Using Discovery Learning to Improve Students' Chemical Problem-Solving Skills

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ABSTRACT: This study aims to describe the effectiveness of discovery learning on electrolyte and non-electrolyte solution materials to improve problem-solving skills. This research was conducted at YP Unila Bandar Lampung High School by using the Pretest-Posttest Control Group design. The results showed that the average n-gain in the experimental and control classes were 0.68 (medium category) and 0.45 (medium category), respectively. Based on statistical test results there are differences in the average n-gain, so it can be said that discovery learning on electrolyte and non-electrolyte solution material is effective in improving problem-solving skills.

Keywords: problem-solving skills, discovery learning, electrolyte, and non-electrolyte solutions,

INTRODUCTION

Since its introduction in the 18th century, the concept of the industrial revolution 4.0 has changed the lives, mindsets, and ways of working of people. In its development, the 4.0 industrial revolution provided challenges and impacts for the young generation of the Indonesian people. In addition to having an impact on the rapid development of science and technology, the industrial revolution 4.0 also has an impact on the emergence of various problems in life [1-3]. So we need a problem solver to overcome various problems that arise.

A problem solver is demanded not only to have knowledge but also must be able to identify and understand the problem that is being faced. Furthermore, designing steps to solve the problem, implement it, and evaluate the results obtained [4]. These stages are related to problem-solving skills (PSS).

Today, PSS has been the main study of several researchers [5-10] and makes someone able to adapt and survive. PSS is closely related to thinking skills where these skills are one of the main goals of education [5].

PSS are skills that can be trained [5, 11-13]. Therefore, learning what teachers do must make students actively search, process, construct, and explore to gain new understanding which will be comprehensively used to solve a problem at hand.

However, the reality in the field of chemistry learning in the field is emphasized only the mastery of concepts alone [14]. The acquisition of the results of Trends in International Mathematics and Science Study (TIMSS) is one of the indications. The 2015 TIMSS results ranked Indonesia 45th out of 50 countries. In the field of science, Indonesia only scored 397 (45th out of 48 countries). These results indicate that Indonesian students only reach the middle level and still have difficulty working on problems that require reasoning especially in solving problems [15].

To overcome the low PSS of students, the government has made improvements. One of them is by issuing Minister of Education and Culture Regulations No. 22 of 2016. Based on this document, to practice PSS it is recommended to use discovery learning, project-based learning, problem-based learning, and inquiry learning models.

Through discovery learning, students are given stimulation or stimulation to be faced with problems or phenomena encountered in students' daily lives. Next students are asked to identify problems, collect data to prove through an experiment and then process it so that conclusions can be drawn. With such a learning phase, one of the chemical materials that can be applied with discovery learning models is an electrolyte and non-electrolyte solution material.

Some researchers report the results of their studies related to the discovery learning model. The Discovery learning model effectively improves students' mathematical PSS [14,16-17] and student physics problems [18]. Therefore, discovery learning is expected to improve students' chemical PSS. So in this article, the researcher will reveal how to improve using discovery learning models in learning PSS.

METHODS

This research was a quasi-experimental design with a pretest-posttest control group [19]. This research was conducted at the High School of YP Unila Bandar Lampung. Sampling used a purposive sampling technique. The 10th grade of MIPA-6 (28 people) was an experimental class that was applied to the discovery learning model and the 10th grade of MIPA-8 (28 people) was a control class that was applied to conventional learning.

Before learning, students in both the experimental and control classes were given a pretest in the form of open-ended questions that measure PSS. Furthermore, in learning in the experimental class students were given a phenomenon regarding the sulfuric acid solution that could conduct electricity so that the battery function could work. Then, students were asked to mention whether there was another solution that could conduct electricity. To answer these problems, students must go through a series of activities such as identifying kinds of solutions, making observations, making hypotheses, conducting experiments, and processing data to prove hypotheses. Based on the experiment results students were asked to draw conclusions and communicate the results. At the end of learning, students were given a post-test problem.

The data obtained were analyzed statistically using SPSS version 23.0. The analysis conducted includes the normality test, homogeneity test, and independent t-test. Improved student PSS is measured based on n-gain and is interpreted using the criteria of low, medium, and high [20].

RESULT AND DISCUSSION

Result

The average scores of students' pretest and posttest PSS were presented in Figure 1.

