ATLANTIS PRESS
Advances in Social Science, Education and Humanities Research, volume 440
International Conference on Online and Blended Learning 2019 (ICOBL 2019)

Effectiveness of Web-Based Simulation Integrated with Guided Discovery Learning to Enhance Students' Critical Thinking Skills in Physics

Riki Perdana[1]
Physics Science
Graduate School Program,Yogyakarta State University
Country Yogyakarta, Indonesia
rikifisika95@gmail.com

Riwayani[2]
Physics Science
Graduate School Program,Yogyakarta State University
Country Yogyakarta, Indonesia
riwayani95@gmail.com

Jumadi[3]
Physics Science
Graduate School Program,Yogyakarta State University
Country Yogyakarta, Indonesia
jumadi@uny.ac.id

Dadan Rosana[4]
Physics Science
Graduate School Program,Yogyakarta State University
Country Yogyakarta, Indonesia
danrosana@uny.ac.id

***Abstract*—This study aimed to assess the effectiveness of Web-Based Simulation integrated with Guided Discovery Learning (WBS-GDL) model in improving the critical thinking skill in Physics Grade XI students in Islamic State School Yogyakarta, Indonesia. The GDL-WBS model was compared to the Direct Instruction model (DI). The comparison of their level before and after learning was determined to assess the effectiveness of WBS-GDL and DL group. The level of students' critical thinking skill in these groups before and after they thought with the model was determined. Pretest and posttest with experimental group design and descriptive comparative was used to processing data from 50 students. We use ANOVA mixed design, independent sample t-test, and paired sample t-test to analysis data. The result of the study are (1) Level of students' critical thinking skill of both group before learning is generally very low and increased after learning; (2) there is a significant differences in the level of students' critical thinking skill in the WBS-GDL group with n-gain 0.42 (medium); (3) In this study, the WBS-GDL model improve students' critical thinking skill as 57.8% while DI only 6.7%. The conclusion of this study is WBS-GDL can be used to enhance students' critical thinking skill and more effective than DI model. For the next study, our recommendation is to assess other aspect of critical thinking skill with some learning model integrated simulation based learning.**

Keywords: web-based simulation, guided discovery, critical thinking

I. INTRODUCTION

The main objective in physics is to make mathematical models that can predict and explain physical phenomena [1]. In physics learning, there is more than one representational form that is often used in conveying information and supporting knowledge construction [2]. Students who study physics must use and move between various forms of representation including describing concepts, using conceptual diagrams or computer simulations, using mathematical equations to calculate, and explaining changes in variables in tables or graphs [3].

Physics learning must apply a new learning paradigm that has the potential to facilitate efforts to develop students' social spiritual attitudes, character, and critical thinking skills [4]. The process of physics learning must be applied into activities of scientific inquiry or discovery, in order to grow students' critical thinking skills and scientific attitudes so they are able to solve problems [5]. Some physics teachers agree that the reason students choose physics majors is to learn critical thinking [6].

Critical thinking is a wise process that is done intentionally in making a decision to judge, reject or accept an idea delivered [7]. As stated in Ref [8], it is a skill that combines the use of evidence and / or logic to evaluate and draw conclusions. Critical thinking is a metacognitive process carried out through deliberate judgment, by increasing the ability to produce logical conclusions on an argument or problem solving solution [9].

Critical thinking is an important aspect of everyday life in all fields of international relations, justice, economics, politics, and health to education [10]. However, many studies show that students' critical thinking skills still in middle level. As stated in Ref [11] the students' critical thinking skill levels are mostly in middle level (77.3 %), only a few parts of them (22.4 %) have high level critical thinking skills, and only one of the students (3 %) has low level critical thinking skills.

In Indonesia, students' critical thinking skill is rather below. As stated in [12] the students' critical thinking skills level also in middle level (42.8%), only a few of them (25%) have a high level and a few students (32.2%) has low level critical thinking skill. Reference [13] found that the average score of students is still low level critical thinking skill (65.7). Therefore, it is necessary to develop learning tools/teaching

material to enhance students' critical thinking skills in Indonesia. The research question in this study are (1) How is the level of students' critical thinking skill in Islamic State School on Yogyakarta, Indonesia? (2) How is level of effectiveness of WBS-GDL in enhancing students' critical thinking skill? (3) Is any significant difference between WBS-GDL compared with DL in enhancing students' critical thinking skill?

