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IMPROVING STUDENTS' PROBLEM-SOLVING SKILL BY USING E-SCAFFOLDING DURING INQUIRY-BASED LEARNING

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ABSTRACT

Abstract: The purpose of this study was to analyze the effect of e-scaffolding on Newton's law material on student's problem-solving abilities. This research uses a mixed method type of explanatory design. Subjects in this study were 71 students of class X natural science program Senior High School 5 Malang, 35 students as the experimental group and 36 students as the comparison group. The results showed that the problem solving ability of student who received inquiry learning using e-scaffolding was 62.11 higher than students who learned using the usual method of 47.15. E-scaffolding conceptual-procedural provided helps students understand the concept of Newton's law which guides and directs them to find solutions to a problem.

INTRODUCTION

Problem-solving skills are essential to all scientific areas (Docktor et al., 2015). As a scientific field, physics demands students to possess problem-solving skills. As stated by (Hegde, 2012; Rampho et al., 2018), an important objective of learning physics is to ensure that students can effectively absorb the content and apply their knowledge to assess the most recent physics problems; one approach to achieve this is by teaching students' problem-solving abilities. According to (Docktor & Mestre, 2014), one of the primary goals of learning physics is to enable students grasp the fundamental ideas of physics in sufficient depth to be able to use them when solving issues.

The ability to solve problems is one of the fundamental talents that must be taught to children. Problem-solving abilities aid in the development of self-worth and foster a strong feeling of community among students. Problem-solving ability is a logical and methodical intellectual process that assists individuals in identifying and selecting the optimal answer for a given set of circumstances (Ahghar, 2012). A person with problem-solving skills is able to think logically, analytically, and creatively (Seyhan, 2015, Syafii & Yasin, 2017; Syukri et al., 2018).

Students' problem-solving skills will be diminished if they continue to struggle with concept comprehension. The ability to solve difficulties after discovering the underlying concept is one of the traits of a skilled problem solver (S. Lin & Singh, 2011). After identifying the underlying concept, students can use their grasp of the concept to solve issues (Docktor et al., 2016).

The study's findings (Trowbridge & McDermott, 1981) revealed that pupils still struggled to comprehend acceleration and force in one-dimensional motion and beyond (Reif et al., 2009). According to (Reiner, 2000), students continue to make errors in their comprehension of Newton's third law about the concept of action-reaction force because they do not fully comprehend object interactions. Students typically grasp in physics courses (Hestenes et al., 1992) that an item travelling at a constant speed exerts a resultant force in that direction. Students believe that the force exerted on an object must remain with the thing; otherwise, the object cannot move.

Students' problems with Newton's law topic can be resolved by utilizing the inquiry learning methodology, which is consistent with the topic's qualities. The teacher gives phenomena or problems that direct students to create problem formulations, condition students to determine and control variables, conduct experiments, assess experimental data, and identify variables to be further examined (Wenning et al., 2011). Students are able to construct their own understanding of their relationships with the environment, with other individuals, and with the phenomena they observe when the inquiry learning approach is implemented (Ku, 2014).

Utilizing scaffolding is one technique to maximize inquiry learning thus students can apply the underlying concepts to problem-solving. Scaffolding is a strategy including the provision of aid to overcome obstacles in the learning process and the development of necessary skills (T. Lin et al., 2012). Beginning with substantial scaffolding help, it is gradually reduced as students learn to become competent science actors (Eslinger et al., 2008). The purpose of scaffolding in learning is to support the task by directing, training, and modeling the learning process; assisting students in planning, predicting, and evaluating assignments; and adjusting the level of complexity of student tasks.

Because one-to-one scaffolding is the best type of scaffolding, one-to-one scaffolding is used to provide scaffolding (Belland & Evidence, 2017). However, the implementation of one-to-one scaffolding ran into hurdles, particularly teachers' inability to communicate with each student. Consequently, the provision of scaffolding is suboptimal. So, employing alternate computer-based scaffolding in which scaffolding is delivered via a website page that students may visit from anywhere, and scaffolding can be provided individually.

