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Basic science process skills of biology laboratory: improving through discovery learning

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ABSTRACT

Discovery learning model applied in Biology laboratory practice is expected to complete all necessary science process needed by students during learning activity. The research was an experiment to find the differences in learning outcome in the form of students' science process skills between discovery learning and the conventional model of biology laboratory practice. The research was conducted at the Public Junior High School 4, Ternate City for the 8th-grade students from October to December 2018. The research instrument used for basic science process skills was observation sheet. The indicator of basic science process skills consisted of observing, classifying, measuring, communicating, inferring, and predicting. The data analysis result showed that t count value was 4.261 with the significance of 0.000. The discovery learning model of biology laboratory practice was better in improving students' basic science process skills than the learning model of conventional laboratory practice. According to the result, it was concluded that there were differences in students' basic science process skills between the discovery learning model and the conventional model of Biology laboratory practice. Discovery learning model of biology laboratory practice was better in improving the student's basic science skill than the conventional one.

INTRODUCTION

Process skills are obtained from various underlying mental, physical, and social skills training (Subali, 2011; Karacop., & Diken, 2017; Handayani, Adisyahputra, & Indrayanti, 2018). If trained continuously, it will eventually establish an active power. Similarly, science process skills are formed from inter-related basic skills (Zeidan & Jayosi, 2015; Dwianto, Wilujeng, Prasetyo, &

Suryadarma; 2017; Tosun, 2019). Those basic skills are necessary for students as a requirement to be able to develop knowledge independently in the future (Sumarni, 2016; Usmeldi, 2016; Siachibila & Banda, 2018). Science process skills of junior high school students can be acquired through the laboratory practice activities in biology subject. Understanding the essence of natural sciences integrally, i.e., natural sciences as the process, product, and application, students should have the science process skills. The scientific process occurs when science process skills are used in carrying out scientific work to create science products (Prayitno, Corebima, Susilo, Zubaidah, & Ramli, 2017; Dwianto, et al., 2017; Handayani, et al., 2018). Deep understanding of science requires science process skills (Ristanto & Djamahar, 2019; Lestari, Ristanto, & Miarsyah, 2019; Anggarini, Rahayu, Rusdi & Ichsan, 2018). Having science process skills means preparing future scientists who have scientific literacy (Windyarini, 2017; Ristanto, Zubaidah, Amin & Rohman, 2017; 2018; Juhanda & Maryanto, 2018) and allowing students to use scientific information in everyday life (Ergül et al., 2011; Handayani et al., 2018). Science process skills are essential for every student as a provision to use scientific methods in developing science to develop their knowledge (Zeidan & Jayosi, 2015; Prayitno et al., 2017).

Science process skills in natural sciences subject put more stress on the formation of skills to gain knowledge autonomously as well as to communicate the results (Subali, 2011; Prayitno, et al., 2017; Karacop., & Diken, 2017). Science process skills are expected to improve the skills possessed by the students (Ergül et al., 2011; Siachibila & Banda, 2018; Handayani et al., 2018). Science process skills consist of primary and integrated skills. The basic skills include observing, classifying, predicting, measuring, summarizing, and communicating (Zeidan & Jayosi, 2015; Handayani, et al., 2018). The combined skills consist of identifying a variable, making data tabulation, presenting data in chart format, making connection inter-variables, collecting and processing data, analyzing research, arranging hypothesis, defining variable operationally, designing and conducting an experiment. Science process skills can be used by the students to learn the process, as well as provide a chance for them to act like a scientist in real (Subali, 2011; Prayitno, et al., 2017; Siachibila & Banda, 2018).

Biology subject is included the natural sciences subject cluster and in the subject group of Science and Technology (Ristanto, et al., 2017). Biology is an instrument to improve knowledge and skill, as well as to build the learners' positive attitude. Thus, biology teacher should be able to creatively applies such a learning strategy that enhances thinking ability, skill, as well as building students' positive attitude (Bahtiar, 2013; Anggraini et al., 2018; Noviyanti, Rusdi & Ristanto, 2019). Biology deals with any studies concerning natural phenomena, both qualitatively and quantitatively, as well as various matters related to its application to build technology to solve peoples' problems. In biology, the natural phenomenon can be viewed from the object, issue, theme, as well as the site. Thus, biological learning needs activities of examination or experiment through laboratory practice as a part of scientific work that involves process skill (Prajoko, Amin, Rohman & Gipayana, 2017; Suryanda, Rusdi & Kusumawati, 2017). Biology learning at schools should be implemented through learning that train and develop the student science process skills (Karacop., & Diken, 2017; Risnani, 2017).

