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Appropriate Scaffolding Format in Physics Learning through Lesson Study on Improving Students' Problem Solving Skills

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ABSTRAK

Setiap materi pembelajaran memiliki bentuk scaffolding yang berbeda-beda untuk mencapai penguasaan yang maksimal. Penelitian ini bertujuan untuk menganalisis perbedaan pemecahan masalah siswa pada materi temperatur akibat scaffolding dan menemukan bentuk scaffolding yang tepat pada materi temperatur melalui lesson study terhadap pencapaian keterampilan pemecahan masalah siswa. Jenis penelitian ini adalah desain pra eksperimen dengan kelas replikasi. Instrumen yang digunakan dalam penelitian ini adalah tes uraian konversi suhu dan lembar refleksi pembelajaran. Analisis penelitian ini menggunakan SPSS Versi 17. Instrumen penelitian ini berupa tes uraian 5 soal yang valid dan reliabel dengan nilai Alpha Cronbach 0,97 dan lembar refleksi pembelajaran. Peningkatan kemampuan pemecahan masalah dianalisis berdasarkan Gain-score. Pemberian scaffolding berdampak pada perbedaan peningkatan kemampuan pemecahan masalah siswa pada materi suhu melalui lesson study. Bentuk scaffolding yang dapat meningkatkan kemampuan pemecahan masalah pada materi suhu adalah pemberian bahan ajar yang dilengkapi dengan pendekatan teknik menemonic, jeda dibuat untuk membuka pertanyaan selama proses pembelajaran, perlunya aturan tempat duduk berbentuk U untuk meningkatkan interaksi dalam satu kelompok . Saran penelitian ini perlu dilakukan interaksi antar kelompok dan membuat evaluasi dengan aplikasi digital untuk mengukur kemampuan individu dengan hasil yang cepat.

ABSTRACT

Each learning material has a different form of scaffolding to achieve maximum mastery. This study aims to analyze the differences in students' problem solving on temperature material due to scaffolding and find the right form of scaffolding on temperature material through lesson study on the achievement of students' problem solving skills. This type of research is a pre-experiment design with a replication class. The instruments used in this research are temperature conversion essay test and learning reflection sheet. The analysis of this study used SPSS Version 17. The instrument of this research is an essay test of 5 questions that are valid and reliable with an Alpha Cronbach value of 0.97 and a learning reflection sheet. The improvement of problem solving ability was analyzed based on the Gain-score. The provision of scaffolding has an impact on the difference in improving students' problem solving skills in temperature material through lesson study. The form of scaffolding that can improve problem solving skills on temperature material is the provision of teaching materials equipped with menemonic technique approach, pauses are made to open questions during the learning process, the need for U-shaped seating rules to increase interaction in one group. Suggestions for this research need to be done interaction between groups and making evaluations with digital applications to measure individual abilities with fast results.

1. INTRODUCTION

The concept in physics has a connection with other concepts. Therefore, in solving physics problems in addition to mastering the meaning or definition, other skills such as mathematical ability are needed. This is caused by the concepts that exist in physics can be translated into mathematical language (Alfika & Mayasari, 2018; Diani, 2015). The results of the national exam evaluation of various subjects tested by physics students occupy the second rank from the bottom. It is indicated that physics is one of the subjects that is difficult to prove students are unable to solve the problems that have been given (Ikhwanuddin, 2010; Sumarsih et al., 2018). Students' inability to solve physics problems is due to a lack of conceptual deepening and ignorance of the information presented in the problem and errors in the use of principles or procedures in solving the problems presented.

The problem-solving ability cannot grow naturally, so students need to be trained on how to solve each problem given. Students need to know the right strategies and methods for each problem presented, because each problem has a different character to solve. Thus problem solving ability is

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identical to the ability to think critically, creatively (Febriyanti & Irawan, 2017; Giselsson, 2020; Isnaeni et al., 2018). Problem solving skills can be practiced during learning. Teachers need to ensure that students have mastered the concept through the arrangement of various learning resources such as books, modules, real media, interactive media and even nature learning (Mubarrok & Mulyaningsih, 2014; Sari et al., 2017). The achievement of learning objectives that have been set through the interaction of students with teachers, if there are students who have difficulty in the achievement then the teacher needs to prepare scaffolding to students (Badriyah et al., 2017; Xun & Land, 2004).

