

The Effect of Guided Inquiry Learning Using PhET Media on Students' Problem Solving Skill and Critical Thinking

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Abstract

The research aimed to know whether there is influence of guided inquiry learning using PhET media to students' problem solving skill, to know whether there is influence of guided inquiry learning using PhET media to students' critical thinking skill, to know whether there is correlation or positive correlation between students' problem solving skill and critical thinking taught by guided inquiry learning using PhET media. This research was quasi experiment research. The population was all students of class X-MIA SMA Negeri 4 Medan Perak Academic Year 2016/2017. The sample selection was done by using random class technique of two classes. The first class was the X-MIA 4 class as the experimental class taught by guided inquiry learning using PhET media and second class was X-MIA class 7 taught by conventional learning. The instruments consisted of a validated tested problem solving skills and critical thinking. The data in this study were analyzed by using one-way ANOVA. The results showed that students' problem solving skills and critical thinking of who were taught by guided inquiry learning using PhET media were better than students taught by conventional learning. The guided inquiry learning using PhET media has an influence on students' problem solving skills and critical thinking in physics learning. There was a positive correlation between students' problem solving skills and critical thinking.

Keywords: Guided Inquiry, PhET, Problem Solving Skill, Critical Thinking

1. Introduction

Physics is one branch of natural science underlying the development of technology and the concept of living in harmony with nature (Subagya & Wilujeng, 2013). Physics needs to be learned to provide students with knowledge, and as a vehicle to cultivate students' thinking skills that are useful in everyday life. Skill thinking is very important in the learning process and teachers should be able to develop students' thinking skills (Yen & Halili, 2015). High-level thinking skills play an important role in improving student achievement (Lateef, 2016).

The results of the PISA study in 2015 show Indonesia's average score for science subjects below the international average score. The value of PISA Indonesia for the competence of science was 403 points in 2015 (Kemendikbud, 2016). These results showed that Indonesian students have not been able to skillfully process IPA content in the face of daily life problems. Students are only able to know and process physics concept by memorizing, counting, linking, classifying according to national examination indicator. Such thinking skills include basic thinking skills.

Thinking skills required students to transfer their knowledge and apply it to new situations (Gillies, et al., 2014). Thinking skills are fundamental in the learning process (Heong, 2011). A person's mind can affect his ability to learn. When students are given the opportunity to use their minds at a higher level then students will be accustomed to distinguish between truth and false, fact, or opinion (Kurniawati, 2013). The development of students' thinking skills through the learning process is expected to help create critical students, have the thinking skills, and be able to solve the problems faced, and expected to be able to take decisions with more consideration. Therefore, thinking skills have an important role in the learning process so that students need to be trained to develop their thinking skills.

Costa (1985) suggested that the minimum thinking skills a person must have in understanding a problem and solve it is critical thinking skills and problem solving skills. Both types of thinking skills are included in complex thinking skills or high level thinking that was able to process the information around it to be used in every condition that arise (Presseisen, 1985). Problem solving skills are high level thinking processes that include analytical, synthetic and evaluation processes (Eric, 2003). Essential problem solving skills are owned by students to determine attitudes, understand ways to solve problems and ultimately make decisions. Problem solving is a process of thinking and finding solutions to the problem. Solving problems steps according to Polya (1985) that is understanding the problem, devising plan, carrying out the plan and looking back. As learning progresses, students solve problems by using critical thinking. Critical thinking is the cognitive action of reviewing, evaluating, judging something (including an image, information, clue, or opinion) with the aim of making decisions, conclusions or meaning about something rational in a reasonable way (McGregor, 2007).

One of the lessons that can help students to develop problem solving skills and critical thinking skills is guided inquiry learning (Khulthau, et al., 2007). Inquiry learning can develop students' scientific thinking in solving problems and acquiring knowledge (Amilasari & Sutiadi, 2008). The guided inquiry learning has an influence on student problem solving skills (Nurwulandari, et al., 2015). Guided inquiry learning provides students with learning opportunities and experiences and can help students understand concepts and solve

problems through thought processes (Sayyadi, et al., 2016). Kurniawati (2014) stated that the critical thinking skills of students learning by using guided inquiry learning was higher than conventional learning.