Utilizing a well-designed website can improve students' science motivation and comprehension (Mistler-Jackson & Songer, 2000). According to the findings of another study, online debates can increase students' critical thinking and higher order thinking skills (Pisutova-gerber & Malovicova, 2009). According to (Macgregor & Lou, 2004), the scaffolding and web design he created facilitated the acquisition of student information.

To ascertain students' physics proficiency, several earlier research on scaffolding and inquiry learning were carried out. Andrini, (2016) asserts that because students are taught to be fearless in their attempts to share their opinions and knowledge, inquiry learning might enhance students' problem-solving skills. According to research by Richardson, (2008), learning scaffolding improved the reasoning skills of American high school students. The utilization of integrated learning with e-scaffolding improves students' capacity for scientific explanation (Oktavianti et al., 2018). Also, according to study Koes-h et al., (2019), students' problem-solving skills improve as a result of hybrid learning with e-scaffolding.

Although previous studies have looked into inquiry learning, procedural scaffolding, conceptual scaffolding, and e-scaffolding, no research has looked into the effects of combining inquiry learning, procedural scaffolding, conceptual scaffolding, and e-scaffolding on students' problem-solving abilities when it comes to Newton's law material. This study's conceptual-procedural scaffolding is available on a website. For example, there is a concept map display relating to Newton's law material and answer possibilities that influence the maturity of students' concepts for conceptual scaffolding. Instructions or a set of steps presented to students in detail to address a problem (Macgregor & Lou, 2004) and Vee diagrams are examples of procedural scaffolding. Materials, simulations, animations, experiments, phenomena, applications, example questions, practice questions, and questions regarding Newton's law are also available on the website. The use of conceptual and procedural e-scaffolding concepts to inquiry learning is supposed to train and develop students' problem-solving abilities, allowing learning objectives to be met. A qualitative investigation of student learning behavior, the development of students' mindsets, and the impact of changing students' attitudes on their capacity to solve issues was also undertaken in this study.

METHOD

This study employed a combination of quantitative and qualitative methods (mixed methods). The design used in this quantitative study was a quasi-experimental type of non-equivalent control group design. The subjects were selected using cluster random sampling technique. It enrolled 71 students of class X IPA SMA Negeri 5 Malang. The experimental group consisted of 35 students, while the control group consisted of 36 students. In the control group, learning was carried out as is usually done where the teacher gave an explanation of the lesson directly to students, as well as simple demonstration activities shown by the teacher with the help of students. In the experimental group, learning was carried out using conceptual-procedural e-scaffolding in inquiry learning with the same learning time span as the control group. The experimental group's learning began with an online quiz that results in a concept map feedback, which is a type of conceptual e-scaffolding. The students then moved on to the observation stage, when they were provided with phenomena, before moving on to the manipulation stage, where they were asked to devise techniques to explain the phenomena. Students collected data, conducted discussions, and gave presentations during the generalization and verification step. When they run into problems, they used the online student worksheet to get procedural e-scaffolding assistance. The application step was the final level, in which students were given practice questions on a website page. Students were provided conceptual e-scaffolding in the form of guided questions and answer options to assist them solve problems when working on this problem-solving capacity.

Several devices were used to gather quantitative and qualitative data. Using two types of testing, namely initial ability tests and problem solving tests, quantitative data was collected. ANCOVA technique was used to assess quantitative data, after normality, homogeneity, and linearity were examined. Interview guidelines and think aloud were used to collect qualitative data. Subjects for qualitative research were selected using a technique called purposive sampling, which comprised of five experimental group students with the highest problem-solving ability test score.

Students' problem-solving skills are evaluated based on five stages of problem-solving: 1) informative descriptions, 2) physics approach, 3) particular application of physics, 4) mathematical techniques, and 5) advancement in logical reasoning. The following table provides a full description of each stage.