Biology laboratory practice can encourage curiosity through discoveries based on direct experience, utilizing facts, building a concept, theory, and law, as well as train to think creative, critical, analytic, and divergent (Dimyati & Mudjiono, 2002; Suryanda, et al., 2017; Prajoko, et al., 2017). Laboratory practice is vital in biology learning because it can generate student motivation in education, develop basic skills in carrying out experiments, as a vehicle for learning scientific approaches and improve students' understanding of subject matter (Ernawati, Heryanti & mentari, 2017; Sholikah, Rahmawati & Prajoko, 2018). In the laboratory practice activities, students are required to be involved in the process of finding the answer to a problem, so that students' laboratory practice skill can be considered as science process skills (Prajoko, et al., 2017). Concept finding in discovery learning can be done through various activities, including laboratory practice (Suryanda, et al., 2017). Biology laboratory practice that applies the discovery learning model is

expected to complements all of the basic science process skills that are needed by the students during the learning activity. Discovery learning applies to different subjects as an effort to improve students' creativity (Cintia, Kristin, & Anugraheni, 2018; Noviyanti, et al., 2019). Biology experiment can be carried out with laboratory experiment design or field study (Hindriana, 2017). The results of previous studies indicate that the application of guided discovery learning models can improve the science process skills of Labschool High School students (Astra & Wahidah, 2017). Discovery learning strategies enhance performance on all student abilities (Akanmu & Olubusuyi, 2013; Ballen., Thompson., Blum., Newstrom., & Cotner, 2018; Mahlail., Anggraito., & Susilowati, 2018).

The condition of learning in schools shows that students tend to learn science as a product, memorize concepts, theory, oriented to tests or exams. As a result, science as a process and application is not touched in learning (Handayani, Nur, & Rahayu, 2015; Djamahar, et al., 2019). Observation also shows that basic science processes in biology learning of junior high school student in Ternate has not developed well. The efforts of teachers to train the ability of basic science processes through the conventional model of biology laboratory practice have not yet obtained maximum results. The discovery learning model of biology laboratory practice is expected to be a solution to improve the ability of the students' basic science processes (Sartono, Rusdi, & Handayani, 2017). The steps of discovery learning can train students' basic science skills through direct experience by conducting an investigation or experiment (Toy, Karwur, Costa, Langkun, & Rondonuwu, 2018; Sartono, et al., 2017). Discovery learning strategies directly help student activities themselves and apply what they know in new situations, which in turn leads to active learning achievement (Mahmoud, 2014; Abrahamson & Kapur, 2018; Levy, et al., 2018).

The laboratory in school functions as a place of learning that requires specialized equipment challenging to hold in classrooms, and as a place to observe various symptoms directly. The role of laboratories in schools is determined by the ability of teachers to use them efficiently for learning (Suryanda, et al., 2017; Prajoko, et al., 2017). This research is essential to decide on an efficient biology laboratory model to improve students' basic science process skills.

The subject matter of the structure and function of plant tissue is closely related to nature and human life (Zaini & Otari, 2012; Harahap, Nasution, & Manurung, 2019; Mahanal, et al., 2019). The purpose of learning this subject matter in the junior high school is students are expected to understand the structure and function of plant parts (morphology and anatomy) such as roots, stems, leaves, and flowers. Therefore learning the structure and function of plant tissue needs to be done with a useful laboratory practice model. The application of this learning model can also improve students' science process abilities.

METHOD

Design of the Study

The research was an experiment of learning to find out the differences in learning outcome in the form of students' science process skills between a discovery learning and conventional model of biology laboratory practice.

Procedure

In the conventional model laboratory practice learning, the scenario of laboratory practice learning was written in detail in the students' worksheet book of experiment compiled by the teachers. The students only carried out experiments according to the work procedures and material used, recorded the result and then drew a conclusion. In the standard laboratory practice guideline, the problems, hypothesis, working procedures, tools, and materials, as well as the data needed for the experiment had been compiled clearly. Whereas in discovery learning-model laboratory practice, the students worksheet book guided the students in formulating a hypothesis planning and

carrying out an investigation, using tools and materials, observing, grouping, processing, and communicating data.

Participant

The research was conducted in Public Junior High School 4, Ternate, 8th grade, in October to December 2018, with learning subject of Structure and Function of Plants Tissue. The laboratory practice was held in the Natural Sciences Laboratory. The reason for choosing 8th grade because the subject matter for the research is given in it. Determination of the sampling class was done by purposive random sampling.