McDonnell (2013), "Beyond labs, use of computer simulations in guided-inquiry instruction can also increase the conceptual knowledge of science". Merging between technology and inquiry learning is the right strategy to improve the outcome of the learning process. PhET is one of the computer simulations for physics learning. The use of PhET technology in physics learning is more productive than traditional methods such as lectures and demonstrations (Rehn, 2013). Through guided inquiry learning using PhET media is expected to attract students' attention in following learning.

2. Method

This research was conducted in SMA Negeri 4 Medan in Academic Year 2016/2017. The population of this study was all students of class X MIA semester II SMA Negeri 4 Medan consisted of 9 classes. The sample in this research were taken with random class. Samples taken in 2 classes consist of experimental class taught using Guided Inquiry learning using PhET media and control class taught using conventional learning. The experimental class consists of 35 students and the control class consists of 37 students. This research type was quasi experiment by using pre-test and post-test that aimed to know the influence of Guided Inquiry learning on students' problem solving skills and critical thinking. Design research with technical one way analysis of variance (ANAVA). Data collection techniques in this research obtained through problem solving skills test and critical thinking skills test. Data collection conducted in two stages, collecting data on students' problem solving skills and collecting data on students' critical thinking skills.

Test for students' problem solving skills and critical thinking consisted of 5 essay questions for each variable test. Essay scoring using assessment rubric.

3. Result

Students' problem solving skills in conventional class and Guided Inquiry class using PhET media are shown in Table 1 below.

Table 1. The capitals, assets and revenue in listed banks

	Problem Solving Skill	
	Control Class	Experiment Class
Pre-test	33,71	33,24
Post-test	59,35	67,71

Based on Table 1, the description of the average pre-test and post-test problem solving skills in experiment class and control class as follows: Pre-test on control class and experiment class were 33.71 and 33.24. Post-test on control class and experiment class were 59.35 and 67.71.

Student's critical thinking skills on conventional class and Guided Inquiry class using PhET media are shown in Table 2 below.

Table 2. Pre-test and Post-test Result on Critical Thinking

	Critical Thinking Skill	
	Control Class	Experiment Class
Pre-test	36,76	37,11
Post-test	59,78	70,34

Based on Table 2, the description of the average pre-test and post-test critical thinking skill in experiment class and control class as follows: Pre-test on control class and experiment class were 36,76 and 37,11. Post-test on control class and experiment class were 59,78 and 70,34.

Analysis of Critical Thinking Items on Control and Experimental Class

Post-test questions of critical thinking that have been answered by the students are analyzed per point. This analysis was useful to look at which student critical thinking indicator becomes difficult for students. Analysis of conceptual knowledge items each post-test item that has been given to the experimental class and control class can be seen in Table 3 below.

Table 3. Average Value of Student Answers to Each Post-test of Critical Thinking in Class Control and Experiment

No	Indicators of Critical Thinking Skill	Percentage of Achievements	
		Control	Experiment
1	Assess	44,59 %	66,43 %
2	Analyze	63,24 %	72,58 %
3	Interprete	67,56 %	78,67 %
4	Give an argument	61,35 %	73,43 %
5	Evaluate	29,73 %	39,29 %

Based on Table 3, the conclusions of this analysis are the percentage of students achieving the average score that correctly answers the question of students' critical thinking in the experimental class higher than the control class. And the highest percentage of achievement for each indicator lies on the third indicator, that is interpreting, where the percentage of achievement in the experimental class is 78,67% and the control class is 67,56%. This is because the interpreting indicator is easy to solve because the knowledge of interpretation includes understanding and determining the value of the graph.

While the lowest percentage of achievement for each indicator lies on the fifth indicator, that is evaluating where the percentage of achievement in experiment class is 39,29% and control class is 29,73%. This is because the evaluate indicator is considered difficult to completed by students compared with other indicators because the evaluate indicator includes all indicators used in understanding, explaining, and predicting to make conclusions.

Data Analysis of Problem Solving Skills and Critical Thinking

Before testing the first hypothesis tested the prerequisite of normality test, homogeneity, and test results of normal and homogeneous data distribution. After the prerequisite test, then continued with one-way ANAVA with SPSS 17.0

The results of problem solving skills and critical physics thinking on student postes in conventional and Guided Inquiry classes using PhET are shown in Table 4 below.

Table 4. Data Calculation One Way Anava

	Sample	F	Sig
Problem Solving Skill	72	12,011	0,001
Critical Thinking Skill	72	13,471	0,000

Based on Table 4, the results of data analysis are as follows: (1) problem-solving skills of students learning using Guided Inquiry learning using PhET media is better than conventional learning (sig 0.001 <0.05), (2) students' critical thinking skills Using Guided Inquiry leraning using PhET media is better than conventional learning (sig 0,000 <0,05).

