A Comparison between Generative Learning and Conventional Learning Model on Students' Mathematical Literacy in the 21st century

Ellis Salsabila[1], Wardani Rahayu[2], Selly Anastassia Amellia Kharis[3], Agustiani Putri [4]
{ellissalsabila@yahoo.com[1], wardani.rahayu@unj.ac.id[2], sellyanas@yahoo.com[3] }

Department of Mathematics Education, Universitas Negeri Jakarta, Jl. Rawamangun Muka, Jakarta Timur 13220, Indonesia[1,2,3,4]

Abstract. Mathematical literacy concentrates on students' ability to analyze, prove, and express ideas completely, solve, and interpret mathematically. The objective of the study was to distinguish between the generative learning model and the conventional learning model on students' mathematical literacy. This study adopted the quasi-experimental research design. The performance continued for four weeks and at the end of the program, post-test compositions were obtained from the nominees. The sample for the study was performed of 72 undergraduate students represented from two classes. Purposive sampling method was applied in selecting the sample. The results of the research presented that there was a significant discrepancy among the t-test score points of the generative learning and conventional group (P<0.05), namely $t_{count} = 4.044 > t_{table} = 1.667$. Therefore, it can be concluded that the average of students' mathematical literacy skill scores with the generative learning group was higher than the conventional learning group.

Keywords: analytic geometry, generative learning model, mathematical literacy.

1 Introduction

Education has a particularly crucial function in handling those challenges. Education was a system to prevent hazards and vehicles which will expedite increase people's quality of life in continuities [1]. Therefore, education needs to expand strength, flexible, problem-solving, collaboration expertise and discovery of students that expected to enter jobs and life [2]. Education needs to accommodate student capacity to handle data in presence. In this globalization era at the 21st century that people not simply needed content knowledge, however, they additionally demanded skills that related to as 21st century that embrace vital thinking and drawback finding, creativity, communication and collaboration, flexibility, self-confidence, cultural, productivity, answerability, leadership and accountability, and data accomplishment [3],[4]. Mathematical literacy became one of the parts necessary to create 21st-century skills.

Mathematical literacy has been inducted by the National Council of Teacher of Mathematics (NTCM) joined the mathematics education visions that are to mathematically literate. In this vision, the mathematical skill had four previous elements to resolve a haul. that's investigating, correlating, and rationalizing conjointly exploitation modified mathematical strategies [5]. Simplicity, Ojose said that mathematic literacy was the knowledge to grasp and practice basic mathematics in our everyday sustenance [6]. Fit-out opinion before, Steen, Turner, & Burkhardt attach information effectively within the interpretation of mathematical

MSCEIS 2019, October 12, Bandung, Indonesia

DOI 10.4108/eai.12-10-2019.2296539

literacy [7]. Mathematic literacy drew as the capability to apply mathematical information and perception effectively to dress standards of living challenges.

Mathematical literacy in PISA proposes that an individual's capability to express and represent mathematics during a sort of context. It involves rationalizing mathematically and exploitation mathematical concepts, schemes, facts and vehicles to define, interpret, predict phenomena. It serves people to recognize the role that mathematics performs within the world and to create the reasonable judgments and elections expected by engaged voters [8]. The necessary of mathematic literacy also handled attention by the Indonesian government in Education and Culture Ministry that proved from the participation of Indonesia in PISA. Besides that, it can also be detected within the expertise and purposes of learning that encapsulated within the program. In the newest program, the national program as an example, mathematical literacy mirrored in main expertise domain knowledge and skills [9].

All this season, students' mathematical literacy skills observed from the survey taken by PISA. This review investigation used the top tree domain: method, content, and connection. The method domain consists of students' ability to relate the meaning of the problems with math and also answer it. Then, content and connection include the mathematic content tested. The review outcome proves that the mathematical literacy of Indonesian students still low that is 64th from 65 participants. Most of them only can answer the problem below 2nd level [10]. According to the previous study, found many students who had some problems working on mathematical literacy questions in High School Bandung. Students were more familiar with routine questions so that when they met questions related to mathematical literacy, the students had their prejudice that the questions would be difficult to answer and they were desperate. Furthermore, to be able to work on mathematical literacy questions, it took some strong perception of the concept, so that they are capable to connect the mathematics concept to the problems. Some students had some hard time to master the concept [11].