The population of the research was the 8th grade students, and the samples were the students of class VIII2 and VIII4. The discovery learning model experiment was carried out in class VIII2, while the conventional practice model was carried out in class VIII4. The students in both classes have equality in academic ability. The conventional model was used as a comparison class because the traditional model of biology laboratory practice is still often used by biology teachers in Ternate.

Instrument

The research instrument used basic science process skills using observation form. The indicator of basic science process skills is presented in the following Table 1.

Table 1.
Indicators of basic science skill.

No	Basic Skill	Indicator
1.	Observing	Observing, identifying, and naming the characteristics of things and phenomenon in detail.
2.	Classifying	Determining differences, specifying characteristics, finding similarities, comparing and assessing the grouping basis of an object.
3.	Measuring	Choosing and using tools to quantitatively and qualitatively determine the dimension of an object (length, area, volume, time, weight, etc.) accurately.
4.	Communicating	Reading and compiling information in chart/diagram/table, explaining the experiment result, organizing and presenting a report systematically and clearly.
5.	Inferring	Drawing conclusion concerning a phenomenon after collecting and interpreting data and information.
6.	Predicting	Predicting/forecasting based on particular pattern/tendency prediction, or relationship between facts, concepts, and principals of science.

(Nugraheni, & Wuryandani, 2018)

Data Analysis

Research results were analyzed using descriptive statistics such as number, average, and percentage. Hypothesis test used t-test independent analysis with 5% of significance, assisted by SPSS 22 for Windows, preceded by prerequisite test, i.e., homogeneity and data normality test. The homogeneity of the data was tested using levene's test of equality of error variances. The normality of the data was tested using the one-sample kolmogorov-smirnov non-parametric statistic.

RESULT AND DISCUSSION

Research result showed that the average score of students'science process skills in the discovery learning model of biology laboratory practice was higher than those of the conventional model. For more detail concerning average, maximum, and the minimum score of students' science process skills are as presented in the following Table 2.

Table 2.
Corrected average, maximum, and minimum scores of students' basic science skills.

Learning Model of Biology Laboratory Practice	Average	Maximum	Minimum
Discovery learning model	74,20	87,50	83,33
Conventional model	67,50	83,33	62,50

As the requirement of independent t-test analysis, a variable data normality test must be previously conducted. Normality test is expected to show that the sample data comes from a population that is normally distributed. Independent t-test can be used if the data of each variable is normally distributed. Data normality was tested using a one-sample kolmogorov-smirnov non-parametric statistic. The criteria of data normality test are, if the probability value (sig.) of each dependent variable tested is higher from the alpha value used (0.05), then H_0 is acceptable, means there is no deviation against the data normality of independent variable. Thus, the data is considered as normally distributed. The result of data normality test is presented in the following Table 3.

Table 3.
One-sample kolmogorov-smirnov test.

		Students' Basic Science Skills
N		51
Normal Parameters[a]	Mean	70.3333
	Std. Deviation	6.57774
Most Extreme Differences	Absolute	.148
	Positive	.148
	Negative	-.103
Kolmogorov-Smirnov Z		1.054
Asymp. Sig. (2-tailed)		.216

The result of data normality test showed that a data group of students' science process skills tested score was normally distributed and did not have any deviation against data normality. Homogeneity test is expected to shows that two or more groups of data come from a population with the same variance. Homogeneity test was conducted for the corrected average data of each data group of science process skills score. Data homogeneity was tested using Levene's Test of Equality of Error Variances. The criteria of data homogeneity test are, if the probability value (sig.) of each dependent variable is more significant than the alpha value (0.05), then H_0 is acceptable, means there is no variant difference between the data groups. Thus, the data are considered as homogenous. The probability value (sig.) of data variant of science process skills score was more significant than 0.05. Therefore, it can be concluded that there is no variant difference between the data groups so that the data was considered as homogenous. The result of data homogeneity of variance test is presented in the following Table 4.

Table 4.
Test of homogeneity of variances.

Levene Statistic	df1	df2	Sig.
.422	1	49	.519

Statistic was then used to show the science process skills difference on discovery learning and conventional model of biology laboratory practice with the Independent Sample t-test. The significance value was smaller than αvalue (0.05), means H_0 was rejected. Ho rejection means that Hypothesis HI which was stated that there was a difference in science process skills in discovery learning and conventional model of laboratory practice was acceptable. This showed that both models applied in biology laboratory practice delivered different effects on students' science

process skills. Summary of Independent Samples t-test analysis result is presented in the following Table 5.

Table 5.
Independent samples test.