II. METHODOLOGY

A. Participant

This research was conducted in two classes randomly selected from science XI students from the Islamic State School in Yogyakarta, Indonesia. The first class as an experimental group with the WBS-GDL model, consisted of 30 students with 10 males and 20 females. The second class as the experimental group with the DI model consisted of 20 students, 7 males and 13 females. All classes have four sessions, with each session consisting of 60-90 minutes. Teaching materials used are (1) WBS-GDL learning matrix that contains desired competencies based on physical topics (kinetic theory of gases), learning activities, and assessment mechanisms given to students. This matrix has been validated by experts including two professional physics teachers, two graduate students, one doctor, and two professors. (2) Guidelines for teachers based on the learning of the WBS-GDL which consists of learning plans implemented by the teacher, (3) Learning materials which are modules made by the researcher. This module consists of several subtopics about the kinetic theory of gases for class XI students, (4) Test of students' critical thinking skills tests. They were asked to complete 10 questions with 60-90 minutes. All items have been validated by experts. The items of critical thinking skills are analyzed with the assessment rubric using levels 0 - 4. Table 1 shows the level of critical thinking skills.

Table 1. Level of Critical Thinking Skill

Range of Level	Description
0 – 2.39	Very low
2.40 – 2.79	Low
2.80 – 3.19	Average
3.20 – 3.59	High
3.60 – 4.00	Very high

After selecting the experimental class and control class, participants from both classes were given a pretest question according to the indicators of determining critical thinking skills. The results of this test are used to analyze the level of students' critical thinking skills. The experimental class is taught with the WBS-GDL model, while the control class is taught with the DI model, according to the learning module. In the WBS-GDL model, there are several learning stages. The first stage is introduction. This stage is the initial stage where students are given a brief explanation of the learning that will be carried out. The purpose of this stage is to stimulate students to get involved and be active when the learning process takes place. The next step is to provide stimulus or stimulation to students. At this stage the students displayed problems with online simulations from the website provided. Then, they were asked to form a group consisting of 5-6 people to conduct experiments virtually. They are given time to work together to solve problems and complete the experimental phase so that they discover the concept of kinetic theory of gases themselves. In addition, they were given freedom to open other websites to add data, propose reasonable solutions, support their logical reasons and make the conclusions.

B. Item of Critical Thinking Test

There are 10 questions prepared by the researchers according to the indicators of critical thinking skills that are measured. This indicator is integrated with topics in kinetic material theory of gases. The items prepared were assessed by seven experts in the field of physics education - two professors and one doctor at a leading university, two graduate students and two physics teachers. After evaluating the material and based on recommendations from experts, the topics tested in this study are pressure on ideal gas, characteristic of ideal gas, Boyle's Law, Boyle-Gay Lussac's Law, Charles's Law, Root Mean Square Velocity, Average velocity, kinetic energy, and temperature in ideal gas.

C. Assessment and Data Collection

In this study, we used SPSS version 16 to analyze data. Data regarding the profile of students' critical thinking skills were analyzed quantitatively and descriptively using percent and frequency. To determine whether there are significant differences in students' critical thinking skills between our pretest and posttest using paired sample t-test. Independent sample t-test was used to determine whether there were significant differences regarding the level of critical thinking skills of students in the DI group and WBS-GDL. The gain score and partial eta square values are used to determine the effectiveness of the DI and WBS-GDL models for students' critical thinking skills. The gain score is used to determine the level of effectiveness while partial eta square to determine how much influence of the model has on the learning output. The partial eta square value is obtained by using the ANOVA mixed design test on the results of the student's pretest and posttest. The score gain value is determined by Hake's equation [14] :

$$\text{Gain (g)} = \frac{\bar{X}_{\text{posttest}} - \bar{X}_{\text{pretest}}}{\text{maximum score} - \bar{X}_{\text{pretest}}} \quad (1)$$

Where Gain is gain score of the class, X _posttest is mean of posttest, and X _pretest is mean of pretest. The range of effectiveness levels based on the above equation is $g < 0.3$ (low); $0.3 \leq g < 0.7$ (medium) and $g \geq 0.7$ (high).

III. FINDING AND DISCUSSION

A. DI Group

In the test of critical thinking skills, students are given 10 questions according to aspects of this skill during the pretest and posttest. The results of the analysis of their answers are shown in Table 2. This table shows the level of their critical thinking skills based on the answers in the pretest and posttest.