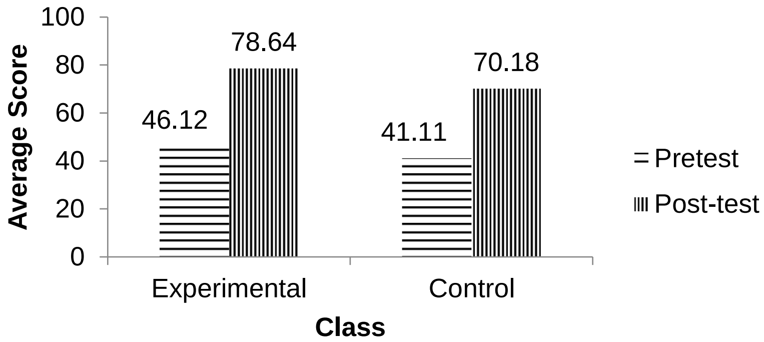

FIGURE 1. Average scores of students' pretest and posttest PSS.

Statistical test results on the average score of the PSS pretest were presented in Table 1. The significance value in the Kolmogorov-Smirnov Z test and the Lavene test was greater than 0.05. Likewise, the significant value in the Lavene test was also greater than 0.05. This indicated that the average score data of the PSS pretest came from populations that were normally distributed and had homogeneous variances. Independent t-test results inform that the significance value obtained was more significant than 0.05. Thus it could be said that the average scores of the pretest PSS in the experimental and control classes were the same.

TABLE 1. Statistical test results on the average score of the PSS pretest

Class	Kolomogorov-Smirnov test		Lavene test		Independent t-test	
	Z	Sig.	F	Sig.	T	Sig.
Experimental	0.122	0.192	0.000	0.990	0.381	0.704
Control	0.130	0.128				

Information:
Sig. is the significance value

The average n-gain data of students' PSS was presented in Figure 2.

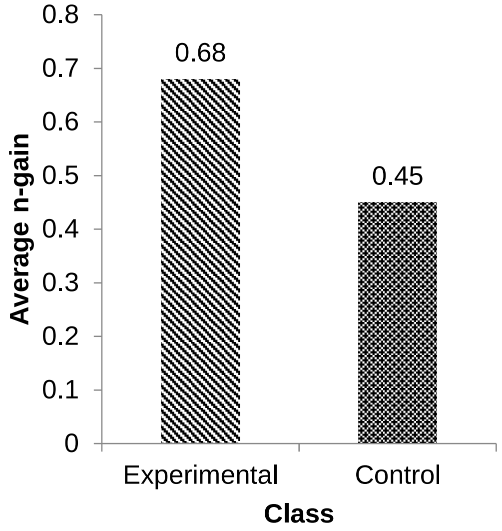

FIGURE 2. Average n-gain of students' PSS

The results of statistical tests on the average n-gain of students' PSS were presented in Table 2. The Kolmogorov-Smirnov Z test and the Lavene test have given significance values greater than 0.05. This showed that the average n-gain data of PSS come from normally distributed populations and have a homogeneous variance.

TABLE 2. Results of statistical tests on average n-gain PSS

Class	Kolomogorov-Smirnov test		Lavene test		Independent t-test	
	Z	Sig.	F	Sig.	T	Sig.
Experimental	0.126	0.163	1.227	0.272	10.605	0.000
Control	0.126	0.159				

Information:
Sig. is the significance value

The significance value in the independent t-test was smaller than 0.05. That was, the average n-gain PSS in the experimental class differed from the average n-gain PSS in the control class.

Discussion

Based on the description above it could be said that discovery learning was effective in improving the skills of solving chemical problems related to electrolyte and non-electrolyte solution material. The stages in discovery learning trained students' thinking skills, including PSS as described below.

Stage I. stimulation

Learning electrolyte and non-electrolyte solution materials using discovery learning models began by presenting phenomena in everyday life presented in discourse. In the 1st worksheet, students were asked to read the discourse related to battery water and its use on motorized vehicles. In the 2nd worksheet, students were given illustrations in the form of a solution of kitchen salt, vinegar, and sugar with different lights. In the 3rd worksheet, students were presented with representations of polar ions and covalent compounds in water and their hooks with electrical conductivity.