Table 1. Problem Solving Stages

Problem Solving Stages	Explanation
Useful Description	Assessing students' ability to organize information from a given problem into an appropriate representation (summarizing important information symbolically, visually, or in writing)
Physics Approach	Assessing students' ability to choose the right concepts and principles of physics to solve problems

Specific Application of Physics	Assessing students' ability to apply concepts and principles of physics to the specific conditions of the given problem
Mathematical Procedure	Assessing students' ability to execute the main solution by using appropriate mathematical procedures and following the rules of math work for students solve the given problem
Logical Progression	Assessing students' ability to communicate students' reasoning abilities, stay focused on goals, and are able to evaluate the resulting solutions consistently

Adapted from Docktor, (2009)

Furthermore, students' problem-solving skills are categorized into two, namely expert and novice. A complete explanation of the criteria for categorizing problem-solving skills can be seen in Table 2.

Table 2. Expert-Novice Summary

Expert Problem Solving	Novice Problem Solving
Categorizing problems based on physics principles (deep categorization structure)	Categorizing problems based on objects and features (the categorization structure is still on the surface)
Having knowledge of physical principles that are stored as schematics that include procedures and conditions for them to apply them	Not able to connect their physics knowledge with procedures to apply it (does not have the ability to connect or are able to connect but are weak)
Writing a brief detailed qualitative analysis (or basic description) of a problem before writing the equation	Started solving problems by writing mathematical equations
Having a strategy to monitor progress when solving problems and evaluating answers	Frequently encounter an obstacle when solving problems
Able to generalize key features and methods to generate solutions to problems	Having difficulty in abstracting similar problems

Adapted from Docktor*, (2009)*

RESULTS

Quantitative Data

The problem-solving skills of the students in the two groups varied. Students that utilize conceptual-procedural e-scaffolding have an average problem-solving skill of 62.11, with a standard deviation of 9. In contrast, the mean score for students in the control group who followed the typical educational paradigm was 47.15 with a standard deviation of 12.03. These results imply that the experimental group's problem-solving skill is superior to that of the control group. Table 3 provides an overview of the outcomes of the first ability test and problem solving for both groups.

Table 3. Summary of Initial Ability Test Results and Problem Solving

Data	Group	Total of students	Variable Average	Standard Deviation
Initial test	Experimental	35	40.53	11.36
	Control	36	33.64	8.37
Problem Solving test	Experimental	35	62.11	9.94
	Control	36	47.15	12.03

Figure 1 below displays the outcomes of the problem-solving skills test at each level of the problem-solving stage.

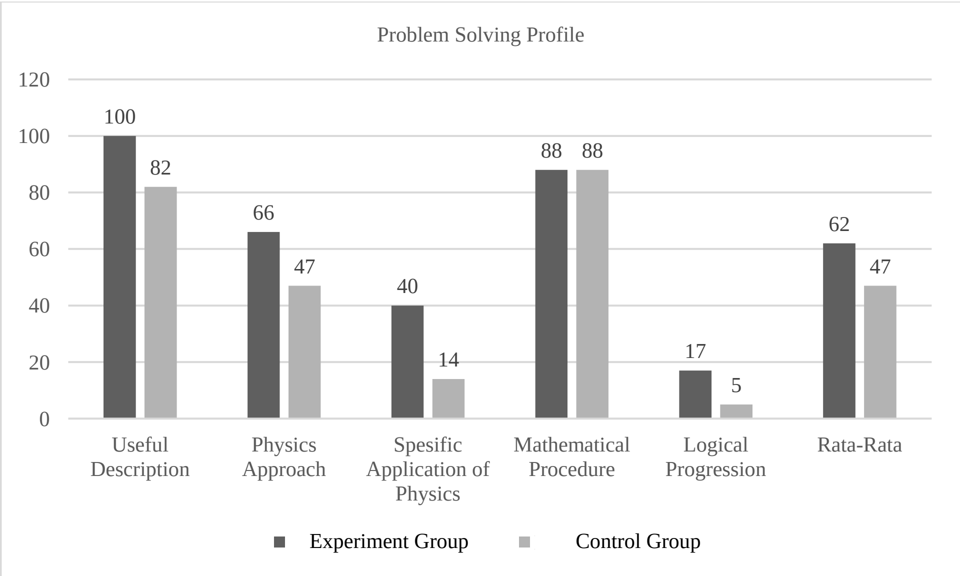

Figure 1. The difference in the score of each stage and the average problem-solving ability of experimental and control class students

Before examining the difference in problem-solving ability between the experimental and control groups, a normality and homogeneity test demonstrated that the data were normally distributed and homogeneous, respectively. The normality test results of the initial ability test and the problem-solving ability test are summarized in Table 4, while the homogeneity test results of the initial ability test and the problem-solving ability test are summarized in Table 5.