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference
Students' Basic Science Skills	Equal variances assumed	.422	.519	4.261	49	.000	677.385
	Equal variances not assumed			4.263	48.987	.000	677.385

According to the corrected average score of science process skills for both applied learning models, as well as according to the Independent Samples t-test hypothesis, it can be concluded that the discovery learning model of biology laboratory practice was better in improving the students' science process skills than the conventional one. It was related to the laboratory practice learning steps of discovery learning model that guides the students to improve their academic subject in the form of science process skills. Discovery learning of biology practice guides students independently in formulating problem and hypotheses, planning and conducting experiments, using tools and materials, observing, grouping and processing data, and communicating data (Mahmoud, 2014; Abrahamson & Kapur, 2018; Toy, et al., 2018; Levy, et al., 2018), so that it is better in binding students' basic science skills compared to the conventional model.

Indicators of science process skills such as formulating problems and hypothesis, planning and experimenting, using tools and materials, observing, grouping/processing data, communicating data (Subali, 2011; Prajoko, et al., 2017; Prayitno, et al., 2017; Siachibila & Banda, 2018) have already planned carefully and carried out in discovery learning laboratory practice steps. In conventional model laboratory practice learning, the scenario of experiment learning had been written in detail in the laboratory practice guidelines made by the teacher. Students were only carrying out an experiment in accordance with the working procedure as well as tools and material being used, recording data of experiment result, and then drawing a conclusion (Zeidan & Jayosi, 2015; Prajoko, et al., 2017; Handayani, et al., 2018). In the students' worksheet book of conventional laboratory practice, the problems, hypothesis, working procedures, tools, and materials, as well as data needed had been written in detail. Thus, students' skill on formulating problems, planning an experiment, as well as processing data was not encouraged in the learning activity (Prajoko, et al., 2017; Siachibila & Banda, 2018; Winarti, Yuanita & Nur, 2019). The results of previous studies indicate that the students' worksheet book in the form of modules in the discovery learning model is sufficient to improve generic science skills (Prajoko, et al., 2017; Khabibah, Masykuri, & Maridi, 2018).

As for the discovery learning laboratory practice model, the students' worksheet book of discovery learning laboratory practice guides the students to formulate problems and hypothesis, plan and carry out an experiment, use tools, and materials, observe, group and process data, as well as to communicate the data (Subali, 2011; Karacop., & Diken, 2017; Prajoko, et al., 2017). At the stimulation step, students' skill in doing the observation was stimulated with a stimulant that was relevant to the subject theme (Dwianto, et al., 2017; Tosun, 2019). At the problem statement step, students were trained to make the statement or identify as many questions (problems) as possible in a group concerning the presented subject theme and will be answered through learning activity, as well as try to make short answer (hypothesis) for the question. Data collection step revealed that students collected the required data, that would then classified and processed at the data processing step. Verification step showed that each group of students discussed and verified their observation

result with data or theories on source literature and made it as a base to conclude the generalization step.

Discovery learning has two main processes, i.e., involving students in proposing or formulating questions as well as finding the answer for the problem through a series of examinations. Discovery learning is a learning model that encourage students to find their knowledge through particular activity. This finding may be an improvement or an accomplishment of the existing conclusions, or may also create brand new ideas. The research result showed that discovery learning help to improve learning effectiveness (Joy, 2014; Akanmu & Olubusuyi, 2013; Ballen, et al., , 2018; Mahlail., Anggraito., & Susilowati, 2018). Scientific attitude of learners that was taught in the discovery learning yield at an 'excellent' category (Patrianingsih & Kaseng, 2016; Nugraheni & Wuryandani, 2018; Handayani, et al., 2018).

Discovery learning makes students exposed to various situations, questions, or assignments that allow students to "find" for themselves the concept or subject matter (Wilke & Straits, 2017; Levy, et al., 2018). Discovery Learning maximally involves students' whole skills to find and to investigate systematically, critically, and logically, so that they can find their knowledge, attitude, and skill by themselves. The teacher can apply the discovery learning model to guide students to do an experiment activity in finding a knowledge concerning the learning subject that can be put to experiment, as well as to train students' science process skills. Also, Guritno, Masykuri, & Ashadi (2015) & Subali (2011) suggested that students with high basic science process skills tend to have better psychomotor learning achievement than students with lower basic science process skills. Learning by discovery is a technique for helping learners create and organize knowledge and involving mindful participation and active inquiry (Honomichl & Chen, 2012; Mahmoud, 2014; Abrahamson & Kapur, 2018).

CONCLUSION

According to the result and discussions, it was concluded that there were differences in students' basic science process skills between the discovery learning model and the conventional model of Biology laboratory practice. Discovery learning model of biology laboratory practice was better in improving the student's basic science skill than the conventional model.

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