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THE EFFECT OF GIVING ILL-STRUCTURED MATH PROBLEM AND WELL-STRUCTURED MATH PROBLEM ON THE SELF-EFFICACY OF JUNIOR HIGH SCHOOL STUDENTS

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Abstract

This study aimed to determine the effect of giving ill-structured problems and well-structured problems to students' self-efficacy. The study population was class VIII students at Junior High School 1 Ngawen Blora which consisted of an experimental class and a control class with the selection of samples using purposive sampling technique. This research is a quantitative research with a comparative problem formulation that compares the increase in self-efficacy between students who are given well-structured math problems and ill-structured math problems. The data analysis technique used was t-test dependent and t-test independent. The results showed that: 1) there is an effect of giving ill-structured math problems on students' self-efficacy at a significant level of 0.05; 2) there isn't an effect of giving well-structured math problems on students' self-efficacy at a significant level of 0.05; 3) there is a difference in changes in student self-efficacy between giving ill-structured math problems and giving well-structured math problems at a significant level of 0.05

Keywords: ill-structured problem, self-efficacy, well-structured problem

1. Introduction

Mathematics is one of the important sciences, because it is related to all aspects of life. However, not all humans have good ability to understand mathematics, this can be seen through the Program for International Study Assessment (PISA) survey in 2018 under the Organization for Economic Cooperation and Development (OECD) 79 countries. Putrawangsa & Hasanah (2022) said that PISA 2018 results shows around 72% of indonesian students are categorized as having low ability on mathematical literacy. Based on these data, it can be said that the ability of mathematics in Indonesia is quite low. Budiono (in Ulandari, Hudiono, & Bistari, 2015) states that the curriculum used in Indonesia tends to apply questions that only have one answer or well-structured problems in learning mathematics. This causes students to be unfamiliar with looking at problems from different perspectives, so students tend to be afraid of making mistakes in solving problems and this will affect students' self-efficacy. The level of student self-efficacy is very influential in the learning process, because based on research conducted by Sahendra, Budiarto & Fuad (2018) states that there is a relationship between self-efficacy and student learning outcomes, namely the higher the self-efficacy, the higher the academic ability . So that needed several ways to increase students' self-efficacy, one of them is by giving ill-structured math problems in the hope that students can be more confident in their abilities because the ill-structured math problems consist of various types of answers.

Mathematics is always related to problems and problem solving processes. A problem in mathematics is a problem that can be represented, analyzed, and can be solved by mathematical methods. Mathematical method is a method that consists of several steps of solving a mathematical problem which is referred to as a problem solving process. Polya (in Toy, 2007) states that the problem solving process consists of several steps, namely understanding the problem, planning problem solving strategies, carrying out problem solving plans, and reviewing the results obtained. The problem solving process has an important role in the mathematics learning process. In the problem solving process there are several things that affect it. Siswono (in Alifia & Rakhmawati, 2018) states that there are several factors that influence problem solving abilities, including: Initial experience (experience with story problem solving tasks); Mathematical background (students' ability to understand mathematical concepts at different levels which can trigger differences in students' ability to solve problems); Desire and motivation (strong encouragement from within myself such as growing my confidence to be able to complete the given problem or task); and the problem structure (problem structure that given to students, such as verbal or pictorial formats, complexity (level of difficulty), context (background story or theme), language problems, or the form of one problem with another can interfere with students' ability to solve some problem). Of these several factors, there are two factors that are quite interesting to study because they can be observed in the problem solving process. The two factors are desire and motivation factors that can be observed by filling out the questionnaire so that it can be seen from the final score of filling out the questionnaire, and the problem structure which has certain characteristics that can be conditioned by humans.