Table 4. Normality testing of initial test and problem-solving test

Data	Group	*Saphiro-Wilk*		
		Statistic	df	*sig.*
Initial test	Experimental	.958	35	.196
	Control	.955	36	.153
Problem solving test	Experimental	.988	35	.954
	Control	.945	36	.075

Table 5. Homogeneity testing of initial test and problem-solving test

Data	Levene Statistic	df_1	Df	sig.
Initial test	3.158	1	69	.080
Problem solving test	.321	1	69	.573

The average difference test of problem solving ability was carried out by ANCOVA. The summary of the results of the analysis of covariance is in Table 6. below.

Table 6. Summary of ANCOVA test of both test

Source	Type III Sum of Squares	Df	Mean Square	F	sig.	Partial Eta Squared
Corrected Model	4141.312[a]	2	2070.656	16.991	.000	.333
Intercept	11720.855	1	11720.855	96.176	.000	.586
Model/ Intervention	3201.413	1	3201.413	26.269	.000	.279
Initial test score	98.339	1	98.339	.807	.372	.012
Error	8287.054	68	121.868			
Total	225009.000	71	225009.000			
Corrected Total	12019.887	70	12019.887			

Qualitative Data

To supplement the quantitative data, semi-structured interviews were conducted with five students from the experimental group who were influenced by the treatment. In general, these five students felt that the information supplied aided their problem-solving attempts. The inclusion of procedural e-scaffolding in the form of Vee diagrams, guiding questions, statements, suggestions, and other learning tools on online worksheets aids them in doing experiments. In addition, conceptual questions and response choices a-b are provided at each phase of problem solving to assist students in constructing concepts and solving issues. This support in the form of conceptual questions and answer alternatives is known as conceptual e-scaffolding. Beginning with useful description indications, physics approach, specialized application of physics, mathematical processes, and logical progression, this guidance is supplied.

The value produced from the outcomes of data analysis is insufficient to indicate the level of problem-solving skills possessed by pupils; therefore, classification is required. The level of students' problem-solving ability is separated into two categories: expert and beginner. Table 7 displays the results of the classification of students' problem-solving skills.

Table 7. Problem solving classification of both groups

Group	Level	Total of students	Percentage
Experimental	*Expert*	10	28.57 %
	Novice	25	71.42 %
Control	*Expert*	1	2.77 %
	Novice	35	97.22 %

DISCUSSION

Problem Solving

Table 7 demonstrates that the experimental group possesses a higher level of problem-solving skill than the control group. However, the majority of students in the experimental group were at the novice or beginner level of problem-solving, whereas only one student in the control group achieved the expert or reliable level. According to research (Handono et al., 2020), the majority of students fall into the category of novices, while only a small percentage fall into the category of experts. The findings of this study are consistent with these findings. This level discrepancy is possible for numerous reasons, one of which is that students do not comprehend the underlying physics concept.

Achievement of Problem Solving Ability Stages

The lowest level of problem-solving accomplishment in this study is logical progression, whereas the highest level is meaningful description. This demonstrates that the majority of pupils are just able to identify the problem and cannot apply logical reasoning to it. According to research (Handono et al., 2020), there are four types of novices: those who can only represent problems; those who can represent problems and choose the appropriate concept; those who can represent problems, choose appropriate concepts, and connect objects, concepts with physical principles; and those who cannot represent problems, cannot choose appropriate concepts, and cannot connect objects, concepts with physical principles.

