The Journal of Social Sciences Research
ISSN(e): 2411-9458, ISSN(p): 2413-6670
Vol. 6, Issue. 5, pp: 592-597, 2020
URL: https://arpgweb.com/journal/journal/7
DOI: https://doi.org/10.32861/jssr.65.592.597

Academic Research Publishing Group

Original Research Open Access

The Effect of Learning Models and Academic Ability on Students' Scientific Literacy in Disaster Preparedness

Endang Widi Winarni*
Department of Elementary Education, Faculty of Teacher Training and Education, University of Bengkulu, Bengkulu, Indonesia

Endina Putri Purwandari
Department of Information System, Faculty of Engineering, University of Bengkulu, Bengkulu, Indonesia

Rizqa Dwi Shofiya M. I.
Department of Elementary Education, Faculty of Teacher Training and Education, University of Bengkulu, Bengkulu, Indonesia

Abstract

Scientific literacy is important for elementary students, especially for disaster preparedness issues. The research purpose was to analyze the effect of Problem Based Learning models and students' academic abilities on scientific literacy in attitudes, contexts, competencies, and knowledge. The research method used a quasi-experimental with the matching only pretest-posttest control group design. The populations were 4 elementary schools with a disaster preparedness program. Samples were taken by cluster random sampling. The homogeneity test based on the average scores from odd semester 2018/2019 in fourth-grade elementary school for subjects such as civic education, mathematics, Indonesian language, science, and social sciences. The independent variable was thematic with PBL learning model. The moderator variable was a student's academic ability and the dependent variable was scientific literacy which includes attitude, context, knowledge, and competence. Instruments in this study were attitude questionnaire, context and knowledge test, and science competency observation. Quantitative data were analyzed with IBM SPSS Statistics 25. The research experiments show that (1) PBL model has a significant influence on the student in scientific literacy aspects such as attitudes, contexts, knowledge, and competencies; (2) academic ability does not significantly influence the scientific literacy aspects. School principals, teachers, and future researchers suggested to download the information and make learning resources about earthquake disaster preparedness education on the www.wartabencana.com to foster earthquake safety culture for students optimally.

Keywords: Problem based learning; Academic ability; Scientific literacy; Disaster preparedness; Elementary school.

1. Introduction

Bengkulu classified as a disaster-prone province because located in a seductions zone between the active Indo-Australian and Eurasian plates (Van Gorsel, 2018). It is necessary to provide preparedness knowledge of natural disasters especially earthquakes that aims to foster the Safety Culture. Based on the Bengkulu City Regional Regulation No. 02 in 2017 states that education and preparedness training carried out by the City Government and community, both individuals and groups, social institutions and other parties, formal and non-formal education, and information with training, technical, and simulation. The other regulation for implementing disaster preparedness in schools explained in the National Disaster Management Agency No. 4 in 2012 as a guideline for implementing safe schools from disasters.

Amri *et al.* (2016), said that School of Disaster Preparedness is an effort to improve the disaster awareness for all elements in school and environment. According to Winarni (2018c), the implementation of preparedness education integrated into school subjects. Disaster preparedness education leads to (1) understanding of disasters; (2) understanding of vulnerability; (3) understanding of physical vulnerabilities and critical facilities for emergencies; (4) attitudes and concerns about disaster risk.

One effort to increase the disaster knowledge and preparedness is to increase the scientific literacy capabilities of Indonesian society. The importance of scientific literacy for students in disaster-prone areas is to master the environment, health, economy, and disaster preparedness issues. Winarni and Purwandari (2018b), concluded that there is a significant influence of literacy on community preparedness in facing disasters.

Scientific literacy influenced by many things and developed through education (Cansiz and Turker, 2011). According to Suryandari *et al.* (2018), these factors include the curriculum and education system, the teachers learning methods and models, learning facilities and resources, teaching materials. The use of curriculum and learning models is one of its factors. The elementary school currently used the 2013 curriculum with integrated thematic learning. Disaster preparedness is one of material that integrated into thematic learning, which requires a learning model to facilitate students both individually and groups to actively explore, discover concepts and principles holistically, authentically, and sustainability.

