ISSN 2614-5103 (Print)
2614-5111 (online)
IndoMath
Indonesia Mathematics Education
https://indomath.org/index.php/indomath
Vol 5, No. 1, February 2022, pp. 34-41

Integration of Principles of Education for Sustainable Development in Mathematics Learning to Improve Student's Mathematical Problem Solving Ability

Jaya Dwi Putra
Program Studi Pendidikan Matematika, Universitas Riau Kepulauan,
Program Studi Pendidikan Matematika, Universitas Pendidikan Indonesia,
jaya@fkip.unrika.ac.id

Didi Suryadi
Program Studi Pendidikan Matematika, Sekolah Pascasarjana
Universitas Pendidikan Indonesia
ddsuryadi1@gmail.com

Dadang Juandi
Program Studi Pendidikan Matematika, Sekolah Pascasarjana
Universitas Pendidikan Indonesia
d42ngdj@upi.edu

ABSTRACT

This study aims to examine the differences in the improvement of mathematical problem solving ability between students who receive the jigsaw cooperative learning type based on education for sustainable development and students who receive conventional learning. This study is a quasi-experimental study with a non-equivalent control group design. The population in this study were students of grade 2 at one of the state high schools. The sample consisted of two classes which were selected by random sampling. The instrument used is a mathematical problem solving ability test. Based on the data analysis, it is concluded that the improvement students mathematical problem solving ability who received the jigsaw type of cooperative learning based on education for sustainable development was better than students who received conventional learning.

Keywords: education for sustainable development, mathematical learning, mathematical problem solving ability.

ABSTRAK

Penelitian ini bertujuan untuk menelaah perbedaan peningkatan kemampuan pemecahan masalah matematis antara siswa yang memperoleh pembelajaran matematika terintegrasi prinsip education for sustainable development dan siswa yang memperoleh pembelajaran konvensional. Penelitian ini merupakan penelitian kuasi eksperimen dengan desain non-equivalent control group design. Populasi pada penelitian ini adalah siswa kelas XI pada salah satu SMA Negeri. Sampel terdiri dari dua kelas yang dipilih secara random. Instrumen yang digunakan tes kemampuan pemecahan masalah matematis. Berdasarkan analisis data disimpulkan bahwa bahwa peningkatan kemampuan pemecahan masalah matematis siswa yang memperoleh pembelajaran kooperatif tipe jigsaw berbasis education for sustainable development lebih baik dibandingkan siswa yang memperoleh pembelajaran konvensional.

Kata Kunci: education for sustainable development, kemampuan pemecahan masalah matematis, pembelajaran matematika.

Copyright © Authors. This is an open access article distributed under the Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Based on Permendikbud (2014), one of the abilities that must be developed in mathematics learning is the ability to solve mathematical problems. The ability to solve mathematical problems is one of the main focuses in mathematics learning. Because problem solving ability is an essential and fundamental ability (Rahayu, 2015; Widyastuti, 2015; Ibrahim, 2021; Widodo, 2021). The ability to use previous knowledge into new problems is one form of problem solving ability. Wardhani (2010) defines problem solving as the process of applying previously acquired mathematical knowledge into new situations. In accordance with the opinion of Duffin (2000) that mathematical problem solving ability is the ability to explain problems and use knowledge in different situations. Besides, abilities in problem-solving are related to understanding problems and arranging solutions to mathematics problems. Related to this, Mariam (2019) argues that problem-solving abilities need to be developed, namely the ability to understand problems, make mathematical models, solve problems, and interpret solutions. Juandi (2006) suggests that students need to understand mathematical concepts, operations and relations in mathematics.

Polya (1973) suggests the stages in solving mathematical problems, namely; (1) understand the problem or problem; (2) make a plan or way to solve it; (3) solve problems; (4) re-examine the results obtained and the steps for processing them. Furthermore, Polya (1973) and Widodo (2015) suggests two kinds of mathematics problems, namely; (1) problem to find. This problem is defined as a problem that must be solved by trying to construct any type of object or information that can be used; (2) problem to prove. This problem is interpreted as a problem that must be demonstrated correctly. This problem prioritizes the hypothesis or conclusion of a theorem whose truth must be proven.

In solving a mathematical problem sometimes unusual thinking is needed. Widodo et al (2020) and Hidayat (2018) argues that solving mathematical problems requires creative thinking. In this study, the indicator of problem solving ability is adjusted to Sumarmo (2013) as follows; (1) identify the elements that are known, in question, and the adequacy of the elements needed; (2) formulate mathematical problems or compile mathematical models; (3) implement strategies to solve various problems (types and new problems) in or outside mathematics; (4) explain or interpret the results according to the original problem; (5) use math meaningfully.