Desire and motivation factors are factors that quite related to self-efficacy (Lunenburg, 2011). This is because the desire and motivation are related to students' beliefs (Zimmerman, 2000). Self-efficacy is self-confidence in completing certain tasks or actions to achieve a goal (Alifia & Rakhmawati, 2018). Self-efficacy abilities can affect a person's choice of activities, effort, and persistence when solving problems (Bandura, 2010). Self-efficacy is one of important role in life, especially for students who are solving math problems. With the existence of high self-efficacy abilities in students, it is expected to be successful in solving mathematical problems. Because high self-efficacy can create calm in front of the task or students' self-control ability in dealing with the given task and confidence to solve difficult problems. Several studies discuss self-efficacy and student learning outcomes, including research conducted by Ayotola & Adedeji (2009) which states that there is a relationship between self-efficacy and student learning outcomes. This statement is in accordance with research by Sahendra, Budiarto, & Fuad (2018) which states that there is a relationship between self-efficacy and student learning outcomes, namely the higher the self-efficacy, the higher the academic ability. Self-efficacy is also a determinant that influences a person's choice in an effort to persevere in facing difficulties and the mindset and emotional reactions they experience. From some of these explanations, it can be said again that self-efficacy or self-confidence that students have in solving problems is very influential in the mathematics learning process because self-efficacy affects students in the problem solving process and student learning outcomes.

The next factor is the structure of the problem. Based on the structure, problems can be divided into two, namely open problems is problems that have several types of solutions and closed problems is problems that only have one type of solution (Yee, 2002). These two things are one of the elements which make problem divided based on their elements. Based on the elements, problems are divided into ill-structured problems and well-structured problems (Hendriana & Soemarmo, 2014). An ill-structured problem is a problem which there is no complete information, an unstructured problem design, and has various types of solutions. Meanwhile, a well-structured problem is a problem that has a well-defined initial state, has a purpose, and has a clear operating formula for solving calculations (Goel, 1992), so that in the solution there is only one type of correct answer. Chi & Glaser (in Hong & Kim, 2016) state several characteristics of ill-structured problems, including the situations given are not concrete, the problems are not well defined, open-ended, and based on contextual mathematics problems in unstructured conditions. . In accordance with this statement, Kim, Lee, Hong & Kim (in Hong & Kim, 2016) define three components in the ill-structured problem, the three components include authentic (problems presented relating to everyday life outside the school environment), complex (the solution steps are not presented directly in the problem), and open-ended (has several solutions to the problem and the essence of the problem is not presented directly). From some of these explanations, it can be restated the difference between the ill-structured problem and the well-structured problem. Ill-structured problems are open-ended, problems are not presented directly and have a variety of solutions. While the well-structured problem is closed-ended, the problem is presented clearly, and only have one solution.

Based on the previous statement, the characteristics of the ill-structured problem are abstract questions and have several types of solutions so that the solution requires abstraction, reasoning and logic skills, as well as deductive and inductive thinking. In Jean Piaget's theory of cognitive level development (in Ibda, 2015) states that these skills and abilities are possessed by children at the stage of formal operational cognitive development, namely children over the age of 11 years. In Indonesia, Junior High School students are generally 12-15 years old, at this age according to Piaget's theory is the stage of formal operational cognitive development. Therefore, the participants in this study were class VIII junior high school students.

According to information from a grade VIII mathematics teacher who teaches at Junior High School 1 Ngawen Blora, namely Ms.Maspuah states that learning mathematics at the school often uses well-structured math problems rather than ill-structured math problems. According to research conducted by Hong & Kim (2016) it is stated that giving ill-structured problem questions can improve students' abstraction skills. Reinforced by research conducted by Cho & Kim (2020) which states that learning using ill-structured problems can improve students' problem solving abilities. Il-structured math problems are questions that have various solutions so that students can solve these problems according to the abilities possessed by each student. In addition, students can also be more flexible and confident in expressing how to solve these types of questions because they are not based on one type of answer, so that giving ill-structured math problem is expected to increase the level of self-efficacy which can later improve student learning outcomes. Based on the statement and the results of that research, it is necessary to conduct a study on the effect of giving ill-structured math problems and well-structured math problems on the self-efficacy of Junior High School 1 Ngawen students.

Based on that statements, the following hypotheses were formulated, including: 1) there is an effect between giving ill-structured math problems on students' self-efficacy; 2) there is an effect between giving well-structured math problems to students' self-efficacy; 3) there is a difference in changes in student self-efficacy between giving ill-structured math problems and giving well-structured math problems.

2. Method

This research is a quantitative research with a comparative problem formulation that compares the increase in self-efficacy between students who are given well-structured math problems and ill-structured math problems.

Data collection was carried out at Junior High School 1 Ngawen Blora in the even semester 2021/2022 academic year. Data collection was carried out on February 24-19 March 2022.

