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Research Article

Science literacy skills through the experience of project activities with assisted local potential based learning materials

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ABSTRACT

Scientific skills literacy is one of the skills that students need to have to support the learning process. This study aims to explain the literacy skills of the students through project experience with the help of local potential-based teaching materials. This research is a quantitative study and it used quasi-experimental design, pre-and posttest design. ANCOVA analysis was used as the data analysis technique at a significant level of 5% ($p < 0.5$). Analysis prerequisite tests included the Kolmogorov-Smirnov test for normality test and homogeneity of variance with Levene's-Test. All data testing was done using the SPSS version 23.0 for Windows. The results of the study show that the experience of project activities has a significant effect on the scientific literacy skills in three competencies. These competencies are to explain scientific phenomena, evaluate and design scientific investigations and interpret scientific evidence and data. Competence in evaluating and designing scientific investigations has the greatest significance compared to the other two competencies.

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INTRODUCTION

A number of 21st-Century skills were introduced with various labels and packaged in a number of clusters, i.e. ways of thinking, ways of working, working and life skill in the world (Binkley et al., 2014; Tan, Choo, Kang, & Liem, 2017). The skills needed in 21st-Century competence known as 4Cs, namely communication, collaboration, critical thinking, and creativity (Chu, Reynolds, Tavares, Notari, & Lee, 2017; Heinrichs, 2016; Osman, Hamid, & Hassan, 2009; Skills, 2009; Talat & Chaudhry, 2014; Wilborn, 2013). In general, mastery of 21st-century skills can be focused on creating high-quality human resources with higher order thinking skills (Bell, 2010; Talat & Chaudhry, 2014; Tindangen, 2018). Today the implementation of science education systems has recommended ways to understand students from complex systems (Chu et al., 2017; Ghaffarzadegan, Larson, & Hawley, 2017; Spraragen et al., 2014; Uswatun & Widiyanto, 2018; Young, 2013). An example in the structure-function framework that has been used to support and examine student systems thinking (Dauer & Dauer, 2016; Speth et al., 2014; Vattam et al., 2011). Known system thinking includes general systems thinking (systems thinking that shows the relationship between structure and function) and dynamic systems thinking (Arnold & Wade, 2015; Carey et al., 2015; Grohs, Krik, Soledad, & Knight, 2018; Monat & Gannon, 2018, 2015).

Scientific literacy skills have been seen as the competencies needed to improve the ability to think dynamically about science in relation to personal, social, political, economic, and other issues. Holbrook and Rannikmae (2009) suggested that scientific literacy skills can be developed through science education. Science education related to the ability to use scientific knowledge and skills creatively based on sufficient evidence with daily life in solving real problems based on reasoning that can be understood based on scientific phenomena (Campbell, Zhang, & Neilson, 2011; Dragoş & Mih, 2015; Gormally, Brickman, & Lutz, 2012; Gultepe, 2016; Holbrook & Rannikmae, 2009; Karamustafaoğlu, 2011; Trna, Trnova, & Sibor, 2012; Turiman, Omar, Daud, & Osman, 2012). Science is not just an accumulation of visible evidence, but observations that require interpretation and inference, so the lack of association of findings is explicit with science content (Campbell et al., 2011). However, the Program International Student Assessment (PISA) reported that the average score of achievement of science literacy in Indonesia was still low. Indonesia ranked, in 2012, is 64th from 65 participating countries (OECD, 2013). The similar finding also found in students' literacy related to health issue (Permana, Suwono, & Listyorini, 2016).

Students' science literacy can be promoted in their learning process (Dragoş & Mih, 2015; Gormally, Brickman, Hallar, & Armstrong, 2009; Turiman et al., 2012). Learning process in the view of constructivism is creating an activity that allows students to build their own knowledge (Schunk, 2012). Referring to the philosophy of constructivism, the learning outcome can be achieved through a learning process that prioritizes the development of creativity, activities, and needs of students (Tantrarungroj & Suwannatthachote, 2012). The achievement of learning outcomes can be designed by providing learning experiences that involve mental and physical processes through various interactions. Provision of project assignments as one of the activities that can link academic content with real contexts arouses student enthusiasm for problem-solving and decision making (Baş, 2011; Bell, 2010; Johnson, 2009; See, Rashid, & Bakar, 2015; Sookpatdhe & Soranastaporn, 2016). The success of the project in learning depends on the number of student activities and a good learning environment (Habók & Nagy, 2016). By utilizing students' real-life condition, they can promote their ability related to science literacy. The students can accommodate their ability to identify questions, gain new knowledge, explain scientific phenomena, and draw conclusions based on facts (Dragoş & Mih, 2015; Holubova, 2008; Schwartz, Tessman, & Mcdonald, 2013; Sookpatdhe & Soranastaporn, 2016).