The study aimed to analyze: (1) the impact of PBL on disaster preparedness material to scientific literacy in attitudes, contexts, competencies, and knowledge; (2) the effect of 'initial abilities on disaster preparedness material

*Corresponding Author

on scientific literacy in attitudes, contexts, competencies, and knowledge. The research benefits are: (1) participating in implementing the Bengkulu City Regional Regulation regarding the National Disaster Management Agency program with disaster preparedness schools and (2) optimizing students' scientific literacy skills in facing disaster preparedness.

2. Material and Method

This research used quantitative research with the philosophy of positivism, which used to examine the treatment or experiment in certain populations or samples. The research used a quasi-experimental method with the Matching Only Pretest-Posttest Control Group Design (Winarni and Purwandari, 2018b). The research population was fourth-grade students in Bengkulu City, namely: public elementary school number 08, and 11 with the accreditation level "A", using curriculum 2013, and socialization about disaster preparedness that implemented for the past 5 years.

The research sample was taken by Cluster Random Sampling. Randomization carried out to take two classes that sampled as the experiment and the control class. The homogeneity test carried out by taking data on the odd semester in public elementary school number 08 and number 11 in thematic learning (civic education, mathematics, Indonesian language, science, and social sciences) in odd semester 2018/2019. The public elementary school number 08 in Bengkulu City with 30 students as an experimental class by applying PBL models and public elementary school number 11 in Bengkulu City with 28 students as a control class by applying conventional models.

The independent variable is PBL model in thematic. The moderating variable is the student's academic ability, and the dependent variable is scientific literacy ability. Thematic learning theme Regional Area of My Place, Subtheme Neighborhood Area of My Place used PBL for the experimental class and conventional learning for the control class. This study covers Indonesian subjects with basic competency by comparing nonfiction texts. Natural Sciences, in basic competency linking forces with the motion to events in the environment, associated with disaster preparedness material.

The ability of scientific literacy includes 4 aspects, namely attitude, context, knowledge, and competence (OECD, 2015). There are three instruments: (a) attitude questionnaire in a closing statement; (b) test for context and knowledge aspects; and (c) science competency observation. All instruments validated by experts and tested. The data analysis technique was quantitative using IBM SPSS Statistics 25.

3. Results

The independent sample test results in Table 1 showed that the significance value of Levene's was homogeneous for competence aspects between learning models amounted to 0.377 > 0.05. Then, Kolmogorov-Smirnov[a] and Shapiro-Wilk distributed normally with a value greater than 0.05. The T-test result for the competency literacy between learning models obtained a significant value of 0,000 <0.05. There are any differences in the competence of literacy aspects between PBL and conventional groups. Furthermore, an independent test was homogeneous with value 0.260> 0.05 and the significance value of Kolmogorov-Smirnov[a] and Shapiro-Wilk is greater than 0.05 that distributed normally. Therefore, the hypothesis test is performed with parametric statistics, namely the t-test. The significance value of the t-test was 0.296> 0.05, so Ho accepted, there was no significant difference between the competencies of literacy for high and low academic ability students.

Table-1. Independent Samples Test for Learning Model and Academic Ability

	Levene's Test for Equality of Variances			**t-test for Equality of Means**		
		F	**Sig.**	**t**	**df**	**Sig.**
Competency in different Learning Model	Equal variances assumed	0.794	0.377	3.741	56	0.000
	Equal variances not assumed			3.707	50.450	0.001
Competency in different Academic Ability	Equal variances assumed	1.294	0.26	1.054	56	0.296
	Equal variances not assumed			1.067	55.909	0.290

The significance value of Kolmogorov-Smirnov[a] and Shapiro-Wilk was greater than 0.05 so the aspects of context, knowledge, and attitude were not normally distributed for different learning models and academic abilities (see Table 2 and Table 3).