The population in this study were students of class VIII Junior High School. Sampling was carried out using a purposive sampling technique. The considerations taken are based on mathematical abilities and students' activeness in learning mathematics with the mathematics scores obtained by students as a determining indicator.

This sampling consisted of two classes, namely, Class A as the Experiment Class with the provision of ill-structured math problems and Class B as the Control Class with the provision of well-structured math problems. The number of samples in the study were 31 students, with 15 students in the experimental class and 16 students in the control class. In the experimental class, treatment was given in the form of giving ill-structured problems to students, while in the control class, treatment was given in the form of giving well-structured problems to students.

The instrument in this study consisted of a self-efficacy questionnaire which was adapted from the MSEAQ (Mathematics Self-Efficacy and Anxiety Questionnaire) questionnaire in the dissertation entitled "Mathematics Self-Efficacy And Anxiety Questionnaire" by Diana K. May (2009). ill-structured math problems worksheet, and well-structured math problems worksheets. The task sheet is in the form of contextual math problems on the Pythagorean and circle material that has been tested for feasibility and given 3 times. Below are the example of ill-structured math problems and well-structured math problems that used in this study.

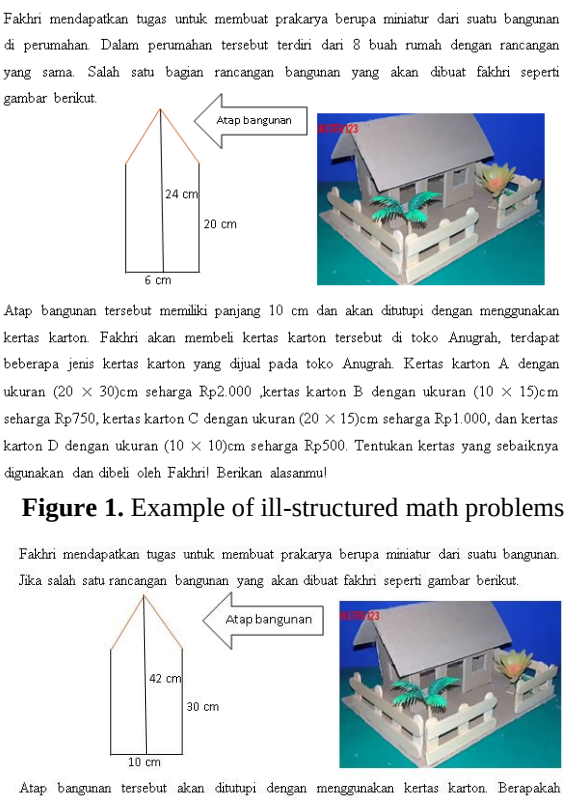

Figure 1. Example of ill-structured math problems

Figure 2. Example of well-structured math problem

The data were obtained from the results of filling out the student self-efficacy level questionnaire before giving the treatment or worksheet and after giving the treatment or worksheet. The following are the variables in the study:

Table 1. Variables in the study

Independent Variable	Giving Ill-structured math problem	Giving well-structured math problem
Control Variable	Class VIII students of Junior High School 1 Ngawen	
Dependent variable	Student Self-efficacy level	

Data analysis techniques to answer the hypothesis using the dependent t-test and independent t-test. The dependent t-test was used to answer the hypothesis about the effect of giving each question on the level of student self-efficacy. The following formula is used to calculate the dependent t-test:

$$t = \frac{\bar{D}}{S\,\bar{x}\,D}$$

The independent t-test was used to answer the hypothesis about the difference in changes of students' self-efficacy levels between two different types of questions. To calculate independent t-test, the data must be normally distributed and homogeneous so normality and homogeneity tests are carried out. Then the independent t-test was calculated with the following formula:

$$t = \frac{\overline{x_1} - \overline{x_2}}{SD\bar{x}}$$

3. Result and Discussion

3.1 Result

Based on the data obtained, the following are the results of calculations to answer the hypotheses that have been made:

The effect of giving math questions*ill-structured problem*on student self-efficacy

To answer this hypothesis, a dependent t-test was conducted. By using manual calculations through Excel the following data are obtained:

H_{01}: There is no effect between giving ill-structured math problems on students' self-efficacy.

H_{a1}: There is an effect between giving ill-structured math problems on students' self-efficacy.

