = \frac{\text{Score obtained}}{\text{Total score}} \times 100 \quad (1)$$

The test was carried out twice, namely the initial ability test (pre-test) and the final ability test (post-test). The pre-test and post-test data were tested for normality using the Kolomogorov Smirnov. The normality test is carried out to determine the normality of the data which will later determine the statistical test in hypothesis testing. Hypothesis testing was then carried out using the paired t test and the Independent sample t-test.

Result and Discussion

The results of the study are pre-test and post-test data on scientific literacy skills in the experimental and control classes on alcoholic fermentation material which can be seen in Table 2. Comparison of the number of participants, the average, the standard deviation, the maximum value and the minimum value can be seen in Table 2. The comparison is obtained from the results of the pretest and posttest between classes using the discovery learning method using blended learning methods using a simple volumetric gasometer and classes implementing conventional learning.

Table 2. Experimental and Control Class Pre-Test Results

Class		Average	Standard Deviation	Max Value	Min Value
Experiment	Pretest	46.84	15.96	80	20
	Posttest	72.37	14.97	100	40
Control	Pretest	45.79	18.98	80	10
	Posttest	60.26	17.78	90	30

Based on these results, the number of participants in this study were in the same two classes, namely 35 students. The average pretest score for the experimental class (46.84) was higher than the control class (45.79). The posttest mean score of the experimental class (72.37) was superior to that of the control class (60.26) even though both of them experienced an increase. In the standard deviation data, the pretest results for the experimental class (15.96) were lower than the pretest for the control class (18.98). The maximum score obtained in the posttest results of the experimental class (100) is higher than that of the control class (90). The results of the post-test were then calculated for the normality of the data using the Kolmogorov Smirnov test. It was found that the data for both classes were normal, so the hypothesis testing used parametric statistics.

Recapitulation of statistical analysis results on both pretest and posttest data on scientific literacy skills between classes using blended learning methods and classes implementing conventional learning are listed in Table 3.

Table 3. Results of Paired T-test and Independent sample T-test

Class	T paired test	Independent Sample T-test
Control	0.00	0.002
Experiment	0.00	

Testing the hypothesis using the paired t-test obtained Sig (2-tailed) = 0.00, less than < 0.05. This means that there are differences in learning outcomes that can be seen from the results of the pre-test and post-test. This indicates that there is an influence of the discovery learning model using a simple volumetric gasometer on class X students. Further hypothesis testing using the Independent sample T test results obtained Sig (2-tailed) = 0.02, less than < 0.05, which means that there is differences in learning outcomes between the control class using conventional learning and the experimental class using the discovery learning model of blended learning using a simple volumetric gasometer.

Wedekaningsih said that discovery learning model learning by blended learning is a learning model with scientific approaches with students finding themselves either part or all of concepts or theories and blended learning means combined learning methods online and face to face face in class. Learning activities using the discovery learning model in the blended learning method are carried out in several stages, namely stimulation, problem statements, data collection, data processing and verification (Nurhamidah et al., 2022).

In the first stage in the discovery learning learning model is stimulation, namely giving stimulus to students in the form of videos of making bread that are dense, after that the students are guided by the teacher to provide comments on what happened in the video. At this stage, learning is carried out online. Problems raised to students can generate curiosity and increase students' understanding of problems, the desire to solve problems. According to Salmi (Nurhamidah et al., 2022) in the discovery learning model the process of delivering material by the teacher is incomplete so that students are required to be actively involved in discovering principles or concepts in a material. After being given the video, students are given suggestions for reading books. and other learning activities to seek information that lead to one day's preparation of problem solving. The problem given is related to the theme of innovation in alcoholic fermentation biology technology listed in the independent curriculum phase E, namely students are asked to be able to observe, question and predict, plan and conduct research, process and analyze data and information, evaluate and reflect, and communicate wrong technological innovations. Only in conventional biotechnology using the principle of fermentation.

The next stage of learning is the problem statement (Problem Identification), students are given the opportunity to comment on the events that occur in the bread-making video and students are directed to make hypotheses related to the problem they will look for a solution to. Generating hypotheses and conducting experiments can move students from consumers to knowledge producers (Eslinger & Kent, 2018). This stage is carried out face-to-face before students carry out the alcohol fermentation practicum using a simple volumetric gasometer.

After identifying the problem, students carry out exploratory activities in the form of data collection, namely by carrying out an alcohol fermentation practice using a simple volumetric gasometer to provide opportunities for students to collect as much relevant information as possible to prove whether or not the hypothesis is correct. Larmer and Mergendoller said that the most important principle in problem solving is developing student activity, interests, and personal responsibility which aims to identify and stimulate student talents (Salybekova et al., 2021). During the experimental activities, students can observe the suitability between the hypotheses and the facts that occur because it can strengthen students' knowledge of the material being discussed (Hofstein & Lunetta, 2004).