Table-2. Test of Normality between PBL and Conventional Learning Model

	Learning Model	**Kolmogorov-Smirnov[a]**			**Shapiro-Wilk**		
		Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Context	PBL	0.182	30	0.013	0.858	30	0.001
	Conventional	0.400	28	0.000	0.645	28	0.000
Competency	PBL	0.163	30	0.041	0.951	30	0.184
	Conventional	0.157	28	0.073	0.965	28	0.454
Knowledge	PBL	0.197	30	0.004	0.864	30	0.001
	Conventional	0.487	28	0.000	0.484	28	0.000
Attitude	PBL	0.152	30	0.076	0.926	30	0.039
	Conventional	0.199	28	0.006	0.845	28	0.001

a. Lilliefors Significance Correction

Table-3. Test of Normality between High and Low Academic Ability

	Academic Ability	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Context	High	0.271	31	0.000	0.805	31	0.000
	Low	0.264	27	0.000	0.796	27	0.000
Competency	High	0.116	31	0.200	0.955	31	0.220
	Low	0.198	27	0.008	0.944	27	0.152
Knowledge	High	0.308	31	0.000	0.758	31	0.000
	Low	0.335	27	0.000	0.754	27	0.000
Attitude	High	0.223	31	0.000	0.852	31	0.001
	Low	0.172	27	0.039	0.920	27	0.039

a. Lilliefors Significance Correction
*. This is a lower bound of the true significance.

Therefore, the research analysis used non-parametric statistics or Mann-Whitney U, as follows:

(1) Hypothesis testing for the aspects of attitude, context, and knowledge, between PBL and conventional learning models, obtained a value of 0.000 <0.005 or Ha is accepted. So, there are differences in attitude, context, and knowledge variables between PBL and conventional models (Table 4).

Table-4. Test Statistics between PBL and conventional Learning Model

	Context	Knowledge	Attitude
Mann-Whitney U	191.500	170.500	94.000
Wilcoxon W	597.500	576.500	500.000
Z	-3.769	-4.252	-5.089
Asymp. Sig. (2-tailed)	0.000	0.000	0.000
a. Grouping Variable: Learning Model			

(2) Hypothesis testing of the aspects of attitude, context, and knowledge, between high and low academic abilities, obtained values greater than 0.005 or Ha is rejected. There are no differences in attitude, context, and knowledge variables between high and low academic ability (Table 5).

Table-5. Test Statistics between High and Low Academic Ability

	Context	Knowledge	Attitude
Mann-Whitney U	407.000	382.500	413.500
Wilcoxon W	903.000	760.500	791.500
Z	-0.190	-0.615	-0.078
Asymp. Sig. (2-tailed)	0.849	0.539	0.938

a. Grouping Variable: Academic Ability

4. Discussion

4.1. Science Literacy in Attitude Aspects

Thematic learning using the PBL model has an influence on scientific literacy especially for students' attitudes in earthquake preparedness disasters. The PBL models in earthquake disaster preparedness materials make students more enthusiastic about solving the problem, formulating hypotheses, collaborating, being thorough, and being responsible. PBL learning trains students to work with scientific steps and scientific attitudes (Hidayati and Retnawati, 2016; Winarni, 2018a).

Students' curiosity attitude is more to be seen in the step of problem orientation, students actively ask and answer questions based on their experiences. The study result is in line with Samson (2015) that learning using the PBL model fosters students' collaborative attitudes through problem-solving activities. Conscientious attitude is seen when students record observational data, groups who do not follow the instructions difficult to prove the proposed hypothesis. The observation's accuracy following procedures and the observations can foster students' conscientious attitudes (Kereh *et al.*, 2017).

The responsibility seen when conducting experiments from group assignment and giving the information obtained. The PBL model can foster a responsible attitude (Susani *et al.*, 2019). Etherington (2011), concluded that PBL models in science learning can improve the scientific attitude of fifth-grade elementary school students.