Table 2. The calculation results of the hypothesis 01

t_{count}	Significant level	dk	t_{table}
2.928485	0.05	14	2.14478

Because $t_{count} > t_{table}$, H_{01} is rejected so that it can be stated that there is an effect of giving ill-

structured math problems on students' self-efficacy.

The effect of giving well-structured math problems to students' self-efficacy

To answer this hypothesis, a dependent t-test was conducted. By using manual calculations through Excel the following data are obtained:

H_{02}: There is no effect between giving well-structured math problems to students' self-efficacy.

H_{a2}: There is an effect between giving well-structured math problems to students' self-efficacy.

Table 3. The calculation results of the hypothesis 02

t_{count}	Significant level	dk	t_{table}
0.176634	0.05	15	2.131450

Because $t_{count} < t_{table}$, H_{02} is accepted so that it can be stated that there is no effect of giving well-structured math problems to students' self-efficacy.

Differences in students' self-efficacy changes between giving ill-structured math problems and well-structured math problems

To answer this hypothesis, an independent t-test was conducted. By using manual calculations through Excel the following data are obtained:

a. Test the homogeneity of the experimental class and control class

Table 4. Homogeneity test calculation results

Treatment	F_{count}	Significant level	F_{table}
Beginning	1.004639	0.05	2.42
End	1.224318	0.05	2.42

Because $F_{count} < F_{table}$, it can be stated that the sample data used is homogeneous.

b. Normality test

Experimental class (Sample with ill-structured problem)

Table 5. The calculation results of the normality test on the experimental class

Treatment	P_{count}	Significant level	P_{able}
Beginning	0.926781	0.05	0.881
End	0.897956	0.05	0.881

Because $P_{count} > P_{table}$, it can be stated that the sample data used is normally distributed.

Control class (Sample with well-structured problem questions)

Table 6. The calculation results of the normality test on the control class

Treatment	P_{count}	Significant level	P_{table}
Beginning	0.964149	0.05	0.863
End	0.951124	0.05	0.863

Because $P_{count} > P_{table}$, it can be stated that the sample data used is normally distributed.

Because the sample of data are homogeneous and normally distributed, it is possible to calculate an independent t-test with the following results:

H_{03}: The level of self-efficacy of students by giving ill-structured math problems is not higher or equal to the level of self-efficacy of students by giving well-structured math problems.

H_{a3}: The level of self-efficacy of students by giving ill-structured math problems is higher than the level of self-efficacy of students by giving well-structured math problems.

Table 7. The calculation results of the hypothesis 03

t_{count}	Significant level	dk	t_{table}
-5.01841	0.05	29	2.045230

Because $t_{count} < t_{table}$, H_{03} is accepted so that it can be stated that the level of self-efficacy of students by giving ill-structured math problems is not higher or equal to the level of self-efficacy of students by giving well-structured math problems.

3.2 Discussion

Based on the results of the data analysis, it can be stated as follows:

a. There is an effect of giving ill-structured math problems to the level of student self-efficacy

In the class given the ill-structured problem, the value of $t_{count} = 2.928485$ is greater than t_{table} with a significant level of 0.05, which is 2.144787. In the results of the study, the average level of student self-efficacy decreased. This can be caused by several influencing factors because in the results of the data obtained there are several students who experience an increase in the level of self-efficacy. Among the influencing factors, students are not accustomed to working on ill-structured math problems type, according to information from teachers who teach students often get math problems that only have one type of answer. From that situation, students who were given ill-structured math problems needed more scaffolding. This is in accordance with research by Cho & Kim (2020) which states that the provision of scaffolding can help in the process of solving ill-structured math problems. The next factor is that there is unexpected treatment carried out on the sidelines of the study. The treatment is giving math test results which can have an impact on the psychological

condition of students. This condition is one of the factors that affect the level of student self-efficacy (Alifia & Rakhmawati, 2018; Bandura, 2010; Siegle, D.: MCCoach, 2007).

b. There is no effect of giving well-structured math problems to students' self-efficacy levels

In the class given the well-structured problem, the value of t_{count} = 0.176634 is smaller than t_{table} with a significant level of 0.05, which is 2.131450. In the research results obtained the average level of self-efficacy tends to remain. When collecting data, students who were given well-structured math problems needed less scaffolding than students who were given ill-structured math problems. Based on this, it can be stated that students are used to working with these types of questions, so it does not have much effect on changes in students' self-efficacy levels.