Correlation Analysis of Problem Solving Skills and Critical Thinking

The correlation of problem solving skills and critical thinking of the student postes in the Guided Inquiry class using PhET media is shown in Table 5 below.

Table 5. Data Calculation Correlation

		Problem Solving Skill	Critical Thinking Skill
Problem Solving Skill	Pearson Correlation	1	1,000**
	Sig (2-tailed)		0,000
	N	35	35
Critical Thinking Skill	Pearson Correlation	0,1000**	1
	Sig (2-tailed)	0,000	
	N	35	35

Based on Table 5, the results of data analysis obtained Significance value (2-tailed) 0,000 <0.05, meaning that there is a significant correlation between problem solving skills and students' critical thinking. It can also be said that good critical thinking skills have a positive relationship with problem-solving skills, where problem-solving skills will increase if critical thinking skills are well trained on students.

For more clearly the correlation of students' problem solving skills and critical thinking shown in Figure 1.

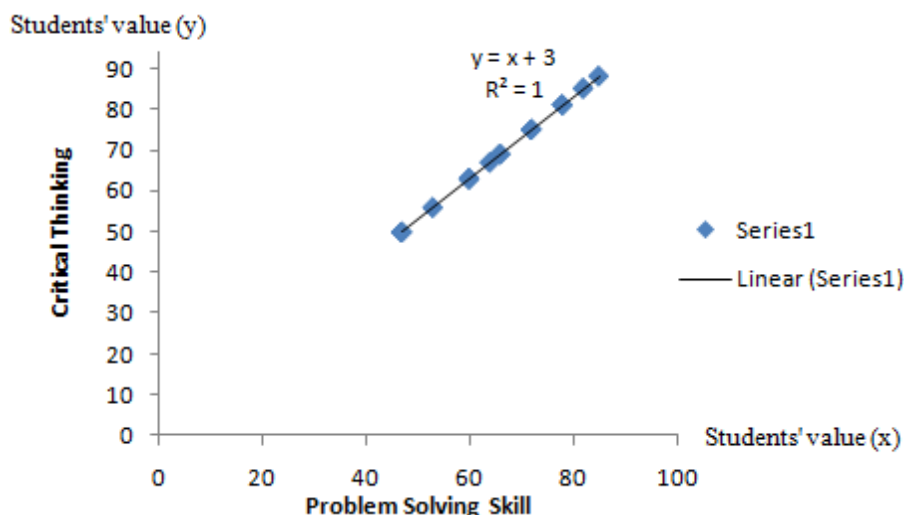


Figure 1. Correlation of problem solving skills and critical thinking of students

The graph shows that there is a correlation between problem solving skills and critical thinking in the class that is taught by Guided Inquiry learning using PhET media. Figure 1 shows a graph with a linear line, meaning that problem-solving skills increase as critical thinking skills show an increase. This confirms from the graph that students' critical thinking skills have a correlation to student problem-solving skills. Well-trained critical thinking skills in students will improve problem-solving skills. Can be seen on the graph equation, problem-solving skills have a correlation with students' critical thinking, meaning that when students' critical thinking skills increase increase then problem-solving skills also increase then the mask skills are also increasing.

4. Discussion

4.1. *The Influence of Guided Inquiry Learning Using PhET Media on Students' Problem Solving Skills*

The results obtained in this study indicate that the problem solving skills of students with Guided Inquiry learning using PhET media is better than conventional learning. This is seen from the sig value of $0.000 < 0.05$ and the average value of conceptual knowledge of experimental class is 67,71 better than control class equal to 59,35. This is because the stages in the Guided Inquiry learning using PhET media can develop problem solving skills including eight stages: opening; immerse; Explore; Identify; Collect; create; Divide; And evaluate. The expected problem solving skills are understanding the problem, planning, executing the plan and re-examining.

This is also because the Guided Inquiry learning has several advantages, such as giving students strategy and skills in researching. Skills in terms of researching are problem solving skills. Students work together in groups to plan for problems to investigate, what processes, and what sources to use. Experimental activities in groups on the learning process to shape the attitude of students to have problem solving skills because students are involved in the learning process in each phase. This is the underlying reason why students who are taught by using Guided Inquiry learning using PhET media is better than students who are taught by conventional learning.