4.2. Science Literacy in Context Aspects

The PBL models influence the components of students' preparedness in natural disasters. Based on the PowerPoint presentation, students respond with asking and answering questions based on preliminary knowledge and linking them to the topic being studied. Real problems from the context of real-life make learning more meaningful for students because it can help students to solve problems well (Winarni, 2018a).

Using the PBL model, students discover concepts by conducting experiments and demonstrations directly, encouraging students to improve the critical thinking to solve real-life problems. As a result, students become more

motivated and more active to find solutions for the problems. The groups of PBL models have increased scientific literacy abilities because students integrate knowledge and skills according to relevant contexts (Hung *et al.*, 2014).

4.3. Science Literacy in Knowledge Aspects

Hypothesis test results indicate that the PBL models have significant influences on the scientific literacy of knowledge aspects. The PBL model provides an influence on training and improving students' critical thinking skills in problem-solving (Ragilia *et al.*, 2018). PBL facilitates students to formulate hypotheses based on relevant information from webpage learning sources www.wartabencana.com about the earthquakes move and movements. By providing additional information related to subject matter can enrich students' content knowledge (Sihaloho and Sahyar, 2017). Literacy aspects of procedural knowledge developed from experiments. Students 'procedural knowledge can be seen by exploring students' knowledge in identifying information as an initial stage in conducting experiments (Surif *et al.*, 2012).

4.4. Science Literacy in Competency Aspects

The PBL learning model influences significantly the scientific literacy in the competency aspects of earthquake disaster preparedness in Fourth-grade elementary school. The PBL models lead students to actively applying their knowledge to understand the concepts and processing the science that useful in making decisions. The PBL model makes students directly involved in solving, identifying problems, finding solutions, and making students as independent learner (Sihaloho and Sahyar, 2017). Scientific literacy is not only measuring scientific knowledge but also understanding of various aspects of the scientific process to apply scientific knowledge and processes to students' real lives.

Science literacy in competence aspects with its indicators explain the phenomena scientifically, remind and apply appropriate scientific knowledge carried out at the orientation stage. At this stage, students can express their knowledge by mentioning and explaining the earthquakes types, soil types, safe and unsafe houses, and encouraging students to find the best solution in dealing with earthquake disasters based on the information presented during the initial stimulus. Stimulus in the learning process can foster students' ability to find solutions and to solve problems based on preliminary knowledge (Samson, 2015).

The indicators make and justify predictions, carried out at the stage of organizing students in conducting investigations. At this stage, the activity begins with students recalling soil types, knowing safe and unsafe houses, making predictions about the relationship between soil types and housing conditions when an earthquake, and seeking information obtained from the www.wartabencana.com about earthquake types. Through these activities train students making hypotheses for the investigation process. Recalling concepts, facts, or scientific terms can foster students' ability to make predictions correctly (Cimer, 2007).

Prediction results used as the basis to formulate hypotheses in the investigating process of "Delicious earthquake" to collect relevant data and information. After the data obtained, students conclude the hypothesis. Winarni (2016), said that the students' activities in formulating and proving hypotheses put forward in learning using the PBL model achieved through the stage of organizing students at the problem investigation stages.

The ability to design and evaluate scientific investigations can be seen in the students' orientation towards the problem. After students ask scientific questions, students evaluate questions by providing answers based on predictions whether the selected question can be searched for truth. At the time of answering must be accompanied by arguments that correspond to each decision. Musingafi and Muranda (2014), concluded that the stimulus provided in the learning process can encourage students to ask questions and provide answers that are appropriate with the learning topic.

The ability aspects interpreted data and facts scientifically, measured by analyzing indicators, and interpreting scientific facts. It began with students presented the results of "Delicious earthquake" experiment based on the earthquake causes, concluded the relationship between force and motion when earthquakes occurred. Students write information based on demonstrations conducted and equipped with information from webpage www.wartabencana.com about safety steps. Students encouraged to provide information about efforts to save themselves by expressing personal opinions based on relevant information, so it influences the indicators to different arguments based on scientific evidence and theories. The activity of collecting and processing data is related to problems given in the learning process that can affect the students' scientific literacy (Dewi *et al.*, 2018).

