

Study of The Effectiveness of Based Learning Programs Problem Guided on The Reaction Rate Topic

Subhan, Kapraja Sangadji[✉]

Institut Agama Islam Negeri Ambon, Indonesia

Info Articles

History Articles:

Submitted 28 November 2019

Revised 11 January 2020

Accepted 1 February 2020

Keywords:

*Guided problem-based learning,
critical thinking skills, and
conceptual understanding*

Abstract

The study on improving st Aimed students, critical thinking skill s and Investigating excellences and problems faced in implementing guided problem-based Learning program. Preliminary field testing in the study used one group pretest-posttest design Samples of the study were 11th grade students at one of senior high school in West Seram residence_consist ing of 36 students. The findings of the study were as follows. Firstly, the program could improve critical thinking skills and conceptual understanding of students. Secondly, the excellence of the program was it could help teachers to explore students 'ideas and develop students' critical thinking skills. Thirdly, problems encountered in implementing it were (a) there was lack of qualitative problems practiced, (b) some students with low academic achievement was difficult, to follow the program, (c) some conceptual questions were difficult, to be answered the by them, (d) they forgot some chemical concepts learned in the previous grade, and (e) implementation of the program was time-consuming. Next, the teacher and students were enthusiastic to spare anticipate in the teaching and learning Finally, students respond ed it positively and they hope it could be further implemented to teach other chemistry topics and events to teach other matters subject.

[✉] Address correspondence:
Email: 16sangadji@gmail.com

INTRODUCTION

Barak, M. et al, reported that most schools tended to emphasize the low-level thinking attachment of learning (Barak, M, Ben-Chaim, D., & Zoller, U, 2017). Students are expected to absorb information passively and then repeat it or remember it while taking the test. The above findings are in line with the findings of several Redhana observers, for example, reporting that most teachers still dominate learning (Redhana, I W, 2017). Generally, teachers teach chemistry with the information and question and answer method in explaining chemistry teachers usually refer to one particular chemistry book, in which the order of material presented by the teacher is outward with the sequence of material contained in the book that the teacher and student hold, The teacher, next, gives a practice of counting questions. Solving these calculation problems requires an algorithmic stage According to Tsapartis & Zoller, problem-solving that is algorithmic requires the application of lower-level thinking skills (Tsapartis, G. & Zoller, U, 2013).

The above learning conditions led to low student achievement and high misconceptions. Redhana and Kirna reported that the mean of high school students' misconceptions in West Seram on the topic of atomic structure and chemical bonds was very high, respectively 57.0% and 63.4% (Redhana, I W. & Kirna, IM, 2014). Some of the students' misconceptions are. (1) the atom is seen as a solid ball which, if heated, expands; (2) in the NaCl compound there is a bond between one Na⁺ ion and one Cl⁻ ion, (3) the bond in the HCl molecule is an ionic bond; and (4) in the p orbitals, electrons move like the number eight on the surface of the orbitals. Further research shows that some of these students' misconceptions originate from the teacher (Simamora, S. & Redhana, I W, 2016). Meanwhile, misconceptions on the topic of hydrocarbons, among others, were found: (1) the reaction of methane substitution by HCl H atoms in methane can be replaced by H atoms with higher capacity; (2) the isomers of a

hydrocarbon compound having the same physical and chemical properties; (3) the most volatile compounds are those that have the highest boiling point and molar mass, and (4) the more branches in an isomer, the higher the relative molecular mass (Redhana, I W., Suardana, I N. & Maryam, S, 2018). To improve the conditions above, educational reform needs to be carried out. The reform referred to as a change in pedagogy, which is a shift from traditional teaching (low-level thinking skills) to learning that emphasizes higher-level thinking skills (critical thinking skills) (Tsapartis, G. & Zoller, U, 2013). This is the essence of the current education reform.