Given the importance of mathematical problem solving abilities in mathematics learning, this ability needs to be considered to be developed in classroom learning. However, the importance of this ability has not been reflected in the achievement of student mathematics learning outcomes. Khamidah (2016) Most students work less paying attention to completion steps, only a small proportion of students successfully complete their learning. Students only care about the final result of the answer, so there are many steps that are not taken even though they are steps that determine the result of the final answer. Likewise, based on the test result data given in the preliminary study, there are still many students who have low mathematical problem solving abilities.

One of the factors causing the low ability of students to solve mathematical problems is the application of the learning model that is not appropriate. Maryati & Fadhilah (2021) suggest the

indicators of making mathematical models are classified as moderate, and checking the correctness of results and answers still relatively low. Besides, this is also due to the lack of meaning in learning that is felt by students. This is in line with the opinion of Putra (2014) that in mathematics learning, there are still many students who are not actively involved in exploring mathematical concepts or ideas in a deep and meaningful way, so that students receive knowledge in a form that is finished and is more memorizing in nature. In learning mathematics students are required to be active while the teacher acts as a facilitator (Putra & Martini, 2015). Therefore, as a solution so that these problems can be overcome, a learning model is needed that can make learning more meaningful so that it can improve students' mathematical problem solving abilities.

Education for Sustainable Development (ESD) is an education concept for sustainable development. ESD consists of 3 words, each of which has a meaning, namely: (1) Education, which means education, both moral and immaterial education, covering basic to advanced education, and a way to tell (educate) others about something according to their opinion. a method. (2) Sustainable, meaning continuously or continuously, has the meaning of a thing or activity that is carried out in earnest for a period of time in order to achieve maximum results. (3) Development, which means development, development, or development, has the meaning to expand existing functions by not throwing away the main elements. Based on these 3 understandings, we can conclude that ESD is education for the development of elements that occur continuously or continuously. Another understanding is education to support sustainable development by providing awareness and ability for sustainable development in the present and in the future. ESD also emphasizes the skills, perspectives, and values that guide and motivate people to seek sustainable livelihoods, participate in a democratic society, and live in a sustainable way. From the explanation above, integrating ESD principles in mathematics learning is needed to train and improve students' mathematical problem solving abilities.

The need to socialize and apply ESD in learning is in accordance with the findings of Ugwa (2012), Ojimba (2012), and Vintere (2017) who view the need to socialize ESD to education actors and develop learning that includes ESD principles. Listiawati (2013) stated that instilling ESD values can be implemented in schools through several learning strategies, including: 1) Integration into subjects; 2) through local content as a separate subjects (monolithic), several schools carry out local content of environmental education which only focuses on environmental perspective; 3) extracurricular activities/personal development programs; 4) habituation (civilization) which is the implementation of the school's vision and mission, including the implementation of school regulations.

Based on some result in the field, there are several things that need to be considered in developing this lesson. Teachers are already very good at teaching but have not specifically integrated ESD principles in learning. The teacher mastered the material being taught, more dominantly used the lecture method in teaching and there were several opportunities to conduct class discussions. The teacher has also designed the lesson and evaluated it well. However, teachers have not used teaching materials and evaluation tools that contain ESD principles. Besides that, the teacher has not specifically paid attention to and focused on students' mathematical problem

solving abilities. This study aims to examine the differences in the improvement of mathematical problem solving ability between students who receive the jigsaw cooperative learning type based on education for sustainable development and students who receive conventional learning.

METHOD

This research is a quasi-experimental research. In this study, the design used was a non-equivalent control group design (Ruseffendi, 2005). The researcher accepted the sample conditions as they were for each selected class. This is based on the consideration that the class has been formed beforehand. The research was conducted in two sample classes, namely the experimental class and the control class. In the experimental class, a jigsaw type of cooperative learning based on education for sustainable development is applied, while in the control class conventional learning is applied. The population in this study were students of grade 2 at one of the state high schools in Harau District, West Sumatra Province. The sample consisted of two classes which were selected by random sampling. The instrument used is a mathematical problem solving ability test. The scoring rubric is a key component in authentic assessment. This rubric is based on the size of the criteria referenced (Reynolds, 2009). With referenced interpretation criteria, Reynolds et al. emphasizes that students are rated for their level of performance in rubrics based on what they know or what they can do. Test item analysis was conducted to determine the quality of students' mathematical problem solving ability. The analysis of the test items carried out was the validity, reliability, level of difficulty, and discriminating power of the items. The data of mathematical problem solving ability that were analyzed included pretest, posttest and n-gain data. Data analysis was carried out with the help of SPSS software.