***Table 2**. Level of CT Skill in DI Group*

Indicator of CT skills	*Pretest*		*Description*	*Posttest*		*Description*
	Mean	*SD*		*Mean*	*SD*	
Focus on the context of the problem	*1.90*	*0.31*	*Very low*	*2.85*	*1.09*	*Average*
Identify the conclusions from a statement	*2.00*	*0.00*	*Very low*	*3.25*	*0.55*	*High*
Consider the procedure for finding evidence	*1.80*	*1.20*	*Very low*	*2.80*	*1.44*	*Average*
Involves any assumption	*2.40*	*1.60*	*Low*	*1.85*	*1.31*	*Very low*
Using logical conditions	*1.65*	*1.04*	*Very low*	*1.15*	*0.67*	*Very low*
Identify and use distinctive features or patterns in the data to draw conclusions	*1.35*	*1.14*	*Very low*	*1.75*	*1.37*	*Very low*
Know the content validity of a definition	*1.75*	*1.65*	*Very low*	*2.65*	*1.42*	*Low*
Identifying assumptions needed for a particular condition	*0.90*	*1.25*	*Very low*	*1.00*	*0.79*	*Very low*
Choose criteria for considering possible solutions	*1.20*	*1.47*	*Very low*	*1.25*	*1.21*	*Very low*
See the total problem and take an action	*1.20*	*0.83*	*Very low*	*1.80*	*0.77*	*Very low*
Overall	*1.62*	*0.45*	*Very low*	*2.04*	*0.80*	*Very low*

Note: 0 – 0.49 = "Very low", 0.50 – 1.49 = "Low", 1.50 – 2.49= "Average", 2.50 – 3.49 = "High", 3.50 – 4.00 = "Very High"

Among the 10 indicators of critical thinking skills given in the pretest, it was found that indicator 8 shows the lowest mean of 0.90 (very low level). Item 4 shows the highest average of 2.40 (low level). In the posttest results it was also found that indicator 8 shows the lowest average of 1.00 (very low level) and indicator 2 shows the highest average of 3.25 (high level). Table 3 presents the level of critical thinking skills of students before and after they are taught using DI models in class 11 kinetic theory of gasses concepts.

Table 3. Level of CT Skill Students before and after learning with in DI model

Level of CT Skills	Before		After	
	f	%	f	%
Very low	19	95	11	55
Low	1	5	8	40
Average	0	0	0	0
High	0	0	1	5
Very High	0	0	0	0
Overall	mean = 1.62 (Very low), SD = 0.62		mean = 2.04 (Very low), SD = 0.63	

Note: 0 – 0.49 = "Very low", 0.50 – 1.49 = "Low", 1.50 – 2.49= "Average", 2.50 – 3.49 = "High", 3.50 – 4.00 = "Very High"

Based on Table 3, overall, students have a level of critical thinking skills at the very low level (mean = 1.62, SD = 0.62) before they were taught with DI models. Most (95% of the total 20) students had very low level of critical thinking skills, and 5% at low levels. Meanwhile, there were no students who had a high and very high level of critical thinking skills. After students in the DI model exposed group in learning the concept of kinetic theory of gases, the number of students at low levels increased slightly (40%) while the number of students at very low levels decrease (55%). There are no students at average, high and very high levels. Overall, the level of students' critical thinking skills is still at the lowest level. This shows that the DI model applied in the learning process does not have a significant effect on improving students' critical thinking skills. This can be caused by DI models that are still focused on the teacher center, so students are less motivated in developing and improving these skills. According to [16], learning that is still a teacher center cannot improve students' physics learning abilities and lacks the corporation's critical thinking skills [17]. The level of critical thinking skills of class XI students in the DI model group is compared based on the results of the pretest and post-test. The paired sample t-test was used to test whether there were significant differences regarding this skill after

being taught with DI models. The results of the paired sample t-test in the DI model group are shown in Table 4.

Table 4. Paired Sample t-test of DI Group

	Mean	SD	t-value	df	Sig
Pretest	1.62	0.62	-3.132	19	0.05
Posttest	2.04	0.63			

Table 4 shows that there are significant differences based on the results of the pretest and posttest in the DI Group (t value 3.23> t table1.729). The difference in the mean value between post-test (2.04) and the pretest (1.62) is very small only 0.42. This shows that DI models in this group are quite helpful in improving students' critical thinking skills even though they are very small.

B. WBS-GDL Group

The students in the WBS-GDL group were also given a pretest and posttest with the same indicators as the DI group. Their answers were analyzed using the same method. The results of the analysis of student answers based on the pretest and posttest in the WBS-GDL group are presented in Table 5.