One of the lessons that allow students to practice using critical thinking skills is problem-based learning. Problem-based learning is purely an open inquiry, where students are only presented with context and students themselves must formulate a process of solving problems and find solutions (National Science Teachers Association, 2018). With activities like this, high school students will experience difficulties because students' learning habits have been different. First, generally, students attend class by listening and taking notes on the teacher's explanation and doing activities according to the teacher's instructions. Second, most teachers assume that they feel they have not taught if they have not explained the material. As a result, teachers tend to complete curriculum targets rather than giving students ways of thinking.

For this reason, modifications need to be made to problem-based learning, namely by including the elements of guidance. The guidance elements that can be used are conceptual questions and Socratic questions. Meanwhile, the use of open-ended which is a characteristic of problem-based learning is still maintained as a learning stimulus. Conceptual questions are used to explore students' ideas related to essential concepts learned on the topic of reaction rates. Meanwhile, Socratic questions are used to develop students' ideas and critical thinking skills. The result of the modification of problem-based learning is guided problem-based

learning. Thus, this study aims to determine the effectiveness of guided problem-based learning programs (hereinafter abbreviated to P2BMT) to improve students' critical thinking skills. Besides, the constraints and advantages of implementing P2BMT and the opinions of teachers and students towards P2BMT are also a concern in this study.

METHOD

Pre-experimental design using a one-group pretest-posttest design was used in a limited trial in this study. This research was conducted in one of the high schools in the western district of Seram with a total of 36 students. The data needed in this study was collected through observation, interviews, tests, and questionnaires. Chemistry content-based critical thinking skills test is an objective test, consisting of 32 items. This test is based on selected indicators of critical thinking skills developed by Ennis in 1985. This test is given to students before and after the implementation of P2BMT on the topic of reaction rates. The researcher observes the learning process that takes place by identifying the constraints and advantages of implementing P2BMT. All observations obtained were recorded in a field log (an anecdotal record). The lesson is recorded with an audiotape and documented with a digital camera. Teacher and student opinions are collected at the end of the lesson, each through interviews and questionnaires.

The data obtained in this study are quantitative data in the form of critical thinking skills test scores before and after learning, as well as qualitative data in the form of constraints and advantages encountered in implementing P2BMT and the opinions of teachers and students towards P2BMT. Quantitative data, then, is analyzed by t-test (paired-sample t-test) (if the data is normally distributed) or Wilcoxon signed-rank test (if the data is not normally distributed) using the SPSS 23.0 program at a significance level of 5%.

RESULTS AND DISCUSSION

Improving Students' Critical Thinking Skills on Reaction Rate Topics

To be able to know the increase in students' critical thinking skills, students' critical thinking skills test scores both before and after learning are tested for normality. The complete test results obtained are presented as follows. The mean pretest and posttest scores were 7.47 (not normal) and 15.94 (normal), respectively. Wilcoxon test results produce p values less than 0.005. This shows that an increase in students' critical thinking skills caused by P2BMT.

Improving Students' Critical Thinking Skills Every Indicator on Reaction Rate Topics

The results of testing the improvement of students' critical thinking skills on each indicator are shown in Table 1. Indicators 1 to 5 in a row are: (1) applying the main principles, (2) identifying criteria to consider possible answers, (3) identifying reasons that are not stated, (4) draw conclusions or hypotheses, and (5) determine equivalent expressions. From table 1 it appears that P2BMT can improve students' critical thinking skills for all indicators of critical thinking skills ($p < 0.005$). These results are illustrated in the graph which can be seen in Figure 1.