Guided inquiry learning can improve student problem solving skills. According to the statement (Nurwulandari, 2015) and (Sayyadi, 2016) which states that the guided inquiry learning gave students the opportunity to be active and can train students' problem solving skills for the better. This is because students are actively involved during learning. In line with opinion (Solikhah, 2014) and (Afifah, 2014) stating that the use of guided inquiry learning using PhET media increased student activity.

The similarity of this study with previous studies lies in the use of learning models, namely Guided Inquiry learning. While the difference lies in the use of media. In this study, Guided Inquiry instructional model coupled with the use of PhET media.

4.2. *The Influence of Guided Inquiry Learning Using PhET Media on Student Critical Thinking Skills*

The results obtained in this study indicate that students' critical thinking with Guided Inquiry learning using PhET media is better than conventional learning. This is seen from the sig value of $0.001 < 0.05$ and the average value of critical thinking of experimental class students 70.34 is better than control class of 59.78. Guided inquiry learning has an influence in improving students' thinking skill. This is due to the guided inquiry learning using PhET media students find their own constructed physics knowledge. Self-discovery is not easily forgotten because the process of student discovery is involved and experienced directly in finding the knowledge, so the critical thinking skills of students through the application of guided inquiry learning has increased significantly compared with conventional learning.

The guided inquiry learning using PhET media can improve students' critical thinking skills. In line with

opinion (Azizmalayeri, et al., 2012) which mentions guided inquiry learning rooted in constructivism, which students obtain information by constructing their own information acquired, thus affecting students' critical thinking skills. The results of the study (Kazempour, 2013), (Kurniawati, 2014), (Afifah, 2014), indicating that the guided inquiry learning has an influence on students' critical thinking skills.

4.3. *Positive correlation between Problem Solving Skills and Student Critical Thinking on Class Guided Inquiry Using PhET Media*

Critical thinking skills of students have a connection to problem-solving skills. This is supported by (Nurwulandari, 2015) and who said that problem-solving skills are at the core of learning because they require critical thinking skills and critical thinking skills can be used to assist students in solving physics problems and making decisions. Good student critical thinking skills such as analyzing, evaluating, arguing, judging, and interpreting will make students have better problem-solving skills than students with poor critical thinking skills. This is because students who have good thinking skills can better solve the problems they face, so the problem solving skills obtained will be better. In line with opinion Afifah, et al., (2014) which says students will more easily solve problems if they have the skills to analyze and reason that are included in critical thinking skills.

Seen in the guided inquiry learning activities using PhET media, students who have good thinking skills such as ability to analyze, evaluate, assess can overcome various problems within the group. Aspects of good critical thinking skills can improve problem-solving skills that require students to solve problems through problem-forming steps, hypothesis submission, hypothesis plotting, hypothesis testing with experiments, process data, analyze data, and draw conclusions through the steps on Guided inquiry using PhET media. Critical thinking skills increasingly honed when found a problem in the process of learning in the classroom. Good critical thinking skills can also make students able to take arguments and make decisions in learning and will encourage students to zeal in solving problems and achieving learning achievement.

Guided inquiry learning using PhET media can train active students in groups to solve problems, so that later will improve problem solving skills and critical thinking of students. With guided inquiry learning using PhET media will produce students who have critical thinking skill in learning environment and have relation to problem solving skill so that good student critical thinking skill will positively influence with student problem solving skill.

5. Conclusion

Based on the results of research conducted by using Guided Inquiry learning using PhET media, it concluded that students' problem solving skills using Guided Inquiry learning using PhET media with average value 67.71 is better than conventional learning with an average score of 59.35

Critical thinking skills of students using Guided Inquiry learning using PhET media with an average value of 70.34 is better than conventional learning with an average score of 59.78.

There was a positive correlation between problem student' solving skills and critical thinking taught by guided inquiry learning using PhET media. Good critical thinking skills have a positive correlation with student problem solving skills, where student problem solving skills will increase if critical thinking skills are well trained in students.