Table 5. Level of CT Skill in WBS-GDL Group

Indicator of CT skills	Pretest			Posttest		
	Mean	SD	Description	Mean	SD	Description
Indicator 1	1.63	0.96	Very low	3.37	0.81	High
Indicator 2	1.63	1.03	Very low	3.77	0.82	Very high
Indicator 3	0.93	1.31	Very low	1.30	1.47	Very low
Indicator 4	1.17	1.46	Very low	2.07	1,70	Very low
Indicator 5	0.97	1.33	Very low	2.83	1.29	Average
Indicator 6	0.43	0.90	Very low	2.90	1.42	Average
Indicator 7	1.37	1.67	Very low	2.97	1.52	Average
Indicator 8	0.47	0.90	Very low	0.87	1.25	Very low
Indicator 9	0.30	1.02	Very low	1.60	1.77	Very low
Indicator 10	0.63	1.07	Very low	2.50	1.31	Low
Overall	0.95	0.82	Very low	2.42	0.86	Low

Note: 0 – 0.49 = "Very low", 0.50 – 1.49 = "Low", 1.50 – 2.49= "Average", 2.50 – 3.49 = "High", 3.50 – 4.00 = "Very High"

Table 5 shows that grade XI students in the WBS-GDL group generally have the lowest level of critical thinking skills (mean = 0.95, SD = 0.82). Based on the pretest, among the 10 indicators of critical thinking skills, the answers of students with the highest average were indicators 1 and 2 with mean of 1.63 (very low level). Student answers that show the lowest average are indicator 9 with mean of 0.30 (very low level). The very low level of critical thinking skills of students in the WBS-GDL group before the learning process shows that this skill was still not improved. The level of students' critical thinking skills in the WBS-GDL group before and after the learning process is presented in Table 6.

Table 6. Level of CT Skill Students before and after learning with WBS-GDL model

Level of CT Skills	Before		After	
	f	%	f	%
Very low	27	90	16	53.33
Low	2	6.67	6	20
Average	1	3.33	1	3.33
High	0	0	2	6.67
Very High	0	0	5	16.67
Overall	mean = 0.95 (Very low), SD = 0.82		mean = 2.42 (Low), SD = 0.86	

Table 6 shows that the level of critical thinking skills of WBS-GDL group students before the kinetic learning theory of gases was very low. Almost all students (90%) were at very low levels and some were in the low level (6.67%) and average level (3.33%). In general, students in this group had very low levels of critical thinking skills with mean level of 0.95 with SD = 0.82 during pretest. None of the students showed higher critical thinking skills.

The level of critical thinking skills is based on after posttest, they are exposed to the learning approach to the concept of kinetic theory of gases with the WBS-GDL at a low level (mean = 2.42, SD = 0.86. In particular, most (53.33%) students still show a level of thinking skills critical at very low level. Some (20%) at low level, 3.33% at average level, 6.67% at high level and even 16.67% at very high level. It should be noted that the number of students at very low levels comparatively decreased by 36.7% after they were exposed to the WBS-GDL. On the other hand, the number of students at high and very high levels comparatively increased. This implies that the intervention carried out has a positive effect in developing and improving students' critical thinking skills. These results are similar to [18] where guided discovery learning can improve critical thinking skills because it creates learning situations where students are guided in order to find facts, relationships and solutions independently [19]. In addition, integrated with internet technology-based learning, can help the development of students' thinking abilities [20]. Similar to [21] found that guided discovery strategies based on e-learning had a positive influence on learning. The difference in the level of critical thinking skills of students in the WBS-GDL group before and after learning was analyzed using paired sample t-test. The results of the paired sample t-test are presented in Table 7.

Table 7. Paired Sample t-test of WBS-GDL Group

	Mean	SD	t-value	df	Sig
Pretest	0.95	0.82	-6.651	29	.000

Post-test	2.42	0.86

Based on Table 7, there are significant differences from the results of the mean of the pretest and posttest level of the critical thinking skills of the WBS-GDL group. Difference in difference between posttest (2.42) and pretest (0.95) of 1.43 shows that the WBS-GDL significantly helps improve the level of students' critical thinking skills.

C. Comparison of the DI and WBS-GDL Group

Comparison of DI and WBS-GDL groups were analyzed using the gain score based on the results of the pretest and posttest on indicators of critical thinking skills. The results of the gain score analysis are presented in table 8.