Vale, Murray, & Brown categorized five students' mistakes in working on the mathematical literacy; they are decoding (reading, seeing), encoding (writing, representing), mathematics counting, carelessness, and effortless. The mistakes caused by the reading was that the lack of understanding of the text within the problem that can be seen by the way the data was interpreted and used in the calculation. The mistakes in seeing are the misunderstanding in symbolic notation, table, or graphic that caused the mistakes. Students knew the problems and they were capable to perform the calculation correctly, however, they failed to explain the solution written accurately [12]. To develop the students' mathematical literacy should be capable to determine the model of learning that close students to get extra actively. There are several learning models that lead to active learning, and the most familiar is a learning model with a constructivist approach. Students with a constructivist approach are supposed to develop their knowledge so that the students can advance their knowledge and be active in the teaching and learning process. One of the learning models that match the Constructivist model of learning is generative learning [13].

Generative learning is a model of learning in which students do not quietly take in learning, but they are actively included in the learning preferably. They create an essential knowledge of the data obtained in the circumstances [14]. Wittrock combines that generative learning consists of four principal methods; (a) concentration, (b) motivation, (c) information and hypothesis, and (d) generation [15]. From that opinion, generative learning makes students can actively assemble an understanding of the data and decide. Therefore, the present study proposes to obtain a comparison between the generative learning model and the conventional learning model on students' mathematical literacy.

2 Method

This study is quantitative research to distinguish among the generative learning model and the conventional learning model on students' mathematical literacy. The sample of this study consisted of 72 students of mathematics education department at Universitas Negeri Jakarta, while the second semester of the 2019/2020 academic years. Purposive sampling method was applied to choose the samples. Purposive sampling is a non-probability sample that is chosen based on the properties of a population and the purpose of the study [16]. Before beginning the program, each group received the preparatory test. The first group was formed applying the generative learning model and the second group was formed applying the conventional learning model. The program continued for four weeks and at the end of the program, post-test activities select from the nominees. Then, later the program, each group received the post-test.

This study was teaching the material of analytic geometry on the conics concept that can be design based on visual aids. based on the manipulative materials. It is designed on the strength of the definition of the circle, parabola, ellipse, and hyperbola. This study instrument applied is a test working the five questions provided after the study. The composition of the test was based on the indicators of mathematical literacy. Before applying the instrument, the instrument was examined applying validity and reliability test implementing the SPSS 16.0 for windows. The data obtained in the study test with quantitative statistics inferential. Hypothesis testing was based on the outcomes of the computation applying the SPSS 16.0 for windows. The hypothesis was examined applying independent sample t-test. If the value of the probability of significance ($P < 0.05$), then the hypothesis is denied.

3 Result and discussion

3.1 The Results of the Tests on Students' Mathematical Literacy

The preparatory test of mathematical literacy was performed before the start of the teaching in both groups, whereas the post-test was performed after completion of the teaching. Treatment was presented seven times in each class with diverse concepts; there are mean, median, mode, range, etc. The data of the post-test on students' mathematical literacy in the generative learning group and conventional learning group presented in Table 1 below.

Table 1. Descriptive Statistics of Mathematical literacy.

	N	Mean	Std. Deviation	Variance
GL	36	75.31	13.020	169.533
Convenional	36	60.67	17.385	302.229
Valid N (listwise)	36			

Table 1 displays the outcome of the post-test mathematical literacy of the generative learning group obtained an average of 75.31 and the conventional learning group gained an average of 60.67. This has revealed that the average post-test of the generative learning group is higher than the conventional learning group. The data normality test gains students'

mathematical literacy skills by applying Kolmogorov Smirnov and Shapiro-Wilk with a significant level of 5% performed in Table 2.

Table 2. The results of the normality test improvement of students' mathematical literacy in the experimental class.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
GL	.132	36	.113	.933	36	.061
Conventional	.109	36	.200	.953	36	.132

The development in both groups has a normal distribution. It can be detected from the value of significance. In Table 3 that the significance value is more significant than $\alpha = 0.05$. Moreover, to test the research hypothesis applied to the independent-sample t-test. It showed in Table 3 below.

Table 3. The Results of Hypothesis Test Using Independent Sample T-Test.