Furthermore, Baxter (2007) suggest that effective learning is not just a good teaching outcome, but the use of local resources that have a direct contribution as learning resources in order to develop the potential of students. The diversity of animals and plants that are characteristic of the Tasikmalaya region is a challenge to be used as a learning resource. It remains a major challenge to utilize biology learning resources by maximizing local potential as a solution to reduce the effects of boredom and develop local resources (Prabowo, Nurmiyati, & Maridi, 2016). In this case, the students will carry out learning experiences by utilizing local potential based learning. For this reason, this study aims to explain the students' science literacy skills through project experience with the help of local potential-based teaching materials.

METHOD

This research was aimed to explain students' science literacy skills through project experience with the help of local potential-based teaching materials. The local potential used was animals and plants which became characteristic of the Tasikmalaya region. The activity carried out by students was to explore animals and plants related to their taxonomy and genetic relationship. The research design used was quasi-experimental, pre-and posttest control group design (Creswell & Guetterman, 2019). The research subjects were students of biology education at the undergraduate level. The population used was 180 people spread in 5 classes. Sampling was done by using purposive sampling technique. The equivalence of the study sample was carried out by placement test. The sample used was one class for the class given treatment with a total of 35 students, while the control class was used as a comparison only. The study was conducted for one semester with a research period of 6 months.

The instruments of scientific literacy skills used are in the form of test techniques that are given before and after the treatment. The items of the questions are arranged based on competence to explain scientific phenomena (variable 1), evaluate and design scientific investigations (variable 2), interpret scientific evidence and data (variable 3) adapted from PISA (2015) and Graber (Holbrook & Rannikmae, 2009). The question items used have been validated by experts and have been tested (instrument trial). The analysis used in calculating the validity of each question is Anates software version 4.0.9 for Windows. The technique used to analyze the data was inferential statistical analysis with ANCOVA analysis at a significant level of 5% (Mertler & Reinhart, 2016). Firstly, the prerequisites of the analysis of the data obtained were tested including normality test (Kolmogorov-Smirnov) and variance homogeneity (Levene's-Test) (O'Neill & Mathews, 2000). The prerequisite test results for each competency are 0.128; 0.30; 0.444. All data testing was done by using the SPSS version 23.0 for Windows.

RESULTS AND DISCUSSION

The results of the scientific literacy skills analysis for each competency are explained in Table 1; Table 2; and Table 3. The results of the covariate analysis in Table 1 can be explained that there is an influence on the experience of project activities on the scientific literacy of competency skills explaining scientific phenomena by removing the pre-test as a covariate at a significance of 0.006 with a value far from 0.05. Simultaneously there is a significant influence on the experience of project activities to explain scientific phenomena (variable 1) at a significance of 0.005 with an F value of 5.839. While the significance of competency variables explaining scientific phenomena is 0.001 with Sig. <0.05 and F values of 11.198.

Table 1. Summary of test results for ANCOVA competencies explaining scientific phenomena

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	42.071[a]	2	21.036	5.839	.005
Intercept	282.250	1	282.250	78.347	.000
Group	4.349	1	4.349	1.207	.006
pretest_variabe1	40.343	1	40.343	11.198	.001
Error	241.372	67	3.603		
Total	4043.000	70			
Corrected Total	283.443	69			

Table 2 explains the significance values of the corrected model with the conclusion that there is a significant influence on the experience of project activities on the competence of scientific literacy skills to evaluate and design scientific investigations at a significance of 0.000 with an F value of 13.839. While the significance for the competence variable evaluating and designing scientific investigations is 0.026 with Sig. <0.05 and F values of 5.183. The experience of project activities has a significant effect on the competency of scientific literacy skills evaluating and designing scientific investigations (variable 2) with pre-test as a covariate at a 0.05 significance level.