The mathematical approach was learned by both the experimental and control groups with the identical profile. The stages in which the control and experimental groups differ significantly are the helpful description, physics approach, specific application of physics, and logical advancement. At the stage of physics approach and specific application of physics, the profile of the experimental group is higher than that of the control group. This is consistent with the statement (Heyworth, 1999) that students who have a strong grasp of concepts and make no procedural errors are dependable problem solvers or experts.

Differences in Problem Solving Ability

Table 3 demonstrates that the problem-solving abilities of the experimental group were considerably different from those of the control group. The experimental group was able to apply previously learned principles when addressing issues. Consequently, it is evident that conceptual-procedural e-scaffolding in inquiry learning might enhance students' problem-solving skills. The findings of this study are confirmed by research (Yu, 2013) indicating that online procedural scaffolding has a good impact on students. Students are assisted in conducting experiments through the use of e-scaffolding in the form of online worksheets. The supply of the initial conceptual e-scaffolding in the form of a concept map following a pre-learning quiz was able to aid students in mapping their mindsets and in the process of interpreting experimental outcomes. Students can also use this concept map to solve problems, particularly during the second problem-solving step, the physics method. The supplied concept map enables students to comprehend the link between factors related to the subject matter being taught. This claim is reinforced by (Donnell et al., 2002), which demonstrates that concept maps enable students to remember and comprehend concepts better than reading textbooks alone, and assist students with inadequate verbal skills or knowledge in recalling previously learned concepts.

While the second style of conceptual e-scaffolding consists of providing questions and answer options a-b at each problem-solving stage. Students are given a choice of solutions, one of which demonstrates the proper notion; with this assistance, they are able to exercise their abilities to the utmost extent. Similarly, (Koes-h et al., 2019) shown that the presence of e-scaffolding in hybrid learning improved students' problem-solving skills. According to Ratnasari (2019), scaffolding-based learning enhanced students' scientific reasoning skills.

The inquiry learning paradigm stresses an exploration process that is effective for gathering evidence and explanations regarding scientific phenomena (Khalaf et al., 2018) and for helping students to think rationally, critically, and methodically. Therefore, conceptual-procedural e-scaffolding in inquiry learning can affect problem-solving abilities due to procedural e-scaffolding in the form of Vee diagrams and prompts on the website, which can help students collect information about material concepts in order to complete tasks or solve problems that arise. offered by examining the notion of the underlying material and providing a sound scientific explanation. The value of students who use procedural scaffolding is higher than that of students who do not utilize procedural scaffolding, according to research published by Yu (2013). In the meanwhile, e-scaffolding consists of concept maps and questions with a-b answer options. Conceptual scaffolding can assist students in narrowing, selecting, and comprehending found material (Belland & Evidence, 2017). Even conceptual scaffolding in problem-based experiments can help students retain and comprehend more concepts from the experiments performed and provide more creative and focused final presentations (Macgregor & Lou, 2004).

According to the findings (Richardson, 2008), scaffolding helps improve the scientific argumentation skills of American high school pupils. According to Hsu et al. (2014), scaffolding facilitates the investigation and development of a concept's understanding. Similarly, inquiry-based learning activities begin with observation, manipulation, verification, generalization, and application, particularly in the application step. At this stage, students are presented with a variety of online problem-solving questions. Providing practice questions include introducing questions, answer options, and providing feedback. According to the findings of the study (Lindstrm & Sharma, 2009), the provision of scaffolding had a positive effect on the problem-solving skills of students compared to students who did not receive scaffolding. According to (Macgregor & Lou, 2004), the scaffolding and website he created supported the development of student information. E-scaffolding is also capable of enhancing pupils' scientific explaining abilities (Oktavianti et al., 2018).