Table 1. Recapitulation of the results of the normality test and the different test between the pretest and posttest scores on each indicator of the appearance of critical thinking (maximum score of 1.00)

Indicator	Pretest rate		Average Postes		P.
	Score	Distribution	Score	Distribution	
Apply the main principle	0.25	Normal	0.47	Normal	0,000 (Sig)
Identifying criteria	0.18	Abnormal	0.36	Abnormal	0,000 (Sig)

a for consid ering possibl e answe rs Identif y reason s not stated Draw conclu sions or hypot heses Deter mine equiva lent expres sions	0.2 2	Abnor mal	0.7 2	Abnor mal	0,000 (Sig)
	0.1 7	Abnor mal	0.4 1	Abnor mal	0,000 (Sig)
	0.2 6	Abnor mal	0.5 4	Abnor mal	0,000 (Sig)

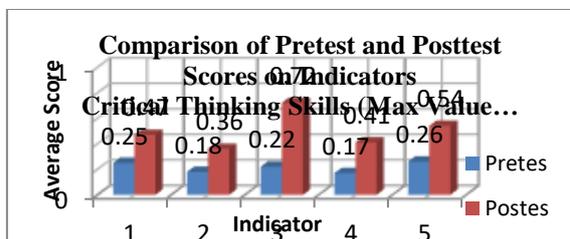


Figure 1. Comparison of mean pretest and posttest scores for each indicator on the topic of reaction rate

Remarks: 1) applying the main principle, 2) identifying criteria to consider possible answers, 3) identifying reasons that are not stated, 4) drawing conclusions or hypotheses, and 5) determining equivalent expressions.

Improving Students' Critical Thinking Skills Per Concept On Topic Reaction Rate

The results of testing the improvement of students' critical thinking skills for each concept on the topic of reaction rate are shown in Table 2. Concepts 1 to 9 are: (1) reaction rate, (2)

concentration, (3) surface area, (4) temperature, (5) catalyst, (6) reaction rate equation (7) reaction order, (B) reaction mechanism, (9) collision, and (10) effective collision. From the table below it can be seen that P2BMT can improve students' critical thinking skills for all concepts on the topic of reaction rate ($p < 0.005$). These results are illustrated in the graph which can be seen in Figure 2.

Table 2. Recapitulation of the results of the normality test and the difference test between the pretest and posttest scores for each concept

Indicato r	Pretest rate		Average Postes		P.
	Sc ore	Distrib ution	Sc ore	Distrib ution	
Reaction rate	0,3 6	Abnor mal	0,4 7	Abnor mal	0,0 00 (Si g)
Concent ration	0.1 4	Abnor mal	0.5 2	Abnor mal	0,0 00 (Si g)
Surface area	0,1 8	Abnor mal	0,7 9	Abnor mal	0,0 00 (Si g)
Tempera ture	0,3 3	Abnor mal	0,5 4	Abnor mal	0,0 00 (Si g)
Catalyst	0,1 4	Abnor mal	0,5 1	Abnor mal	0,0 00 (Si g)
Reaction rate equation	0.1 0	Abnor mal	0,3 1	Abnor mal	0,0 00 (Si g)
Reaction Order (B)	0,3 0	Abnor mal	0.4 8	Abnor mal	0,0 00 (Si g)
Reaction mechani	0,1 1	Abnor mal	0,2 2	Abnor mal	0,0 00

sm				(Si
				g)
Collisio	0,1	Abnor	0,3	0,0
n	7	mal	9	00
				(Si
				g)
				0,0
Effective	0,1	Abnor	0,6	00
collision	9	mal	7	00
				(Si
				g)

Constraints faced in implementing P2BMT To be able to identify the constraints faced in implementing P2BMT, researchers examine the results of field notes and recordings from tape recorders and digital cameras. Obstacles observed can be categorized into two types, namely related constraints with learning tools and constraints related to the learning process.

- 1) Constraints related to learning tools
 - a) In LKS, there were still a few typographical errors related to the concentration of the solution in the exercise questions, such as the concentration of HCl solutions of 0.2 M and 0.3 M. The proper concentrations were 0.02 M and 0.03 M. respectively.
 - b) Training questions that are qualitative in LKS are still very few.
- 2) Problems related to the learning process
 - a) Some students who have the less academic ability have difficulty following this P2BMT.
 - b) Some conceptual questions contained in the worksheet are difficult to answer by students, such as: "How to design an experiment to determine the heat of reaction in LPG combustion?"
 - c) Students forget several concepts that were learned previously in class X, such as the substitution reaction and elimination reaction.
 - d) Implementation of this learning program requires quite a lot of time.