	Levene's Test for Equality of Variances		T-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variances assumed	3.827	.054	4.044	70	.000
Equal variances not assumed			4.044	64.868	.000

Based on Table 3, the significance of value obtained at $0.00 < \alpha = 0.05$. So it can be assumed that development students' mathematical literacy in the generative learning group is better than the conventional learning group. It was because there has been affected by the steps of generative learning model gives a new concept to students after each student made a hypothesis of the problem. This step is very powerful to encourage students' enthusiasm for the new concept presented by the teacher to establish their hypothesis. The conventional learning model has a weaker impression of mathematical literacy skills because the new concepts were delivered before students encounter the problem and get their hypothesis of the problem.

3.2 Analysis of the Comparison of Students' Mathematical Literacy

In this study, the outcomes of the generative learning model and the conventional learning model on students' mathematical literacy were explored. For this view, two groups were built. Whereas the generative learning model was implemented to the first experimental group, while the conventional learning model was implemented to the second group. The data of this investigation has indicated that the generative learning model and the conventional learning model had diversity in students' mathematical literacy. Based on the data report, there was a significant discrepancy in post-test scores of the generative learning group was implemented.

There was additionally a significant discrepancy in post-test scores of the conventional learning model was used. Both models had an accurate impact on students' mathematical literacy.

Here is the analysis' result of mistakes done by the students. There is a line crossing the point E(3,10) and perpendicular to $g \equiv y = \frac{2}{5}x + 4$ so it cut the ellipse $\frac{x^2}{81} + \frac{y^2}{45} = 1$ on point E and F. Find the length of EF. This question involved the representation, reasoning, and argument, planning strategy to solve problems, the usage of symbols, formal language and technical, and the usage of mathematical operations. One of the student's answers shown in **Figure 1**. the student couldn't understand the meaning of the question. The student also wouldn't know what to do with the given information in this question. So, the student couldn't reach the level of metacognition because they even didn't know how to use the information to solve the problem.

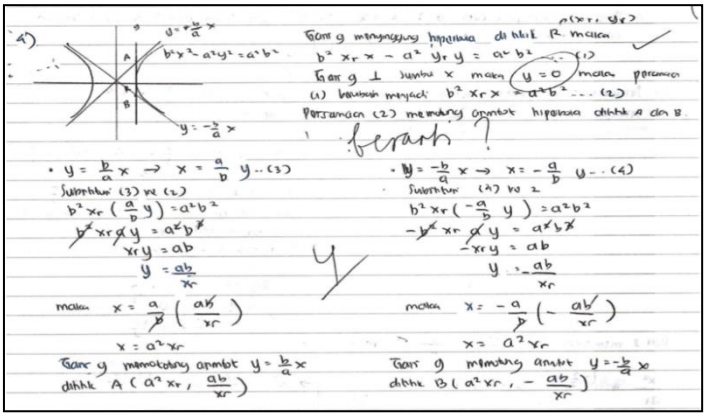

Fig. 1. The result of student written work.

The generative learning model had a greater influence on mathematical literacy because this model provides a new concept to students after each student composed a hypothesis of the problem. This action is very powerful to assist students' enthusiasm for the new concept delivered by the teacher to establish their hypothesis [17]. The conventional learning model had a weaker impression on mathematical literacy because the new concepts were presented before students encounter the problem and obtain their hypothesis of the problem [18].

This study is approved by the previous investigations as regards: (1) The judgments of Grabowski that generative learning model can enhance additions in recall, understanding, and mathematical literacy skill as well as growth in self-regulated learning skill; (2) The judgments of Calfee that conventional learning model highlighted students to assign information with other students to explore the misunderstanding occurred and develop it into a new knowledge assemblies [19]. The outcome revealed that students' mathematical literacy with the generative learning model and conventional learning model improved because these models highlighted the organization of students' new knowledge and existing knowledge.

4 Conclusion

Based on data report, there was a significant discrepancy among the t-test score scores of the generative learning and conventional group ($P < 0.05$), namely t_count=4.044 > t_table=1.667. It can assume that there is a significant discrepancy between students' mathematical literacy skills applying generative learning model and conventional learning model. Therefore, the conclusion is students' mathematical literacy skill with generative learning model is higher than the conventional learning model.

Acknowledgments. This research is fully funded and supported by Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Jakarta.