Table 8. Gain score of DI and WBS-GDL Group

	DI Group N = 20				WBS-GDL Group			
	Pretest Mean	Post-test Mean	Gain score	Description	Pretest Mean	Post-test Mean	Gain score	Description
CT Skill	1.62	2.04	0.17	Low	0.95	2.42	0.48	Medium

The results of the pretest and posttest on the questions with indicators of critical thinking skills were analyzed so that the value of the gain score was obtained. The two groups in this study had a level of critical thinking skills at very low levels with mean DI group = 1.62 and WBS-GDL group = 0.95. Where 95% in the DI Group and 90% in the WBS-GDL group is at this very low level. Based on the gain score criterion by [14] table 9 presents the results of improving the skills of critical students. In the DI group, it can be seen that the gain score is 0.17 (low), while in the WBS-GDL group the gain value of the score is 0.48 (medium). This shows that learning WBS-GDL is able to improve students' critical thinking skills at the medium level, while DI is only at the lowest level. The scores of students 'answers to the critical thinking skills questions in each group were then tested by the independent sample t test to determine whether there were significant differences in the results of students' critical thinking skills after the learning process. Analyze data are based on the value of the pretest and posttest of each class. The results of the analysis are presented in Table 9.

Table 9. Independent sample t-test of both group

Groups	N	Mean	SD	t	df	P	Description
DI	20	0.15	0.27	-2.877	48	0.006	Significant
WBS-GDL	30	0.42	0.35				

Based on the data presented in Table 9, there are significant differences regarding the level of critical thinking skills of students between DI and WBS-GDL Group where t (2.887)> t table (1.684) and significance p 0.006 <0.05. The average difference in the direct learning group (0.15) with learning WBS (0.42) is 0.27 indicating that the level of critical thinking skills in the WBS-GDL study group is better than the DI group. Improvement in the WBS-GDL group because students get experimented even though visually. Through this learning students can solve problems, draw conclusions, and discuss and other activities that can improve critical thinking skills. To determine the greatest influence between DI and WBS-GDL models on critical thinking skills, we used a mixed ANOVA design test based on student pretest and posttest. The results of the analysis are shown in the table 10.

Table 10. Anova mixed design

Group	Sig	Partial Eta Squared
DI	0.069	0.067
WBS-GDL	0.000	0.568

Table 10 shows the value of Partial Eta Square (PES) for the DI and WBS-GDL models. In the DI group the PES 0.067 value was obtained and the WBS-GDL group had a PES value of 0.568. Based on [22] the meaning of PES value for both models, the DI model only can improve students' critical thinking skills as much as 6.7%, while the WBS-GDL model can improve students' critical thinking skills as much as 56.8%. These results indicate that in this study the WBS-GDL model is more effective than the DI model in improving students' critical thinking skills.

IV. CONCLUSION

Based on the findings in this study, we can conclude that critical thinking skills before the learning process was very low. Learning with the WBS-GDL model can improve students' critical thinking skills. In addition, this learning method is more effective than the DI model. Based on gain score, DI model was low level while WEB-GDL was on medium level. The DI model only can improve students' critical thinking skills as much as 6.7% while the WBS-GDL model can improve students' critical thinking skills as much as 56.8%. All indicators of critical thinking skills measured in this study also increased. These indicators relate to aspects of critical thinking skills including clarification of basic and basic skills, advanced clarification, drawing conclusions, and applying strategies and tactics.

Physics learning with the WBS-GDL model can be an alternative for teachers and policy makers to overcome the problems of students' critical thinking skills. With the characteristics of learning that are in accordance with the curriculum needed in this century, learning with the WBS-GDL model can improve students' affective, cognitive, and psychomotor aspects.

This learning is able to improve every aspect of students' critical thinking skills measured in this study. The recommendation for further research is to develop a learning model with a variety of additional technological devices and innovative models. Therefore, the experience and insights of students in critical thinking will continue to develop according to the needs of the present. In addition, further research can also measure other aspects of critical thinking skills in physics with a variety of relevant topics.

ACKNOWLEDGMENT

This study was supported by the Graduate School Program in Yogyakarta State University and The Ministry of Research, Technology and Higher Education of The Republic of Indonesia.

REFERENCES

[1] E. F. Redish, "Analysing the competency of mathematical modelling in physics," in Springer Proceedings in Physics, 2017.

[2] M. Opfermann, A. Schmeck, and H. E. Fischer, "Multiple Representations in Physics and Science Education – Why Should We Use Them?," 2017.