4.5. Academic Ability Variable

The variable of student academic ability doesn't significantly influence the scientific literacy in attitude, context, knowledge, and competence. The aspects of curiosity, cooperation, conscientiousness, and responsibility measured specifically regard to disaster preparedness or "Safety Culture". UNDP (2011), states that people in Bengkulu are very prone to facing earthquake natural disasters. Students who live in Bengkulu city have very often experienced earthquake events. There is no difference in attitude, context, knowledge, and competence of students towards earthquake natural disasters between high and low academic ability groups. Students' ability to think contextually requires an environment that stimulates intellectual processes (Winarni, 2016). One of the principles in environment creation is the students' availability in real experiences that are often facing natural disasters of earthquakes. Students do a self-rescue demonstration by ideas, regulations, and acts of self-rescue. This can happen because the student's experience who live in the Bengkulu city has very often experienced earthquake events so that the earthquake events for the community have become a real context.

5. Conclusion

Based on the experimental data, it concluded that the use of PBL model significantly influences the scientific literacy for attitudes, context, knowledge, and competency aspects. The groups of students who follow learning using the PBL model display all four aspects of scientific literacy better than the groups who take learning conventionally. Academic ability does not significantly influence the scientific literacy for attitude, context, knowledge, and competency aspects. The groups of students with high abilities display all four aspects of scientific literacy not better than the groups with low academic abilities.

Based on the results of research and conclusions, suggestions given as Principals, teachers, and further researchers that the implementation of science literacy learning, especially those aimed at fostering a "safety culture" of natural disasters for students is optimally successful. It recommended downloading information about earthquake disaster preparedness that researchers have developed on the page www.wartabencana.com. As well as using it as a learning resource, the page presents information relevant to earthquake disasters, for example: about earthquake types, types of land, houses that resistant to earthquake, and videos about rescue efforts and the process "Delicious Earthquake" investigation.

Acknowledgments

We would like to thank the Directorate of Higher Education, Ministry of Research, Technology, and Higher Education, Republic Indonesia for financial support throughout the research grant in 2020.

References

Amri, A., Bird, D. K., Ronan, K., Haynes, K. and Towers, B. (2016). Disaster risk reduction education in Indonesia: challenges and recommendations for scaling up. *Natural Hazards and Earth System Sciences*: 1-1. Available: https://doi.org/10.5194/nhess-17-595-2017

Cansiz and Turker (2011). Scientific literacy investigation in science curricula: The case of Turkey. *Journal of Educational Science*: Available: https://www.semanticscholar.org/paper/Scientific-Literacy-Investigation-in-Science-The-of-Cansiz-Turker/84b3de54fab4403a1b742f897479267f0a8dd1db

Cimer, A. (2007). Effective teaching in science: A review of literature. *Journal of Turkish Science Education,* 4(1): 20-44.

Dewi, W. S., Festiyed, F., Hamdi, H. and Sari, S. Y., 2018. "The study of literacy reinforcement of science teachers in implementing 2013 curriculum." In *IOP Conference Series: Materials Science and Engineering. IOP Publishing.* p. 012071.

Etherington, M. B. (2011). Investigative primary science: A problem-based learning approach. *Australian Journal of Teacher Education,* 36(9): 53. Available: http://dx.doi.org/10.14221/ajte.2011v36n9.2

Hidayati, A. U. and Retnawati, H., 2016. "Effectiveness of problem-based learning and scientific approach to improve higher order thinking skills." In *Proceeding of 3rd International Conference on Research, Implementation, and Education of Mathematics and Science. Yogyakarta.*

Hung, P.-H., Hwang, G.-J., Lee, Y.-H., Wu, T.-H., Vogel, B., Milrad, M. and Johansson, E. (2014). A problem-based ubiquitous learning approach to improving the questioning abilities of elementary school students. *Educational Technology and Society,* 17(4): 316–34.