Table 2. Summary of test results ANCOVA evaluates and designs scientific investigations

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	69.765[a]	2	34.883	13.839	.000
Intercept	456.786	1	456.786	181.224	.000
Group	55.312	1	55.312	21.944	.000
Pretest_ variabe2	13.065	1	13.065	5.183	.026
Error	168.878	67	2.521		
Total	1939.000	70			
Corrected Total	238.643	69			

Table 3 significance values in the corrected model can be concluded that there is a significant influence on the experience of project activities on the scientific literacy skills competencies interpreting the evidence and scientific data at a significance of 0.003 with an F value of 6.518. While the significance for the competency variable interprets the evidence and scientific data is 0.001 with Sig. <0.05 and F values of 12.4476. Experience of project activities on the scientific literacy skills of competence interpreting scientific evidence and data (variable 3) with a pre-test as a covariate at a significance level of 0.05. The significance value obtained is 0.045.

The results of the statistical analysis are inferentially concluded that the experience of project activities has a significant effect on the scientific literacy skills in three competencies. Competence in evaluating and designing scientific investigations has the greatest significance compared to the other two competencies at the significance of 0.000 with an F value of 13.839 as explained in Figure 1. These results reinforce that project activity assisted by local potential based teaching materials have a profound effect on scientific literacy skills of the students. Project activity activities carried out during the learning process using the stages or syntax of Hung, Keppell, and Jong (2004) are factually preceded by the student orientation stage on the problem. This stage is the initial activity of the learning process starting with information on the achievement of course learning, information on real phenomena as a source of problems and providing motivation in connection with making projects (Lewinsohn et al., 2014; Macklin, 2001).

Table 3. Summary of ANCOVA test results interprets scientific evidence and data

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	40.211[a]	2	20.105	6.518	.003
Intercept	205.759	1	205.759	66.708	.000
Group	12.927	1	12.927	4.191	.045
Pretest_ variabe3	38.482	1	38.482	12.476	.001
Error	206.661	67	3.084		
Total	2027.000	70			
Corrected Total	246.871	69			

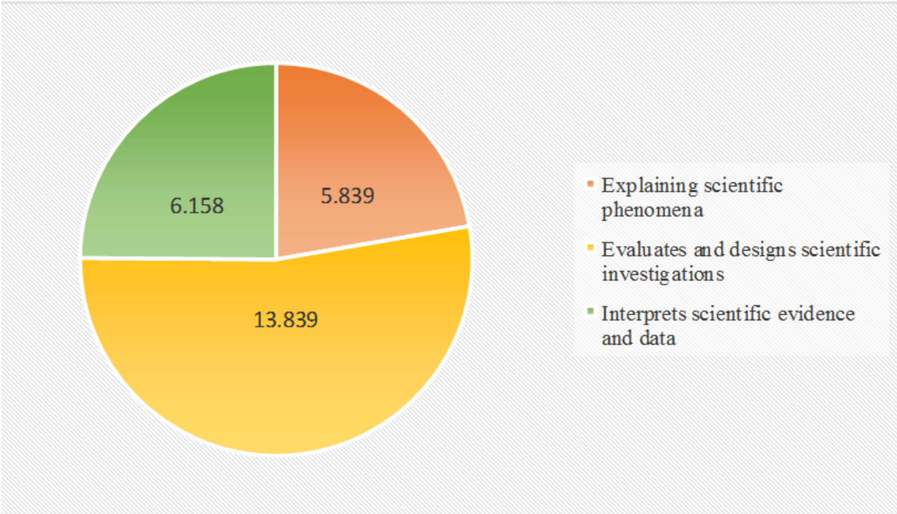

Figure 1. Results of a comparison of the three competencies of scientific literacy skills

The second stage of project activities is organizing students to study. This stage of the activity is how students can prepare through group formation, stabilizing problems and tracing sources. According to Cook and Walsh (2012), these activities help students to foster reinforcement in scientific literacy skills. Strengthening concept was done through critical analytical assignments, which directly train the ability of prospective teacher students in 1) Identifying assumptions, evidence, and reasoning in related texts; 2) Evaluating scientific arguments and evidence from different sources (e.g. newspapers, internet, and research article). This activity is carried out to obtain valid facts and information with the help of all forms of learning resources optimally. Through this activity, students can directly present important information that will be utilized. In addition, students can raise important questions raised in the entire article analyzed (Cook & Walsh, 2012; Holbrook & Rannikmae, 2009; Macklin, 2001; Speros, 2005).