The idea of scaffolding conceptualized by Vigotsky was originally carried out in informal activities. These activities are in the form of assistance from adults to a child who has difficulty solving problems in the form of knowledge or adaptation to the environment (Kusmaryono et al., 2021; Reiser, 2022). Next, scaffolding continues to develop and is carried out in the realm of learning. Scaffolding activities focus on how the teacher's ability to create learning strategies so that students are able to link their prior knowledge to acquire new knowledge (Purawati et al., 2016; Sidin, 2016). The initial ability possessed by the learner is referred to as actual knowledge and the new ability to be mastered by the learner is referred to as potential ability.

Idea of scaffolding continues to develop even in its form scaffolding given to learners can be in the form of human scaffolding and non-human non-scaffolding. Human based scaffolders have a role to design the right learning model, create effective learning tasks, design a comfortable learning environment and continue to observe the learning process (Coltman et al., 2002; Mevarech & Fan, 2018). The next form of secaffoling is non-human based scaffolding which is in the form of media that can support the achievement of goals effectively in the form of flash cards, even making effective questions as an increase in knowledge (Davis, 2000; Sewart, 2014).

In order for the achievement of goals to be realized properly, it is necessary to pay attention to scaffoliding in the cognitive and affective domains. In the cognitive domain, an important aspect that needs to be considered is the relevance of the information to be received by students with old information they already have. Next, the importance of providing affirmation of important information from the material learned, prioritizing aspects of higher order thingkin skill and how to set the right learning strategy. Furthermore, affective aspects also need to be considered, namely the ability to create a learning atmosphere that is comfortable, enjoyable and creates a positive attitude of students to want to continue learning (Fatimah & Santiana, 2017; Saputi & Wilujeng, 2016).

Providing scaffolding in the classroom needs to be evaluated to obtain maximum results. Lesson study is very appropriate for improving the quality of learning through an evaluation system (Alrawili et al., 2022; Saputro, 2018). Lesson study is characterized by continuity between lessons to obtain learning quality and towards positive learning outcomes (Jamaluddin et al., 2019; Susyla & Syofiana, 2019). The main characteristics of lesson study learning are starting from the process of planning, observing, reflecting, discussing and even revising learning and re-implementing**.** So that lesson study is part of improving pedagogical quality and evaluating learning outcomes through student activeness (Ratnawati, 2019; Siregar et al., 2022)**.**

So far, lesson study has been used to improve student learning activities, teacher teaching skills, and student learning achievement. This research uses the type of school action research obtained the results that lesson study has a positive impact on increasing student activity, improving the quality of teacher professionalism and student learning achievement (Effendi, 2016; Waryana, 2021). Lesson study has also been applied to collaborative learning on critical thinking skills. This research with a literature study approach obtained the results that lesson study is effective in improving the quality of students and learning and has an impact on critical thinking skills (Asri, 2022; Maria Josephine Arokia Marie, 2021). Previous study found lesson study applied to PJBL learning is also proven effective to improve learning outcomes and student creativity (Suryanto & Astuti, 2018). Other study found lesson study applied to ADI learning is proven to achieve learning objectives especially students' ability in synthesis, collaboration, communication, and independence and the effectiveness of learning activities (Siregar et al., 2022). Likewise, other studies through Lesson Study Learning Community (LSLC) between students in the class are able to work well together, proven by group members who are able to help group members who are unable to solve problems (Asih et al., 2020). Thus, it has never been researched the right form of scaffolding on certain materials.