References

- Afifah, R., Masjuk, K., Sutarman. 2014. Pengaruh Pembelajaran Guided Inquiry Berbantuan PhET (GIBP) terhadap Kemampuan Berpikir Tingkat Tinggi dan Tanggung Jawab Siswa Kelas XI IPA pada materi teori kinetik gas. *Jurnal Pendidikan Fisika Universitas Negeri Malang*, 2 (1): 4-6.
- Amilasari, A., A. Sutiadi. 2008. Peningkatan Kecakapan Akademik Siswa SMA dalam Pembelajaran Fisika Melalui Penerapan Model Pembelajaran Inkuiri Terbimbing. *Jurnal Pengajaran FP MIPA UPI*, 12 (2): 1-8.
- Costa, A. L. 1985. *Developing Minds : A Resource Book for Teaching Thinking*. West Street Alexandria, Virginia: ASCD.
- Eric, D. 2003. *Problem Solving In Early Childhood Classrooms: ClearingHouse on Elementary and Early Childhood Education University Of Illinois*, (Online), (<http://www.ericps.ed.uiuc.edu/eece/index.html>).
- Gillies, R. M., Nichols, K., Burgh, G., Haynes, M. 2014. Primary Students' Scientific Reasoning and Discourse During Cooperative Inquiry-based Science Activities. *International Journal of Educational Research*, 63 (1): 127-140.
- Heong, Y. M., Yunos, J. M., Hassan, R. B., Othman, W. B., Kiong, T. T. 2011. The Perception of The Level of Higher Order Thinking Skills among Technical Education Students. *International Conference on Social Science and Humanity journal. Faculty of Technical Edu- cation, Universiti Tun Hussein Onn Malaysia*, 5 (2): 281-285.
- Kazempour, E. 2013. The Effect of Inquiry-Based Teaching on Critical Thinking of Student. *Journal of Social Issues & Humanities*, 1(3): 23-27.

- Kementerian Pendidikan dan Kebudayaan. 2016. PISA (Programme for International Assessment), (online) (<http://litbang.kemdikbud.go.id/index.php/survei-internasional-pisa>).
- Kuhlthau, C.C, Maniotes, L. K, Caspari, A. K. 2007. *Guided Inquiry: School Libraries in the 21st Century*. London: Libraries Unlimited.
- Kurniawati, I.D, Wartono, Diantoro, M. 2014. Pengaruh Pembelajaran Inkuiri Terbimbing Integrasi Peer Instruction terhadap Penguasaan Konsep dan Kemampuan Berpikir Kritis Siswa. *Jurnal Pendidikan Fisika Indonesia*, 10: 36-46.
- Lateef, A., Dahar, M. A., Latif, K. 2016. Impact of Higher Order Thinking Skills of University Students on Their Academic Performance. *Journal Pakistan Association of Anthropology*, 28 (2) : 2031-2035.
- McDonnel, J E,. 2013. *The Effects of Guided Inquiry on Understanding High School Chemistry*. Montana: Montana State University.
- McGregor, D. 2007. *Developing Thinking, Developing Learning*. New York: McGraw-Hill.
- Polya, G. 1985. *How To Solve It 2nd ed*. New Jersey : Princeton University Press.
- Presseisen, B. Z. 1985. *Thinking Skill: Meaning and Models*. In A L. Costa (Ed) *Developing Minds: A Resource Book for Teaching Thinking*. Alexandria: ASCD.
- Rehn, D. A., Moore, E. B., Podolefsky, N. S., Finkeilstein, N. D. 2013. Tools For High-Tech Tool Use: A Framework And Heuristics For Using Interactive Simulations. *Journal of Teaching and Learning with Technology*, 2 (1) : 31-55.
- Sayyadi, M., Hidayat, A., Muhardjito. 2016. Pengaruh Strategi Pembelajaran Inkuiri Terbimbing dan Terhadap Kemampuan Pemecahan Masalah Fisika pada Materi Suhu dan Kalor Dilihat dari Kemampuan Awal Siswa. *Jurnal Inspirasi Pendidikan Universitas Kanjuruhan Malang*, 6 (2): 866-874.
- Solikhah N., Winarti, E. R., Kurnasih, A. W. 2014. Keefektifan Model Guided Inquiry dengan Pendekatan Keterampilan Metakognitif terhadap Kemampuan Pemecahan Masalah. *Jurnal Kreano*, 5(1): 18-25
- Subagya, H., Wilujeng, I. 2013. *Buku Guru Fisika Kelas X*. Jakarta: Bumi Aksara.
- Yen, T. S, Halili, S. H. 2015. Effective Teaching ff Higher-Order Thinking (HOT) in Education. *The Online Journal of Distance Education and e-Learning*. 3 (2) : 41-47.