c. There is a significant difference in the change in self-efficacy between students who are given ill-structured math problems and students who are given well-structured math problems

The difference in these changes states that the level of self-efficacy of students who are given well-structured math problems is higher than students who are given ill-structured math problems. The difference in changes in self-efficacy between the experimental class and the control class, the value of t_{count} = -5.01841 is smaller than t_{table} with a significant level of 0.05, which is 2.045230. This change in difference is caused because one of the types of questions given is rarely obtained by students. Students are more accustomed to getting questions with one type of answer (well-structured problem) while in the experiments carried out there are questions that have several types of answers (ill-structured problems) so that it affects the psychological condition of one of the experimental classes which has an impact on changes in the level of self-efficacy student.

Based on some of these statements, it can be restated that there are differences in changes in the level of self-efficacy between students who are given ill-structured math problems and well-structured math problems. The data obtained states that the average self-efficacy of students who are given ill-structured math problems has decreased, while the average self-efficacy of students who are given well-structured math problems tends to remain. This is inconsistent with the initial hypothesis which states that giving math problems ill-structured problems can increase students' self-efficacy levels. Previous research stated that learning with an ill-structured problem approach can improve students' mathematical abstraction skills (Hong & Kim, 2016) and can improve students' mathematical abilities (Cho & Kim, 2020), while the results of the research conducted stated the opposite, namely a decrease in the average level of student self-efficacy when given math problems with ill-structured problems. However, this cannot be generalized completely because there are some students who experience an increase in the level of self-efficacy. The possibility of this happening is caused by other factors that can affect students' self-efficacy levels, such as the experience of having success, the experience of observing other people's performance, verbal persuasion, and students' emotional and physiological conditions (Alifia & Rakhmawati, 2018; Bandura, 2010; Siegle, D.: MCCoach, 2007).

Even though the provision of ill-structured math problems affects the decrease in the average level of students' self-efficacy, it is recommended that these questions be given to students. Because based on several previous studies, the type of ill-structured problem can improve students' mathematical abilities (Cho & Kim, 2020). In addition, in the research conducted, there were several students who experienced an increase in their level of self-efficacy after being given an ill-structured math problem. So it will better if the ill-structured math problems are given alternately with the well-structured math problem so that students are more accustomed to solving these types of problems and can improve students' mathematical abilities.

4. Conclusion

Based on the results of the analysis and discussion, several conclusions can be drawn including: 1) there is an influence between the provision of ill-structured math problems on students' self-efficacy. In the class given the ill-structured problem, the value of t_{count} = 2.928485 is greater than t_{table} with a significant level of 0.05, which is 2.144787; 2) there is no effect between the provision of wel-structured math problems on students' self-efficacy. In the class given the well-structured problem, the value of t_{count} = 0.176634 is smaller than t_{table} with a significant level of 0.05, which is 2.131450; 3) there is a difference in students' self-efficacy changes between giving ill-structured math problems and well-structured math problems. The level of self-efficacy of students

who are given an ill-structured math problems is less than the level of self-efficacy of students who are given a well-structured math problems. The difference in changes in self-efficacy between the experimental class and the control class, the value of t_{count} = -5.01841 is smaller than t_{table} with a significant level of 0.05, which is 2.045230. The difference in changes in the level of self-efficacy is caused by ill-structured math problems that are rarely encountered by students so that students feel foreign and have quite a lot of difficulty in working on the questions. Based on the research results obtained, there are some suggestions from this study including: 1) further research should pay more attention to the condition of the students during the treatment period. Try not to get other factors that students get, for example giving unsatisfactory student learning outcomes with poor teacher feedback, because this can affect students' self-efficacy levels; 2) It is recommended that in giving ill-structured problem questions the teacher provides more scaffolding or verbal persuasion and more encouragement for improvement than when giving well-structured problem questions so that the level of student self-efficacy does not decrease and can still increase the level of students' mathematical abilities; 3) further research should provide guidance and steps for solving ill-structured problems at the beginning of giving questions so that students can more easily understand and solve ill-structured math problems given at the next meeting.