Kereh, C. T., Paais, R. and Limba, A., 2017. "Scientific approach to build students' scientific attitudes and its effectiveness toward their achievement in physics." In *The 4th ICRIEMS Proceedings. Yogyakarta State University.*

Musingafi, M. C. C. and Muranda, K. E. (2014). Students and questioning: A review of the role played by students generated questions in the teaching and learning process. *Studies in Social Sciences and Humanities,* 1(3): 101-07.

OECD (2015). *Pisa 2015 assessment and analytical framework: Mathematics, reading, science, problem solving and financial literacy*. Journal OECD Publishing: Paris. http://www.oecd.org/pisa/pisaproducts/PISA%202015%20framework%20e-book_final.pdf

Ragilia, N., Ambarita, A. and Rusminto, N. E. (2018). Development of problem based learning model learner worksheet to improve critical thinking ability. *Journal of Research and Method in Education (IOSR-JRME),* 8(1): 65-72.

Samson, P. L. (2015). Fostering student engagement: Creative problem-solving in small group facilitations. *Collected Essays on Learning and Teaching,* 8(0): 153-64. Available: https://doi.org/10.22329/celt.v8i0.4227

Sihaloho, R. R. and Sahyar, E. M. G. (2017). The effect of problem based learning (pbl) model toward student's creative thinking and problem-solving ability in senior high school. *Journal of Research and Method in Education (IOSR-JRME),* 7(4): 11-18. Available: https://doi.org/10.9790/7388-0704011118

Surif, J., Ibrahim, N. H. and Mokhtar, M. (2012). Conceptual and procedural knowledge in problem-solving. *Procedia-Social and Behavioral Sciences,* 56: 416-25. Available: https://doi.org/10.1016/j.sbspro.2012.09.671

Suryandari, K. C., Fatimah, S., Sajidan, S., Rahardjo, S. B. and Prasetyo, Z. K. (2018). Project-based science learning and pre-service teachers' science literacy skill and creative thinking. *Cakrawala Pendidikan,* 37(3): 345-55. Available: https://doi.org/10.21831/cp.v38i3.17229

Susani, D. E., Ngabekti, S. and Priyono, B. (2019). The effect of problem based learning for environmental change concept on students' learning outcomes. *Journal of Biology Education,* 8(1): Available: https://doi.org/10.15294/jbe.v8i1.27189

UNDP (2011). *2011 Lesson learned: Supporting the mainstream of DRR in the education system in Indonesia and pilot projects for saver school, safer communities through disaster risk reduction (SCDRR) – UNDP.*

Van Gorsel, J. T. (2018). *Bibliography of the geology of Indonesia and Surrounding areas, ii. Sumatra-sundaland.* 7th edn: Bibliography of Indonesia Geology: Sumatra, Tin Island, Sunda Shelf, Natuna.

Winarni, E. W. (2016). Pengaruh Pelaksanaan Program Risiko Bencana terintegrasi menggunakan model PBL Berbasis ICT bagi siswa Kelas IV SDIT IQRO' 1 di Kota Bengkulu. *Jurnal Inovasi Pembelajaran,* 2(2): 351-59. Available: https://doi.org/10.22219/jinop.v2i2.2626

Winarni, E. W. (2018a). *Pendekatan ilmiah dalam pembelajaran kreatif dan inovatif.* FKIP UNIB: Bengkulu.

Winarni, E. W. (2018c). Mobile educational game for earthquake disaster preparedness in elementary school. *ARPN Journal of Engineering and Applied Science,* 13(7): 2612-18.

Winarni, E. W. and Purwandari, E. P. (2018b). Disaster risk reduction for earthquake using mobile learning application to improve the students understanding in elementary school. *Mediterranean Journal of Social Sciences,* 9(2): 205-14. Available: https://doi.org/10.2478/mjss-2018-0040