RESULT AND DISCUSSION

The data were obtained through tests of mathematical problem solving abilities at the beginning and at the end of the lesson. The data were obtained from 44 students, consisting of 22 students in the experimental class and 22 students in the control class. Data on mathematical problem solving abilities were obtained through pre-test and post-test. From the pre-test and post-test scores then the normalized gain (N-gain) of mathematical problem-solving abilities is calculated in both the experimental class and the control class. The average N-gain obtained from this calculation is an illustration of the improvement in the mathematical problem-solving abilities of students who get jigsaw-based cooperative learning based on education for sustainable development and conventional learning. Table 1 is a description of the pre-test, post-test, and N-gain in the experimental class and control class.

Table 1. Students' Mathematical Problem Solving Ability Data

Data	Experiment			Control		
	Pretest	Postes	N-gain	Pretest	Postes	N-gain
$\bar{x}$	4.31	8.05	0.67	3.95	6.78	0.49
SD	2.06	1.89	0.36	2.56	1.81	0.35

Data	Experiment			Control		
	Pretest	Postes	N-gain	Pretest	Postes	N-gain
N	22					
Ideal score	10.00					

The pretest score analysis used the pretest similarity test and the posttest score analysis used the posttest difference test. The pretest similarity test aims to see whether students' mathematical problem-solving abilities before learning are given to the two classes significantly the same. The posttest difference test aims to see whether students' mathematical problem solving abilities after learning are given to the two classes are significantly different. From the results of the pretest similarity test, it is known that there is no significant difference between the pretest scores of students' mathematical problem solving abilities in the experimental class and the control class. From the results of the post-test difference, it is known that there is a significant difference between the post-test scores of students' mathematical problem solving abilities in the experimental class and the control class.

Analysis of N-gain score of mathematical problem solving ability using normalized gain data. The normalized gain data shows the classification (quality) of the student's score increase compared to the ideal maximum score. The N-gain mean illustrates the increase in the mathematical problem-solving abilities of students who receive experimental learning as well as those who receive conventional learning. Based on the results of the normality test that has been done previously, it is known that the N-gain scores of the experimental class and control class are normally distributed. The homogeneity test results show that the N-gain score of students' mathematical problem solving abilities comes from homogeneous variance. Therefore, to prove that the N-gain score of the experimental class students' mathematical problem solving ability was better than the control class, a difference test of the mean N-gain score was carried out using the t test. The summary of the test results for the difference in the mean N-gain score of the ability. The summary of the test results for the difference in the mean N-gain score of the mathematical problem solving ability is presented in the Table. The following 2.

Table 2 Difference Test of Mean N-gain Score Students' Mathematical Problem Solving Ability

t	df	Sig. (2-tailed)
3,512	42	0.001

Based on the table. 2 note that the value of Sig. (2-tailed) of 0.001 <α = 0.05. It was concluded that H_0 was rejected, meaning that the increase in mathematical problem solving abilities of the experimental class students was better than the control class students.

Based on the results of the test for the difference in the mean score of N-Gain, it is known that the increase in the mathematical problem solving ability of students who receive the jigsaw cooperative learning based on education for sustainable development is better than students who receive conventional learning There are several assumptions why the increase in mathematical

problem-solving abilities of students who receive integrated mathematics learning with principles of education for sustainable development is better than students who receive conventional learning. In integrated mathematics learning with principles of education for sustainable development, students are trained to be independently responsible for mastering the mathematical concepts assigned to them. Moreover, the mathematical problems given are guided by the urgency of education for sustainable development so that learning is felt more meaningful by students. Learning means supporting thinking and stimulating new ideas (Cobern, 1996). This supports students to practice mathematical thinking, namely: developing a mathematical view, assessing the process of mathematics and abstraction, developing competencies and using them in mathematical understanding (Schoenfeld, 1992). In addition, in learning students are required to share and work together in understanding and mastering the assignments given.