References

Alifia, N. N., & Rakhmawati, I. A. (2018). Kajian kemampuan self-efficacy matematis siswa dalam pemecahan masalah. *Jurnal Elektronik Pembelajaran Matematika*, 05(1), 44–54. Retrieved from https://jurnal.uns.ac.id/jpm/article/view/26024/18242

Ayotola, A., & Adedeji, T. (2009). The relationship between mathematics self-efficacy and achievement in mathematics. *Procedia - Social and Behavioral Sciences*, 1(1), 953–957. https://doi.org/10.1016/j.sbspro.2009.01.169

Bandura, A. (2010). *Self-efficacy and educational development. In Self-Efficacy in Changing Societies*. United Kingdom: Cambridge University Press. https://doi.org/10.1017/cbo9780511527692.009

Cho, M. K., & Kim, M. K. (2020). Investigating elementary students' problem solving and teacher scaffolding in solving an Ill-structured problem. *International Journal of Education in Mathematics, Science and Technology*, 8(4), 274–289. https://doi.org/10.46328/IJEMST.V8I4.1148

Goel, V. (1992). *Comparison of Well-Structured & Ill-Structured Task Environments and Problem Spaces*. Fourteenth Annual Conference of the Cognitive Science Society, (January 1992).

Hendriana, H., & Soemarmo, U. (2014). *Penilaian Pembelajaran Matematika*. Bandung: PT Refika Aditama.

Hong, J. Y., & Kim, M. K. (2016). Mathematical abstraction in the solving of ill-structured problems by elementary school students in Korea. *Eurasia Journal of Mathematics, Science and Technology Education*, 12(2), 267–281. https://doi.org/10.12973/eurasia.2016.1204a

Ibda, F. (2015). Perkembangan Kognitif: Teori Jean Piaget. *Intelektualita*, 3(1), 242904.

Kesumawati, N., Retta, A.M., & Sari, N. 2018. *Pengantar Statistika Penelitian*. Depok: Rajawali Pers.

Lunenburg, F. C. (Sam H. S. U. (2011). Self-Efficacy in the Workplace: Implications for Motivation and Performance. *International Journal Of Management, Business, And Administration*, 14(1), 552–557. https://doi.org/10.1177/216507999103901202

May, D. K. (2009). *Mathematics Self-Efficacy and Anxiety Questionnaire*. Universitas Georgia.

Putrawangsa, S., & Hasanah, U. (2022). Analisis Capaian Siswa Indonesia Pada PISA dan Urgensi Kurikulum Berorientasi Literasi dan Numerasi. *Jurnal Studi Pendidikan Dan Pembelajaran, EDUPEDIKA*, 1(1), 1–12.

Sahendra, A., Budiarto, M. T., & Fuad, Y. (2018). Students' Representation in Mathematical Word Problem-Solving: Exploring Students' Self-efficacy. *Journal of Physics: Conference Series*, 947(1), 0–5. https://doi.org/10.1088/1742-6596/947/1/012059

Siegle, D.: MCCoach, D. B. (2007). Increasing Student Mathematics Self-efficacy Through Teacher Training. *Journal of Advance Academics*, 18(2), 278–312.

Toy, S. (2007). *Online ill -structured problem-solving strategies and their influence on problem-solving performance*. ProQuest Dissertations and Theses, 120. Retrieved from https://search.proquest.com/docview/304858126?accountid=10673%0Ahttp://openurl.ac.uk/redirect/athens:edu/?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&genre=dissertations+%26+theses&sid=ProQ:ProQuest+Dissertations+%26+Theses+Global&at

Ulandari, A. R. P., Hudiono, B., & Bistari, B. (2015). Kemampuan representasi matematis menyelesaikan soal open-ended menurut tingkat kemampuan dasar materi segiempat di smp. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa*, 04(6), 1–10.

Yee, F. P. (2002). *Using Short Open-ended Mathematics Questions to Promote Thinking and Understanding*. Proceedings of the 4 Th

International Conference on The Humanistic Renaissance in Mathematics Education, Palermo, Italy., 135–140. Retrieved from http://math.unipa.it/~grim/SiFoong.PDF

Zimmerman, B. J. (2000). Self-Efficacy: An Essential Motive to Learn. *Contemporary Educational Psychology*, 25(1), 82–91. https://doi.org/10.1006/ceps.1999.1016