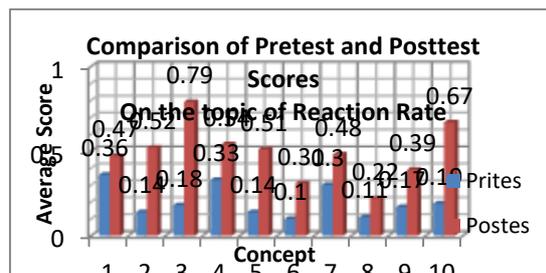


Figure 2. Comparison of mean pretest and posttest scores for each concept on the topic of reaction rate

Note: 1) reaction rate, 2) concentration, 3) surface area, 4) temperature, 5) catalyst, 6) reaction rate equation 7) reaction order, (B) reaction mechanism, 9) collision, and 10) effective collision.

The advantages of P2BMT Theoretical superiority

The advantages of P2BMT can be described as follows:

- a) Open-ended problems in P2BMT can motivate students to study chemistry.
 - b) To begin the problem-solving process students are guided by several conceptual questions.
 - c) helps the teacher explore students' ideas and also to direct students to learn essential concepts related to the problem being solved.
 - d) Socratic questions will help teachers develop ideas, understanding concepts, and critical thinking skills of students.
- 2) Practical excellence

The practical advantages of P2BMT can be seen in the process of implementing learning in the classroom. From the observations, it can be seen that the learning conducted by the teacher becomes more structured and directed towards the goal. Open-ended problems in LKS can help teachers begin learning. Meanwhile, conceptual questions and social questions can also help teachers guide students in constructing knowledge and developing students' critical thinking skills. The teacher is very enthusiastic and motivated to apply P2BMT. Students are

also motivated to participate actively in learning.

Teachers and Students Opinions Against P2BMT

1) Teacher's Opinion

According to the teacher, P2BMT is very effective for teaching chemistry topics, especially reaction rates. This learning program is felt to be very helpful for teachers in implementing learning. Furthermore, this learning program is in line with the results of technical guidance carried out in schools where teachers are expected to apply problem-based learning. However, teachers do not understand the nature of problem-based learning, let alone make learning tools, even though they have received debriefing.

2) Student opinion

According to students, they were very happy with the learning that was followed. They feel that learning, among other things, can: a) challenge them to solve problems; b) motivate them to read learning resources related to the problem; c) guide them to produce ideas; d) encourage them to work together; e) improve communication skills, and f) increase their participation in learning. According to students, the teacher can guide them to answer the questions in the worksheets so they can understand the chemistry material well. Students hope that this learning continues to teach other chemistry topics and even to teach other subjects.

The research results described above show that P2BMT is quite effective in increasing critical thinking skills and students' understanding of chemical concepts. This is due to P2BMT starting learning with open-ended problems. This problem can arouse students' curiosity and encourage them to gather information to solve the problem at hand.

Conceptual questions, on the other hand, provide students with learning issues where these questions guide students to learn essential concepts related to the problem being solved. This question also serves to explore students' ideas related to the material they have learned.

Students' ideas that arise from conceptual questions, then, are developed with Socratic questions. Socratic questions are critical questions that investigate students' understanding of the concepts they have learned and then develop them so that students' understanding can be improved. This question can also develop students' critical thinking skills, where students are asked to provide clarification, assumptions, reasons, evidence, and implications for the opinions expressed. This is possible because Socratic questions consist of six types, namely questions that ask for clarification, questions that investigate assumptions, questions that investigate reasons and evidence, questions about opinions or perspectives, questions that investigate implications or consequences, and questions about questions (meta-questions) (Paul, R., 2017).