In integrated mathematics learning with principles of education for sustainable development, students go through several stages in carrying out their learning activities. This is in accordance with the opinion of Trianto (2009) which states that in carrying out learning activities in this learning, students basically go through four important stages, namely: orientation, grouping, formation and coaching of expert groups, group discussion of experts in groups, tests, recognition. group. At the orientation stage, students are directed to make learning preparations through reading assignments. In addition, at this stage students are also accustomed to understanding and discovering mathematical concepts, procedures and principles individually. This individual understanding will later be conveyed and understood more deeply in expert group and home group discussions. This causes students who receive the jigsaw cooperative learning type based on education for sustainable development from the start to be trained to understand mathematical concepts and establish conjectures in solving mathematical problems.

Significance in learning mathematics is marked by the awareness of what students do, understand and do not understand about learning mathematics (Mawaddah, 2015). It is not surprising that during the final test students who received integrated mathematics learning with principles of education for sustainable development obtained an average score of mathematical problem solving abilities that was better than students who received conventional learning. This causes students who receive the jigsaw cooperative learning type based on education for sustainable development from the start to be trained to understand mathematical concepts and establish conjectures in solving mathematical problems. In integrated mathematics learning with principles of education for sustainable development, encourages the actual development and potential development of students. The actual development of students can be encouraged through independent assignments given to learning, so that the level of actual development appears when students complete assignments or solve various problems independently. The level of potential development is encouraged through student discussion activities with friends or when students complete assignments and solve problems with teacher guidance. In connection with the potential development of students, discussion activities, both discussions between students and between students and teachers. Lie (2002) argues that cooperative interactions have various positive influences on children's development. (Syahbana, 2010).

CONCLUSION

Based on the results of the data analysis, it was concluded that the improvement in the mathematical problem solving ability of students who receive the jigsaw cooperative learning type based on education for sustainable development was better than students who received conventional learning. Based on the research results obtained, the research recommendations submitted include (1) The integrated mathematics learning with principles of education for sustainable development should be used as an alternative learning in schools in an effort to develop mathematical problem solving abilities; (2) Teachers who will apply the integrated mathematics learning with principles of education for sustainable development pay attention to the prerequisite knowledge aspects that students have. Teachers should provide remediation to students with low abilities in order to be actively involved in discussions; (3) In an effort to implement a integrated mathematics learning with principles of education for sustainable development schools, it is recommended that education policy makers make changes to the mathematics learning paradigm including views on mathematics, students and teachers.

ACKNOWLEDGEMENT

This research was supported by Direktorat Jenderal Sumber Daya Iptek dan Dikti through Direktorat Kualifikasi Sumber Daya Manusia in collaboration with Lembaga Pengelola Dana Pendidikan that presents Beasiswa Unggulan Dosen Indonesia. We thank who provided opportunities and funding that greatly assisted the research, although they may not agree with all of the interpretations/conclusions of this paper.

REFERENCES

Anna, V. (2017). Implementation of the education for sustainable development strategy in mathematics education through stakeholder cooperation. Contemporary Educational Researches Journal. 7(4), 174-185.

Cobern, W. (1996). Constructivism and Non-Western Science Education Research. International Journal of Science Education. 4(3), 287-302.

Duffin, J. M., Simson. A.P. (2000). A Serach for Understanding. Journal of Mathematics Behavior. 18(4), 415-427.

Hidayat, W., & Sariningsih, R. (2018). Kemampuan Pemecahan Masalah Matematis dan Adversity Quotient Siswa SMP Melalui Pembelajaran Open Ended. JNPM (Jurnal Nasional Pendidikan Matematika). 2(1), 109-118.

Husna, M., & Fatimah, S. (2013). Peningkatan kemampuan pemecahan masalah dan Komunikasi matematis siswa Sekolah Menengah Pertama melalui model pembelajaran kooperatif tipe Think-pair-share (TPS). Jurnal Peluang. 1(2), 81-92.

Ibrahim, I., Sujadi, I., Maarif, S., & Widodo, S. A. (2021). Increasing Mathematical Critical Thinking Skills Using Advocacy Learning with Mathematical Problem Solving. *Jurnal Didaktik Matematika*, *8*(1), 1-14.

Juandi, D. (2006). Meningkatkan Daya Matematik Mahasiswa Calon Guru Matematika Melalui Pembelajaran Berbasis Masalah. Disertasi Pascasarjana UPI Bandung: tidak diterbitkan.

Khamidah, K. & Suherman (2016). Proses Berpikir Matematis Siswa dalam Menyelesaikan Masalah Matematika Ditinjau dari Tipe Kepribadian Keirsey. Al-Jabar : Jurnal Pendidikan Matematika. 7(2), 231–248.