The number of types of scaffolding in the form of human scaffolding and non-human non-scaffolding, each type of scaffolding is divided into various forms will make it difficult for teachers to choose which one is right on certain materials. This research will describe what scaffolding is appropriate for the temperature material sought through lesson study and see the impact on student problem solving skills. The aims of this research is to analyze the differences in students' problem solving on temperature material

due to scaffolding and find the right form of scaffolding on temperature material through lesson study on the achievement of students' problem solving skills.

2. METHODS

This research uses a pre-experiment research design that evaluates and applies in learning activities (Khumaidah & Achmadi, 2019). The research design is as shown in Figure 1.

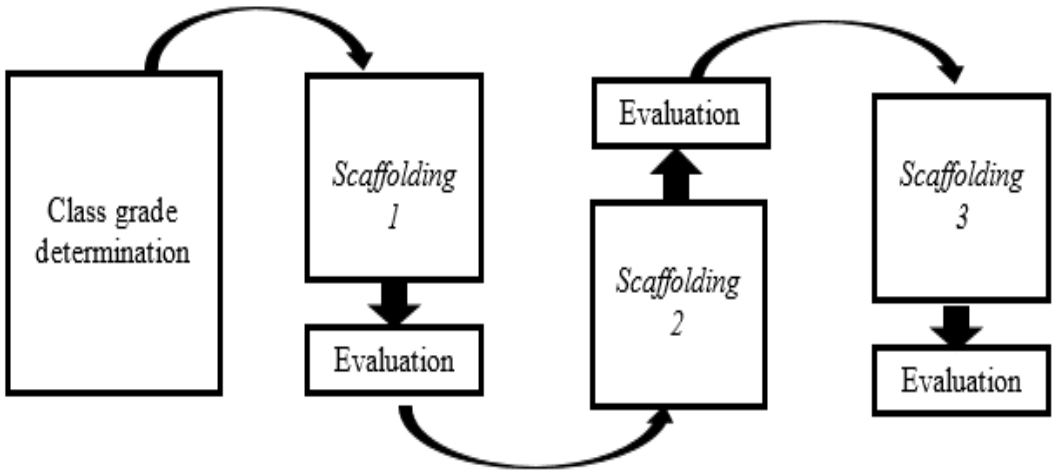

Figure 1. Desain Pre-Experiment Research

The first stage is the selection of the experimental class. The population of this study are four classes A, B, C, and D which will be selected based on the same level of problem solving ability. Of the four classes will be selected into 3 classes that have homogeneous problem solving ability conditions. The three classes will be treated with scaffolding 1, scaffolding 2, and scaffolding 3. Second stage is to conduct trials in the scaffolding 1 class. The first class to get treatment is a homogeneous class and has an earlier schedule in lectures. Face-to-face lecture activities amounted to 2 credits, namely students were given modules and lecturers explained concepts, questions and answers, quizzes and post tests.

Third stage is to conduct trials in the scaffolding class 2. The second class that gets the treatment is a homogeneous class and has a schedule after the completion of the first class. The learning design in the second experimental class has changes in scaffolding based on the evaluation results in the scaffolding 1 class. The nature of the lecture is carried out face-to-face for 2 credits, namely students are given modules and lecturers explain concepts, questions, quizzes and post tests. Fourth stage is to conduct trials in the scaffolding class 3. The third class that gets the treatment is a homogeneous class and has a schedule after the completion of the second class. The learning design in the third experimental class has changes in scaffolding based on the evaluation results in the scaffolding 2 class. The nature of the lecture is carried out face-to-face for 2 credits, namely students are given modules and lecturers explain concepts, questions and answers, quizzes and post tests.

The instrument of this research is an essay test of 5 questions that are valid and reliable with an Alpha Cronbach value of 0.97 and a learning reflection sheet (Ikhwanuddin, 2010). The improvement of problem solving ability was analyzed based on the Gain-score table as Table 1.

Table 1. N-Gain Score Improvement of Problem Solving Skills

N-Gain score	Criterion
0.70 < N-Gain	High
0.30 ≤ N-Gain ≤ 0.70	Moderate
N-Gain < 0.30	Low

The results of the calculation of the three classes will be tested using the anova test using SPSS version 7 to determine whether there is a difference in the provision of scaffolding to improve problem solving skills on temperature material.