At this stage, students were asked to identify and understand the problems expressed in the discourse. Students' PSS at this stage could be seen when understanding students' problems could mention the information provided and asking questions related to the discourse given.

PSS at this stage increased seen from the percentage of students' curiosity activities from the 1st to 3rd worksheets. This was marked by enthusiasm in asking questions and looking for information both from books and the internet. This was consistent with the opinion of Sudjana [21] that one of the characteristics of the learning process that requires students to participate actively was that students ask questions to both the teacher and other students so that students' curiosity could be well trained.

Stage 2. problem statement

After identifying problems contained in the discourse, students were asked to formulate problems and determine hypotheses. Based on the discourse in the 1st worksheet, students wrote less relevant problem formulations. This indicated that students have not been able to identify and understand problems.

The implication of writing a less relevant is the formulation of the hypothesis proposed by students. In practice, students still experience difficulties in writing hypotheses. Accordingly, students were given direction and guidance by the teacher to be able to formulate problems and hypotheses correctly. It has been observed that students have been able to write problem formulations and hypotheses in the 2nd and 3rd worksheets well.

Through the activities of making problem formulation, students' PSS could be trained wherein each meeting, the skills to identify and understand the problems of each group have increased, as seen from the formulation of the problems that are relevant to the discourse. This was consistent with the opinion of Fadiawati *et al*. [5] that the skill of identifying and analyzing the problems they face was a helpful technique in building students so that they were accustomed to finding a problem.

Stage 3. data collection

Students answered the formulation of the problem and proved the formulation of the hypothesis proposed through inquiry in the form of experiments. Sanjaya [22] stated that the process of obtaining and obtaining information is done by observation or experimentation to find answers to questions or problem formulations.

PSS that were trained at this stage includes designing solutions and solving problems according to plan. With the teacher's guidance, students are asked to design and conduct experiments. In the process, students were asked to determine in advance the independent, control, and bound variables. The predetermined variables were then controlled. Then students designed the experimental procedure, determine the tools and materials to be used, and made observational tables [23-24].

The experimental design results were then discussed with the teacher for input. Then students conducted experiments based on experimental designs that had been made. This was in agreement with Trianto [25] who suggested that students should learn through active participation with concepts and principles to gain experience and through experiments to find the principles themselves. Besides conducting experiments, data collection activities were conducted by observing submicroscopic representations of electrolyte and non-electrolyte solutions to be further identified and filled into the observation tables.

Stage 4. data processing

At this stage, students did data processing to find the relationship between one piece of information with another piece of information. In the implementation, the teacher gave questions, and students were asked to discuss answering the questions contained in the worksheet.

In the 1st worksheet, after experimenting students were asked to identify the test of the lights and gas bubbles that occur in each solution, classifying which solutions produce flame lights and/or gas bubbles and which do not produce them, defining electrolyte and non-electrolyte solutions as well as strong electrolyte solutions and weak based on the results of the experiment. In the 2nd worksheet, students were asked to write down the ionization reaction of the test solution and connect the number of ions in the test solution to the electrical conductivity. In the 3rd worksheet, students were asked to identify the types of compounds that can conduct electric current based on the type of bond. Related to this, Sudjana [21] argued that one of the characteristics of the learning process that requires students to participate is that students receive information and seek information.

Stage 5. verification

After finding the answers to the formulation of the proposed problem, students examined carefully to prove the truth of the hypothesis and then linked it to the results of data processing. Related to this Syah [26] argued that the teacher must provide opportunities for students to collect as much information as was relevant to prove whether or not the hypothesis.

Stage 6. generalization

Students concluded from the results of gathering information and experimental data. Students were allowed to conclude the findings with their groups to be conveyed in the forum. In addition, the teacher also allows other groups to criticize the answers delivered by adding, refuting, or giving other answers. Munandar [27] said that discovery learning involves all students' abilities to search for and find things (objects, people, or events) systematically, critically, logically, and analytically so that students can formulate their findings with confidence. Through stages of learning like this, it can be ensured that students' PSS could be trained.

CONCLUSION

In discovery learning, students identified problems, formulated problems and determined hypotheses, designed solutions and solved problems according to plan, made temporary conclusions (inferences), decided on actions to overcome problems, and communicated them to others. Students have made research reports to overcome chemical problems. Based on the average pretest, posttest, and n-gain values obtained, it could be concluded that the discovery learning model was effective in improving PSS in the electrolyte and non-electrolyte solution material.