The third stage of project activities is guiding students to carry out project activities. Many activities carried out by students in this stage, begin the learning process by observing objects in accordance with the animal and plant characteristic. Students identifying questions and distinguishing it, then they answered it scientifically. Examples of when students are faced with a number of fish specimens, character observations are made about the state of the head (head shape, head size, mouth, jaw, eyes, nostril, operculum), body condition (body shape, body symmetry, scales, lateral lines), the state of the tail (shape / type, tail) and other characters that can be used for identification. Based on the results above, several problem formulations have been collected which require answers.

The examples of results of answers to prospective teacher students when writing the problem statement:

1) Are there differences in the body shape between freshwater fish and seawater fish?

2) How to do fish body measurements?

3) Are there differences in fin fingers in fish?

4) Are there different scales between freshwater fish and seawater fish?

In connection with this activity, students learn how to explore questions scientifically and evaluate them. Exploration carried out in the context of collecting data based on experimental results. Some research showed that these activities help students to improve their science literacy skills (Anelli, 2011; Dragoş & Mih, 2015; Holbrook & Rannikmae, 2009).

Other circumstances when students are faced with a number of specimens from the frog group, character observations are carried out about 1) the dorsal part of the head (caput), oral cavity and snout; 2) fingers and toes; 3) other characters (supra tympanum folds, dorsolateral folds, coarse or fine-grain skin, body color). Students organize data to make hypotheses, analyze data according to investigative studies and conduct analysis/discussion analysis. The ability to obtain information/data is obtained quantitatively and qualitatively as a basis for testing hypotheses.

The examples of results of student answers when making hypotheses:

1) *There is a difference in the swimming membrane on the fingers of a frog*

2) There is a difference in the swimming membrane on the toes of frog

3) There are body color differences in frogs

4) There are differences in the skin on frogs

In this connection, students learn how to analyze and interpret data and present it in the form of hypotheses. These activities are activities that train the scientific literacy skills of students.

The fourth stage of project activities is the development and presentation of project results. The stages of the activities carried out are collaborating in the preparation and presentation of reports as a result of the investigation. The form of presentation is in the form of a lab report as study material for discussion presentations. Examples of student results when generalizing and conclusions:

"*The shape of the body of the fish is almost like that of a carp, but it is slimmer with a thin snout and in the corner of its mouth there is one pair of touching grunts. The movements are more agile than carp. The body color is silvery white, the back is dark, the front edge of the dorsal fin and the outer edge of the caudal fin is black. The dorsal fin is supported by 3 hard fingers and 8 soft fingers. The anal fin is supported by 3 hard fingers and 5 soft fingers. The pelvic fin is supported by 2 hard fingers and 8 soft fingers. The pectoral fin is supported by 1 hard radius and 15-16 soft fingers. The number of lateral lines is 28-29 pieces."*

The conclusions obtained are reinforced by relevant reference libraries so that products as a result of project work can be made in the form of posters. In connection with the above, students learn a lot at this stage, including how to make and justify proper predictions, transform data from one representation to another, distinguish between arguments based on scientific evidence and theories based on other considerations, evaluate scientific arguments and evidence from different sources, and draw the right conclusions.

The fifth stage of project activities is analyzing and evaluating the process of project activities. The final stage of this activity is that students reflect on the processes taken during the project activities. Reflection is a way of thinking about what has been learned or already done. Reflection is a response to new events, activities or knowledge received. Students learn how to explain and evaluate various ways to ensure data reliability, data objectivity, and general explanatory abilities and explain the potential implications of scientific knowledge for the wider community. This reflection can be in the form of student notes, impressions and suggestions, direct questions, discussions, and works. The key to all this is how that knowledge settles in the minds of students. One of the examples of the problem of scientific literacy skills that refers to the competence of evaluating and designing scientific investigations are:

Natural disturbances or threats that can interfere with the life of a turtle at any time, including:

- *Predation of hatchlings, both for hatchlings that have just come out of the nest (including by wild boar, wild dogs, monitor lizards, and eagles) as well as on hatchlings in the sea (including by cucut fish).*
- *Disease, which is caused by bacteria, viruses, or because of pollution of the aquatic environment.*
- *Climate change causes sea levels to rise and a lot of beach laying erosion occurs so that it affects the change in hatchability and balance of hatchling sex ratio*

Question: *Based on this, what efforts can be made to maintain hatchlings in cultivation?*

The philosophical aspects of higher education as a place to prepare students to be able to live in the community, the learning experience involving student project activities is enabling and very important learning to be developed. Viewed from the context of improving the quality of education, this learning process is one of the lessons that can be used to improve the learning system that involves changes in pedagogy.