References

[1] Moretti, G. A. S. and Frandell, T.: Literacy from a right to education perspective. Retrieved from http://unesdoc.unesco.org/images/0022/002214/221427e.pdf (2013)
[2] Pacific Policy Research Center.: 21st century skills for students and teachers. Honolulu. Retrieved from http://www.ksbe.edu/_assets/spi/pdfs/21_century_skills_full.pdf (2010)
[3] Ariyadi Wijaya.: 2016 Students' Information Literacy: A Perspective From Mathematical Literacy IndoMS Journal Mathematics Education Volume 7 No. pp. 73 – 82 (2016)
[4] OECD.: PISA 2012 Results: What students know and can do. Student Performance in mathematics, reading, and science. Paris: OECD (2013)
[5] Stacey, K. and Turner, R.: Assessing Mathematical Literacy. (K. Stacey & R. Turner, Eds.). Cham: Springer International Publishing. http://doi.org/10.1007/978-3-319-10121-7 (2015)
[6] Ojose, B.: Mathematics literacy: Are we able to put the mathematics into everyday use? Journal of Mathematics Education, 4(1). http://educationforatoz.com/images/Bobby_Ojose.pdf (2011)
[7] Steen, L. A., Turner, R. and Burkhardt, H.: Developing mathematical literacy. In Modelling and Applications in Mathematics Education (pp. 285–294). Boston, MA: Springer US. http://doi.org/10.1007/978-0-387-29822-1_30 (2007)
[8] Organisation for Economic Cooperation and Development. (2013). PISA 2012 assessment and analytical framework : Mathematics, reading, science, problem solving and financial literacy. OECD. http://doi.org/10.1787/9789264190511-en (2013)
[9] Menteri Pendidikan dan Kebudayaan Republik Indonesia. (2016). Peraturan Menteri Pendidikan dan Kebudayaan nomor 24 tahun 2016 tentang kompetensi inti dan kompetensi dasar pelajaran pada Kurikulum 2013 pada pendidikan dasar dan pendidikan menengah, Peraturan Menteri Pendidikan dan Kebudayaan (2016)
[10] Hapsari. (2018). Analysis of students' difficulties in mathematical literacy. Journal of Mathematics and Science Education, Vol. 39(1). pp.863-877 (2018)
[11] Organisation for Economic Co-operation and Development. (2014). PISA 2012 results: What students know and can do (Volume I, Revised edition, February 2014). Pisa: OECD Publishing. http://doi.org/10.1787/9789264208780-en (2014)
[12] Vale, P., Murray, S., & Brown, B 2012 Mathematical literacy examination items and student errors: an analysis of English Second Language students' responses. Per Linguam: a Journal of Language Learning= Per Linguam: Tydskrif vir Taalaanleer, Vol. 28. Pp. 65-83 (2012)
[13] Bonn, K. L., & Grabowski, B. L. (2001, January). Generative learning theory: A practical cousin to constructivism. Paper presented at the Joint Meeting of Mathematics, New Orleans, L. A (2001)
[14] Lee, H. W., Lim, K. Y., & Grabowski, B. L. 2008. Generative Learning : Principles and Implications for Making Meaning. Handbook of Research on Educational Communications and Technology. New York: Lawrence Erlbaum Associates (2008)

[15] Wittrock, M. C. (1992). Generative learning processes of the brain. Journal of Educational Psychologist, Vol. 27(4), pp. 531-541(1992)
[16] Bernard, H. R. (2002). Research methods in anthropology: Qualitative and quantitative approaches (3rd ed.). Walnut Creek, CA: Alta Mira Press (2002)
[17] Maknun, J. (2015). The implementation of generative learning model on physics lesson to increase mastery concepts and generic science skills of vocational students. American Journal of Educational Research, Vol 3(6), pp 742-748 (2015)
[18] Galbraith, P. L., Stillman, G., & Brown, J. (2010). Turning Ideas into Modeling Problems. In R. Lesh, P. L. Galbraith, C. R. Haines & A. Hurford (Eds.), Modeling Students' Mathematical Modeling Competencies (pp. 133-144): Springer US (2010)
[19] Farouk, A. & Elfateh, A. (2016). Effectiveness use generative learning model on strategic thinking skills and learning level of basics offensives. Science, Movement, and Health, Vol. 16(1), pp. 33-38 (2016)