CONCLUSION

In each level of the inquiry learning model, beginning with observation, manipulation, verification, and generalization, conceptual-procedural e-scaffolding is introduced. The given conceptual-procedural e-scaffolding can aid pupils in practicing their problem-solving abilities. Alternating conceptual-procedural e-scaffolding is offered. The first instance was conceptual e-scaffolding in the form of a concept map as a return activity when students completed the quiz prior to the session. Then, the provision of procedural e-scaffolding for students to practice with LKS in the form of Vee diagrams and prompts. Problem-solving abilities are mostly trained during the application phase, where students are provided with questions and answer options to help train their problem-solving skills. On each indicator of students' problem-solving abilities, valuable problem-solving ability problems and answers are provided for pupils. The supply of conceptual-procedural e-scaffolding has a positive effect on the experimental group's problem-solving abilities.

REFERENCES

Ahghar, G. (2012). Auto-regulation learning of High School Students in Tehran. *Procedia - Social and Behavioral Sciences*, *69*(Iceepsy), 688–694. https://doi.org/10.1016/j.sbspro.2012.11.462

Andrini, V. S. (2016). The Effectiveness of Inquiry Learning Method to Enhance Students ' Learning Outcome : A Theoritical and Empirical Review. *Journal of Education and Practice*, *7*(3), 38–42.

Belland, B. R., & Evidence, E. (2017). *Instructional Scaffolding in STEM Education*.

Docktor, J. L. (2009). *Development and Validation of a Physics Problem-Solving Assessment Rubric* (Nomor September).

Docktor, J. L., Dornfeld, J., Frodermann, E., Heller, K., Hsu, L., Jackson, K. A., Mason, A., Ryan, Q. X., & Yang, J. (2016). *Assessing student written problem solutions : A problem-solving rubric with application to introductory physics*. *010130*, 1–18. https://doi.org/10.1103/PhysRevPhysEducRes.12.010130

Docktor, J. L., & Mestre, J. P. (2014). Synthesis of discipline-based education research in physics. *Physical Review Special Topics - Physics Education Research*, *10*(2), 1–58. https://doi.org/10.1103/PhysRevSTPER.10.020119

Docktor, J. L., Strand, N. E., Mestre, J. P., & Ross, B. H. (2015). *Conceptual problem solving in high school physics*. *020106*, 1–13. https://doi.org/10.1103/PhysRevSTPER.11.020106

Donnell, A. M. O., Dansereau, D. F., & Hall, R. H. (2002). *Knowledge Maps as Scaffolds for Cognitive Processing*. *14*(1), 71–72.

Eslinger, E., White, Æ. B., & Frederiksen, Æ. J. (2008). *Supporting Inquiry Processes with an Interactive Learning Environment : Inquiry Island*. 610–617. https://doi.org/10.1007/s10956-008-9130-6

Handono, S., Prastowo, B., Rahayu, M. P., & Jember, U. (2020). *Karakteristik Kemampuan Siswa SMA Dalam Menyelesaikan Well dan Ill Structured Problems Pada Pembelajaran Fisika*. *6*(1).

Hegde, B. (2012). *How do they solve it ? An insight into the learner ' s approach to the mechanism of physics problem solving*. *010109*, 1–9. https://doi.org/10.1103/PhysRevSTPER.8.010109

Hestenes, D., Wells, M., & Swackhamer, G. (1992). *Force concept inventory*. *141*. https://doi.org/10.1119/1.2343497

Hsu, Y., Lai, T., & Hsu, W. (2014). *A Design Model of Distributed Scaffolding for Inquiry-Based Learning*. *88*. https://doi.org/10.1007/s11165-014-9421-2