REFERENCE

1. I.N.A. Putri, N. Fadiawati, and M.M.F. Syamsuri, Inter. J. Chem. Educ. Res., 3 (1), 23-28, (2019).
2. Y. Sarif, N. Fadiawati, and M.M.F. Syamsuri,. Inter. J. Chem. Educ. Res., 3 (1), 29-34, (2019).
3. B. Prasetyo, and U. Trisyanti, Revolusi Industri 4.0 dan Tantangan Perubahan Sosial. IPTEK J. Proceed. Series, 5, 22-27, (2018).
4. G. Polya, How to solve it 2nd. (Princeton University, New Jersey, 1973).
5. N. Fadiawati, C. Diawati, R. Meidayanti, and M. Syamsuri,. Jurnal Pendidikan Progresif, 9 (2) 198-208, (2019).
6. F.I. Gunawan, and S.G. Sunarman, In Prosiding Seminar Nasional Pendidikan Matematika Etnomatnesia, (2018).
7. A. Bahri, D. Putriana, and I.S. Idris, Sainsmat: Jurnal Ilmiah Ilmu Pengetahuan Alam, 7 (2), 114-124, (2018).
8. T. Thayeb, and A.P. Putri, MaPan : Jurnal Matematika dan Pembelajaran, 5, 1, (2017).
9. R.L. Mbembok, A. Fatmawati, and S.R. Adawiyah,. Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram, 5 (1), 25-32, (2017).
10. R.M. Tanjung, S. Simatupang, and M.P. Simanjuntak, INPAFI (Inovasi Pembelajaran Fisika), 6 (3), (2018).
11. A. Husniyah, L. Yuliati, and N. Mufti, Jurnal Pendidikan Sains, 4 (1), 36-44, (2016).
12. K. Kokom, In Prosiding Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA, Fakultas MIPA, Universitas Negeri Yogyakarta, 1, (2011).
13. U.N. Warih, Pengembangan Panduan Pelatihan Keterampilan Pemecahan Masalah (Problem Solving Skill) dengan Cinemeducation untuk Siswa SMP.(Tesis). DISERTASI dan TESIS Program Pascasarjana UM, (2011).
14. D.E. Nurhasanah, N. Kania, and A. Sunendar, Didactical Mathematics, 1, 1, (2018).
15. G. Nadhifah, and E.A. Afriansyah, Mosharafa: Jurnal Pendidikan Matematika, 5, 1, 33-44, (2016).
16. Y. Herdiana, Wahyudin, and R. Sispiyati, AIP Conference Proceedings, 1868, 1, (2017).
17. R.D. Anggreini, R. Asnawati, and B. Koestoro, Jurnal Pendidikan Matematika Unila, 6, 3, (2018).
18. Indarti, A. Suyudi, and C.I. Yogihati, Jurnal Pendidikan Fisika dan Teknologi, 01, 332-340, (2019).
19. J.R. Fraenkel, N.E. Wallen, and H.H. Hyun, How to Design and Evaluate Research in Education. (McGraw Hill Inc. New York, 2012).
20. R.R. Hake, American Journal of Physics, 66, 1, 64-74, (1998).
21. N. Sudjana, Cara belajar siswa aktif. Dalam Proses Belajar Mengajar. (Sinar Baru Algesindo, Bandung, 1989).
22. W. Sanjaya, Strategi Pembelajaran 121 Berorientasi Standar Proses Pendidikan. (Kencana Prenada Media, Jakarta, 2011).
23. N. Fadiawati, and M.M.F. Syamsuri, Merancang Pembelajaran Kimia di Sekolah: Berbasis Hasil Riset dan Pengembangan. (Media Akademi, Yogyakarta, 2016).
24. N. Fadiawati, and M.M.F. Syamsuri, Perancangan Pembelajaran Kimia. (Graha Ilmu, Yogyakarta, 2018).
25. Trianto,Model Pembelajaran Terpadu. (PT Bumi Aksara, Jakarta, 2010).
26. M. Syah, Psikologi Pendidikan dengan Pendekatan Baru. (Remaja Rosdakarya, Bandung, 2010).
27. U. Munandar, Pengembangan Kreativitas Anak Berbakat. (Rineka Cipta, Jakarta, 2012).