Lie, A. (2002). Cooperative Learning. Jakarta: Gramedia

Mariam, S. (2019). Analisis Kemampuan Pemecahan Masalah Matematis Siswa MtsN dengan Menggunakan Metode Open-Ended Di Bandung Barat. Jurnal Cendekia: Jurnal Pendidikan

Matematika. 1(3), 178-186.
Maryati, I., & Fadhilah, D. N. (2021). Sequence and Series: An Analysis of Mathematical Problem Solving Ability. Indonesia Mathematics Education. 4(2): 95-106
Mawaddah, S., & anisah, H. (2015). Kemampuan Pemecahan Masalah Matematis Siswa pada Pembelajaran Mateamtika dengan Menggunakan Model Pembelajaran Genertif Di SMP. Jurnal EDU-MAT: Jurnal Pendidikan Matematika. 3(2), 166-175.
Palapasari, R., & Anggo, M. (2019). Pengaruh Penerapan Konstruktivis Realistik Dan Kemampuan Dasar Matematika Terhadap Peningkatan Kemampuan Pemecahan Masalah Siswa SMP. Jurnal Pendidikan Matematika. 8(1), 46-56.
Permendikbud. (2014). Peraturan Menteri Pendidikan dan Kebudayaan RI Nomor 103, Tahun 2014, tentang Pembelajaran pada Pendidikan Dasar dan Pendidikan Menengah.
Polya, G. (1973). How To Solve It. Princeton: Princeton University Press.
Putra, J. D. (2014). Penerapan Accelerated Learning dalam Peningkatan Kemampuan Penalaran Matematis Siswa Sekolah Menengah Pertama. Jurnal Pythagoras. 3(2), 85–98.
Putra. J. D., Martini, J. (2015). Pengaruh Penerapan Quantum Learning dengan Mind Mapping terhadap Hasil Belajar Matematika Siswa Sekolah Menengah Pertama. Jurnal Pythagoras. 4(2), 43–55.
Rahayu, D. V., & Afriansyah, E. A. (2015). Meningkatkan kemampuan pemecahan masalah matematik siswa melalui model pembelajaran pelangi matematika. Mosharafa: Jurnal Pendidikan Matematika. 4(1), 29-37.
Reynolds. (2009). Self-regulation and mathematics instruction. Learning Disabilities Research & Practice, 22(1), 75-83.
Ruseffendi, H.E.T (2005). Dasar-Dasar Penelitian Pendidikan dan Bidang Non Eksata Lainnya. Bandung: Tarsito.
Rusman. (2011). Model-Model Pembelajaran. Jakrata: Rajawali Pers.
Saraswati, Sari, dkk. 2014. Matematika: Strategi Pemecahan Masalah. Yogyakarta: Graha Ilmu
Schoenfeld, A. H. (1992). Learning to Think Mathematically: Problem Solving, Metacognition and Sense of Mathematics. Research on Mathematics Teaching and Learning (334-370). New York: Macmilan.
Slavin, R. E., (2005). Cooperative Learning (cara efektif dan menyenangkan pacu prestasi seluruh peserta didik). Bandung: Nusa Media
Sugianto. (2010). Model-model pembelajaran Inovatif. Surakarta. Yuma Pustaka.
Trianto, 2009. Mendesain Model Pembelajaran Inovetif-Progresif (Konsep, Landasan, dan Implementasinya pada Kurikulum Tingkat Satuan Pendidikan (KTSP). Jakarta: Kencana.
Widodo, S. A. (2015). Keefektivan Team Accelerated Instruction Terhadap Kemampuan Pemecahan Masalah dan Prestasi Belajar Matematika Siswa Kelas VIII. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *6*(2), 127-134.
Widodo, S. A., Irfan, M., Trisniawati, T., Hidayat, W., Perbowo, K. S., Noto, M. S., & Prahmana, R. C. I. (2020, October). Process of algebra problem-solving in formal student. In *Journal of Physics: Conference Series* (Vol. 1657, No. 1, p. 012092). IOP Publishing.
Widodo, S. A., Ibrahim, I., Hidayat, W., Maarif, S., & Sulistyowati, F. (2021). Development of Mathematical Problem Solving Tests on Geometry for Junior High School Students. *Jurnal Elemen*, *7*(1), 221-231.
Widyastuti, R. (2015). Proses Berpikir Siswa dalam Menyelesaikan Masalah Matematika Berdasarkan Teori Polya Ditinjau dari Adversity Quotient Tipe Climber. Al-Jabar : Jurnal Pendidikan Matematika. 6(2), 120–132.