[3] P. M. Kind, C. Angell, and Guttersrud, "Teaching and Learning Representations in Upper Secondary Physics," in Multiple Representations in Physics Education, 2017, pp. 25–45.

[4] I. W. Santyasa, I. W. S. Warpala, and I. K. Sudarma, "The Power of Group Investigation Model on Student Critical Thinking, Attitude, and Character in Learning Physics," in 1st International Conference on Creativity, Innovation and Technology in Education (IC-CITE 2018), 2018.

[5] E. Effendi, T. Firdaus, and E. Erwin, "The influence of problem-based physics learning using guided inquiry toward scientific attitude," in International Conference on Mathematics and Science Education of Universitas Pendidikan Indonesia, 2018, pp. 136–139.

[6] E. Etkina and G. Planinšič, "Defining and Developing 'Critical Thinking' Through Devising and Testing Multiple Explanations of the Same Phenomenon," Phys. Teach., 2015.

[7] A. EL-Shaer and H. Gaber, "Impact of Problem-Based Learning on Student Critical Thinking Dispositions, Knowledge Acquisition and Retention," J. Educ. Pract., 2014.

[8] M. L. Styers, P. A. Van Zandt, and K. L. Hayden, "Active learning in flipped life science courses promotes development of critical thinking skills," CBE Life Sci. Educ., 2018.

[9] C. P. Dwyer, M. J. Hogan, and I. Stewart, "An integrated critical thinking framework for the 21st century," Think. Ski. Creat., 2014.

[10] A. H. Franco, H. A. Butler, and D. F. Halpern, "Teaching critical thinking to promote learning," in The Oxford handbook of undergraduate psychology education, 2015.

[11] H. Aktamiş and N. Yenice, "Determination of the science process skills and critical thinking skill levels," in Procedia - Social and Behavioral Sciences, 2010.

[12] R. Purwati, H. Hobri, and A. Fatahillah, "Analisis Kemampuan Berpikir Kritis Siswa dalam Menyelesaikan Masalah Persamaan Kuadrat pada Pembelajaran Model Creative Problem Solving," KadikmA, vol. 7, no. 1, pp. 84–93, 2016.

[13] W. M. Matsun, Sunarno, and Masykuri, "Using Real and Virtual Laboratory in Physics Learning with Considered Inquiry Models from Mathematical and Critical Thinking Skills," J. Pendidik. Fis., 2017.

[14] R. R. Hake, R. Wakeland, and R. Bhattacharyya, A. Sirochman, "Assessment of individual student performance in an introductory mechanics course," AAPT Announc., vol. 24, no. 4, p. 76, 1994.

[15] E. Effendi, T. Firdaus, and E. Erwin, "The influence of problem-based physics learning using guided inquiry toward scientific attitude," in In International Conference on Mathematics and Science Education of Universitas Pendidikan Indonesia, 2018, pp. 136–139.

[16] T. Gok, "The Evaluation of Conceptual Learning and Epistemological Beliefs on Physics Learning by Think-Pair-Share," J. Educ. Sci. Environ. Heal., 2018.

[17] L. Surayya, I. W. Subagia, and I. N. Tika, "Pengaruh Model Pembelajaran Think Pair Share Terhadap Hasil Belajar Ipa Ditinjau Dari Keterampilan Berpikir Kritis Siswa," Pengaruh Model Pembelajaran Think Pair Share Terhadap Has. Belajar Ipa Ditinjau Dari Keterampilan Berpikir Krit. Siswa, 2014.

[18] K. Yuliani and S. Saragih, "The development of learning devices based guided discovery model to improve understanding concept and critical thinking mathematically ability of atudents at Islamic Junior High School of Medan," J. Educ. Pract., 2015.

[19] R. Lavine, Guided Discovery Learning. N. Seel (Ed.), Encyclopedia of the sciences of learning. Boston: Springer US., 2012.

[20] F. Mohamad and N. Mat Daud, "The Effects of internet-assisted language learning (IALL) on the development of ESL students' critical thinking skill," World Appl. Sci. J., 2013.

[21] C. J. Shieh and L. Yu, "A study on information technology integrated guided discovery instruction towards students' learning achievement and learning retention," Eurasia J. Math. Sci. Technol. Educ., 2016.

[22] N. . Leech, K. . Barret, and G. A. Morgan, SPSS for Intermediate Statistics: Use and Interpretation, Second Edi. Marwah: Lawrence Erlbaum Associates Publishers, 2005.

.