One of the principles of science learning is an active process. This is the main point in scientific literacy skills. This principle implies that science learning must involve activities carried out by students, not by lecturers. Students must be given physical or sensory motoric experience as a basis for developing abstract ideas. Students have control over what they want to learn. This is in line with some research revealed that learning can be enjoyed when they are given more responsibility (Cook-Sather, 2010; Swain, 2012; Yap, Neo, & Neo, 2016). This opportunity makes it easy for lecturers to use various opportunities for learning by doing. The active process has mental and physical implications. Hands-on activities are not enough; students must have minds-on practices. The implementation of project-based learning was giving meaningful experience to the student (Schwartz et al., 2013) because they will force their creativity to solve problems (Chiang & Lee, 2016; Isabekov & Sadyrova, 2018)

Learning is basically a meaningful process to achieve competence or life skills. The meaning of life occurs in context. Therefore learning will be meaningful if the learning material is associated with the real life of students (Holubova, 2008; Schwartz et al., 2013). The principle is in line with the results of the study of See et al. (2015) and Skills (2009) which show that if the lecturer creates meaningful learning activities on resources, the strategy and context are in accordance with student life, then the level of cooperation, communication, critical skills, and academic abilities will increase. This is confirmed by a statement from (Zubaidah, 2016) that knowledge grows and expands exponentially so that indicators of success are based on complex abilities.

Findings from cognitive psychology provide a basic theory for improving learning in general. The basic premise in cognitive psychology is that learning is a process of constructing new knowledge based on existing knowledge. The concept from David Ausubel of emphasizing meaningful learning processes hints at the importance of repetition before learning begins (Ausubel, 1968). This kind of mental activity helps students reformulate new information or restructure their knowledge into a broader/more complete cognitive structure so that it reaches a deep understanding. Scientific phenomena that can be accessed directly and observed are mental processes that can be done to obtain facts through various abilities (Speros, 2005). One example, after obtaining observational data in a laboratory, students can carry out inference activities through explanations and conclusions. Scientific literacy skills can be produced not only through competency to explain phenomena scientifically, but also require scientific evidence (Gormally et al., 2009, 2012). Therefore, any scientific statement must be in harmony with empirical evidence and new evidence can revise pre-existing scientific knowledge. But it cannot be denied that it is very difficult to make observations and interpretations that are truly objective (Lederman, 2007).

The findings of this study have implications that the achievement of scientific literacy skills refers to the science process, namely the mental processes involved when answering a question or solving a problem (Gormally et al., 2012). The inclusiveness of scientific literacy as a major competency for learning science tends to develop on scientific questions. The hope is as Amin (2017) said that the achievement of scientific literacy products is to be human beings who are able to keep up with the times, this can have the provision in facing increasingly complex life problems. In line with the view of Hudha, A. M., Amin, M., and Bambang (2016) who argued that the century of knowledge needed high-quality human resources. The implication of the result is a teacher be able to construct students' scientific literacy skills through experience in project activities. It is very possible for local potential based teaching materials to be used at the learning process by the teacher at the secondary school level to supporting the improvement of the learning achievement with relevant material.

CONCLUSION

The result showed that the variable of explaining scientific phenomena at a significance of 0.005 with an F value of 5.839; evaluating and designing scientific investigations at a significance of 0.000 with an F value of 13.839 and interpreting scientific evidence and data at a significance of 0.003 with an F value of 6.518. The experience of project activities has a significant effect on the scientific literacy skills in three competencies. This result is as an implication in the learning process to be able to construct scientific literacy skills through experience in project activities. It is very possible for local potential based teaching materials to be used at the learning process by the teacher at the secondary school level to supporting the improvement of the learning achievement with relevant material.

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