The above findings are in line with previous findings that have been reported by several authors (Yalcin et al, 2016); (Barak et al. 2017); Akinoglu & Tandogan, (2017); for example, "reporting that teachers who use real cases in the real world of students who are assisted with open-ended questions provide opportunities for students to investigate natural phenomena and conduct inquiry experiments to improve students' critical thinking skills". Meanwhile, (Akinoglu & Tandogan, 2017) found that problem-based learning can develop higher-order thinking / critical thinking skills and scientific thinking skills.

CONCLUSION

The conclusions that can be drawn from the results reached in this study are as follows: 1) P2BMT is effective enough to improve students' critical thinking skills. 2) The advantage of P2BMT, among others, is that this learning program can help teachers explore ideas and develop students' critical skills. 3) The problems faced in implementing P2BMT, among others, are (a) the LKS still needs to be added with qualitative questions; (b) some students with low academic ability are rather

difficult to follow P2BMT, and (c) the time required to implement P2BMT is quite a lot. 4) Teachers are very enthusiastic about implementing P2BMT. 5) Students welcome learning that is followed very well. They hope that this learning continues to teach other chemistry topics and even to teach other subjects

REFERENCE

- Akinoglu, O. & Tandogan, R. O. (2017). "The Effects of Problem-Based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning" *Eurasia Journal of Mathematics, Science & Technology Education*. 3(1), 71-81.
- Barak, M, Ben-Chaim, D., & Zoller, U. (2017). *Purposely Teaching for the Promotion of Higher-Order Thinking Skills. A Case of Critical Thinking*. [Online]. Tersedia: <http://l4ruwrff.springerlink.com/content>. (14 Januari 2018)
- Ennis, R., (2015). *Curriculum for Critical Thinking*. In A. L. Costa (Eds). *Developing Minds. A Resource Book for Teaching Thinking*. Alexandria: Association for Supervision and Curriculum Development.
- National Science Teachers Association (1998). *Standard for Science Teacher Preparation*. Association for the Education of Teachers in Science.
- Paul, R. (2017). *Critical Thinking: What Every Person Needs to Survive in a Rapidly Changing World*. Rohnert Park, CA. Center for Critical Thinking and Moral Critique.
- Redhana, I W. & Kirna, I M. (2014). *Identifikasi Miskonsepsi Siswa SMA Negeri di Kota Singaraja terhadap Konsep-konsep Kimia*. Laporan Penelitian DIKTI. Tidak Diterbitkan.
- Redhana, I W. (2017). "Chemistry Teachers' Views towards Teaching and Learning and Assessment of Critical Thinking Skills." *Proceeding of The First International on Science Education*. October 27st, 2007. ISBN: 979-25-0599-7. 498-504.
- Redhana, I W., Suardana, I N. & Maryam, S. (2018). *Model Perubahan Konseptual pada Pembelajaran Kimia di SMA Negeri 4 Singaraja (Studi Kasus pada Pembelajaran Kimia di SMA Negeri 4 Singaraja)*. Laporan Penelitian DIKTI. Tidak Diterbitkan.
- Simamora, S. & Redhana, I W. (2016). *Identifikasi Miskonsepsi Guru Kimia pada Pembelajaran Konsep Struktur Atom*. Laporan Penelitian Undiksha. Tidak Diterbitkan.
- Tsapartis, G. & Zoller, U. (2013). "Evaluation of Higher vs. Lower-order Cognitive Skills-Type Examination in Chemistry: Implications for University in-class Assessment and Examination" *U.Chem.Ed.* 7, 50-57
- Yalcin, B. M., Karahan, T. F., Karadenisil, D., & Sahin, E. M. (2016) "Short- Term Effects of Problem-Based Learning Curriculum on Students' Self-Directed Skills Development." *Croatia Medical Journal*. 47,491-498