Before carrying out the alcoholic fermentation practicum, students demonstrated an experiment to prove that alcoholic fermentation produces CO_2 gas using two Erlenmeyer tubes connected to each other by a silicon hose. Tube one is filled with warm water, yeast and a reacted sugar solution while tube 2 is filled with an aqueous solution which is added with lime and phenolphthalein. Here it can be observed the occurrence of gas bubbles in tube 1 and the change in color of phenoltalein from pink to clear due to the formation of CO_2 gas which will react with lime water to form HCO_3 acid. Students record scientific phenomena data and volume changes that occur in a simple volumetric gsometer in the observation table based on worksheets (LKPD).

The next learning stage is data processing (data processing). Students are guided by the teacher for the next scientific literacy skill, namely processing data by calculating the speed of alcohol fermentation from the data on changes in the volume of water on the gasometer per unit of time and the data must be graphed and the data interpreted. The data obtained by students through experimental activities is then processed to answer the questions that are already available in the worksheets. These questions have been designed so that students are directed to the correct final conclusions. Regarding this question students are required to discuss with group mates to find answers based on the data obtained, so that students can exchange information.

After processing the data, the next stage is verification, where students carry out class discussions. The results of the experiments and discussions were conveyed by one group and responded to by another group. Submission of the results of this experiment provides an opportunity for students to exchange information between groups. In addition, the deficiencies of each group related to alcoholic fermentation material can be identified during class discussions. The teacher/researcher can provide final conclusions until a conclusion is obtained based on the concept or theory of alcoholic fermentation.

The learning process for both the experimental class and the control class were given the same learning stages, namely the discovery learning model with alcohol fermentation practicum using a simple volumetric gasometer. What is different from these two classes is the method of learning where the experimental class has more free learning time because it is done online and face-to-face while the control class is only face-to-face. The frame of mind of the students in the experimental class during the practicum had already gone through the stimulation stage so that they could get prior information compared to the control class during face-to-face learning in class (practicum).

The scientific literacy skills of class X students have varied data. By obtaining the standard deviation, it shows that the control class data has varied data compared to the experimental class. After carrying out statistical tests, it can be seen that there is a significant average difference between the control class and the experimental class. Hypothesis testing using the paired t test obtained Sig (2-tailed) = 0.00, less than < 0.05. This means that there are differences in learning outcomes that can be seen from the results of the pre-test and post-test. This indicates that there is an influence of the discovery learning model using a simple volumetric gasometer on class X students. The next hypothesis test using the Independent sample t-test obtained the results Sig (2-tailed) = 0.02, less than < 0.05 which means that there are differences in learning outcomes between the control class that uses conventional learning and the experimental class that uses the discovery learning model of blended learning using a simple volumetric gasometer. The acquisition of pretest scores for each indicator of the two classes has the same lowest score on the indicator, namely the indicator explaining the chemical changes in the material in the fermentation reaction on bread.

The highest scores in the control and experimental classes are found in the same indicator, namely the indicator explaining the chemical changes in the material in the fermentation reaction on bread. The acquisition of pretest scores for each indicator of the two classes has the same lowest score on the indicator, namely the indicator explaining the chemical changes in the material in the fermentation reaction on bread. The highest scores in the control and experimental classes are found in the same indicator, namely the indicator explaining the chemical changes in the material in the fermentation reaction on bread. The acquisition of pretest scores for each indicator of the two classes has the same lowest score on the indicator, namely the indicator explaining the chemical changes in the material in the fermentation reaction on bread. The highest scores in the control and experimental classes are found in the same indicator, namely the indicator explaining the chemical changes in the material in the fermentation reaction on bread.

After learning using the discovery learning model using a simple volumetric gasometer, the posttest average value is higher than the pretest results. The results of hypothesis testing in the experimental class and the control class showed that the data on the results of the value of scientific literacy skills before learning and after learning class has a higher posttest average percentage value.

Based on the Independent sample t test, there is a significant difference in the average value in the experimental class compared to the control class. Novak, Gowin, and Johansen saw that students who were unable to assimilate new knowledge in their cognitive structures were due to students not being precise or misinterpreting concepts (Alvarez & Risko, 2007). This is because the experimental class uses blended learning so that students have more free learning time opportunities to find as much information as possible with directions from the teacher using technology (stages of stimulation) so that it can help solve problems. In addition to the advantage of being able to search for information with a more flexible time, students can also prepare practicums more thoroughly with the time available so that the possibility of errors occurring when carrying out practicum procedures is less than that of the control class. Online learning can help practicum preparation by reducing the potential risk of cognitive dissonance and can improve student organizational abilities leading to better experimental learning outcomes and student perceptions of laboratory experiences (Gregory & Di Trapani, 2012).

Learning experience and performance can increase when face-to-face learning is integrated with online learning (Kintu et al., 2017; Adiwisastra et al., 2020). Online learning really demands student independence, where students are required to play a more active role especially in finding information through relevant sources regarding the material being explained and discussing with teachers or friends about material that they have not understood (Nurhamidah et al., 2022).

Conclusion

Based on the results of the research, learning the discovery model by means of blended learning with practical methods using a simple volumetric gasometer can support scientific literacy. This can be seen from the results of a significant average difference from the post-test results which are higher than the pre-test, as well as the difference in the average post-test results for the experimental class which is higher than the control class.

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