Khalaf, B. K., Academy, L., Bt, Z., Zin, M., & Academy, L. (2018). *Traditional and Inquiry-Based Learning Pedagogy : A Systematic Critical Review. 11*(4), 545–564.
Koes-h, S., Suwasono, P., & Pramono, N. A. (2019). *Efforts to improve problem solving abilities in physics through e-scaffolding in hybrid learning Efforts to Improve Problem Solving Abilities in Physics Through E-scaffolding in Hybrid Learning. 030006*(March). https://doi.org/10.1063/1.5094004
Ku, K. Y. L. (2014). *HKBU Institutional Repository Integrating direct and inquiry-based instruction in the teaching of critical thinking : An intervention study. 42*, 251–269.
Lin, S., & Singh, C. (2011). *Using isomorphic problems to learn introductory physics. 020104*(March), 1–16. https://doi.org/10.1103/PhysRevSTPER.7.020104
Lin, T., Hsu, Y., Lin, S., Changlai, M., Yang, K., & Lai, T. (2012). *A review of empirical evidence on scaffolding for science education. October 2011*, 437–455. https://doi.org/10.1007/s10763-011-9322-z
Lindstrøm, C., & Sharma, M. D. (2009). *Link maps and map meetings : Scaffolding student learning. January*, 1–11. https://doi.org/10.1103/PhysRevSTPER.5.010102
Macgregor, S. K., & Lou, Y. (2004). *Web-Based Learning : How Task Scaffolding and Web Site Design Support Knowledge Acquisition. 5191*, 161–175.
Mistler-jackson, M., & Songer, N. B. (2000). *Student Motivation and Internet Technology : Are Students Empowered to Learn Science ? 37*(5), 459–479.
Oktavianti, E., Handayanto, S. K., & Saniso, E. (2018). *Jurnal Pendidikan IPA Indonesia STUDENTS ' SCIENTIFIC EXPLANATION IN BLENDED PHYSICS LEARNING WITH E-SCAFFOLDING. 7*(2), 181–186. https://doi.org/10.15294/jpii.v7i2.14232
Pisutova-gerber, K., & Malovicova, J. (2009). *Critical and Higher Order Thinking in Online Threaded Discussions in the Slovak Context. 10*(1).
Rampho, G. J., Ramorola, M. Z., Sutarno, S., Setiawan, A., Saleh, H., Suryadi, D., & Dahlan, J. A. (2018). *The profile of students ' problem-solving skill in physics across interest program in the secondary The profile of students ' problem-solving skill in physics across interest program in the secondary school.*
Ratnasari, D. (2019). *JPBI (Jurnal Pendidikan Biologi Indonesia) Empowering scientific thinking skills through creative problem solving with scaffolding learning. 5*(1), 61–68.
Reif, F., Allen, S., & Reif, F. (2009). *Cognition for Interpreting Scientific Concepts : A Study of Acceleration Cognition for Interpreting Scientific Concepts : A Study of Acceleration. February 2015*, 37–41. https://doi.org/10.1207/s1532690xci0901
Reiner, M. (2000). *Naive Physics Reasoning : A Commitment to Substance-Based Conceptions. March.* https://doi.org/10.1207/S1532690XCI1801
Richardson, J. C. (2008). *of evidence-based arguments among middle school students*. 401–422. https://doi.org/10.1007/s11423-007-9074-1
Seyhan, H. G. (2015). *The effects of problem solving applications on the development of science process skills , logical thinking skills and perception on problem solving ability in the science. 16*(2), 1–31.
Syafii, W., & Yasin, R. M. (2017). *Problem Solving Skills and Learning Achievements through Problem-Based Module in teaching and learning Biology in High. 9*(12), 220–228. https://doi.org/10.5539/ass.v9n12p220
Syukri, M., Soewarno, S., Halim, L., & Mohtar, L. E. (2018). *Jurnal Pendidikan IPA Indonesia THE IMPACT OF ENGINEERING DESIGN PROCESS IN TEACHING AND LEARNING TO ENHANCE STUDENTS ' SCIENCE PROBLEM-SOLVING SKILLS. 7*(1), 66–75. https://doi.org/10.15294/jpii.v7i1.12297
Trowbridge, D. E., & McDermott, L. C. (1981). Investigation of student understanding of the concept of acceleration in one dimension. *American Journal of Physics*, *49*(3), 242–253. https://doi.org/10.1119/1.12525
Wenning, C. J., Ed, D., Khan, M. A., Lecturer, S., Khan, A., & Secondary, H. (2011). *Levels of Inquiry Model of Science Teaching : Learning sequences to lesson plans. 6*(2), 17–20.
Yu, F. (2013). *ascilite Effects of online procedural scaffolds and the timing of scaffolding provision on elementary Taiwanese students ' question-generation in a science class. 29*(3), 416–433.