3. RESULT AND DISCUSSION

Results

Scaffolding for each class continues to be improved so that the problem solving ability at temperature increases. The following data on the forms of scaffolding that are improved based on lesson study activities for each lesson are shown in Table 2.

Table 2. Results of Reflection on the Application of Scaffolding in Learning

Obeservation	Description of scaffolding	Result of Reflection
Scaffolding 1	**Non-Human Scaffolder** Students are given a module in the form of how to convert temperature by comparison method and contains examples of problem solving **Human Scaffolder** Lecturers design comfortable learning by pausing each material to provide opportunities for students to think. Giving questions in the form of quizzes (those who are correct get additional value scores) followed by questions and answers.	**Weaknesses** 1. Students are still passive in learning 2. There are still few students who dare to answer the quiz 3. Students still take a long time to calculate the temperature value **Advantages** 1. Providing material modules streamlines learning time 2. Giving quizzes and followed by questions and answers can measure student abilities 5. **Recommendation** It is necessary to create a learning module with mnemonic technique approach. It is necessary to make a group for the quiz given.
Scaffolding 2	**Non-Human Scaffolder** Students are given a module in the form of how to convert temperature using the comparison method and the donkey bridge equation containing examples of solving problems using mnemonic technique approach. **Human Scaffolder** Lecturers design comfortable learning by pausing each material to give students the opportunity to think. Lecturers form groups to complete quizzes followed by questions and answers.	**Weaknesses** 1. Students interact in groups to complete quizzes 2. Interaction in one group has not been maximized due to the seats between groups being far apart. **Advantages** 1. Providing material modules streamlines learning time 2. Providing modules with the help of mnemonic technique approach makes students more courageous to answer quizzes. **Recommendations** It is necessary to make a learning module with a mnemonic technique approach that needs to be maintained and there needs to be a rule of seat shape in a group in the form of the letter U.
Scaffolding 3	**Non-Human Scaffolder** Students are given a module in the form of how to convert temperature using the comparison method and the donkey bridge equation containing examples of problem solving using the mnemonic technique approach. Designing group discussions with the letter U. **Human Scaffolder**	**Weaknesses** 1. Students interact in one group only and do not want to ask questions to other groups. 2. Evaluation measurements are still in groups, so they do not measure individual abilities. **Advantages** 1. Providing material modules streamlines learning time

Obeservation	Description of scaffolding	Result of Reflection
	Lecturers design comfortable learning by pausing each material to give students the opportunity to think. Lecturers form groups to complete quizzes followed by questions and answers.	2. Providing modules with the help of completion with a menemonic technique approach makes students more courageous to answer quizzes. 3. Formation of seats with the letter U increases interaction in one group 4. **Recommendation** It is necessary to make a learning module with a menemonic technique approach and the arrangement of chairs in groups in the form of the letter U needs to be maintained. There needs to be an opportunity to ask other groups if there are difficulties in understanding the concept. It is necessary to make an individual evaluation of the material through digital applications in order to check the mastery of individual problem solving.

After completing the learning process, students are always given a post test to measure their ability to master problem solving in temperature material. The results of the post-test measurements are shown in Table 3.

Table 3. Average Ngain-Score of Problem-Solving Ability

Classes	Variables	Average	Ngain	Criterion
Scaffolding 1	Pre-test Post-test	13.7 56.2	0.56	Moderate
Scaffolding 2	Pre-test Post-test	14 67	0.63	Moderate
Scaffolding 3	Pre-test Post-test	13.1 77.2	0.73	High

Based on Table 3, it is known that in the experimental class with scaffolding 1 obtained N-Gain Score of 0.56 including in the medium category. The scaffolding 2 class obtained an N-Gain Score of 0.63 including in the medium category. scaffolding 3 obtained an N-Gain Score of 0.76 including in the high category. In the N-gain score data there is an increase in the ability of problem solving skills. The distribution of problem solving skills on temperature material for each class is shown in Figure 2.

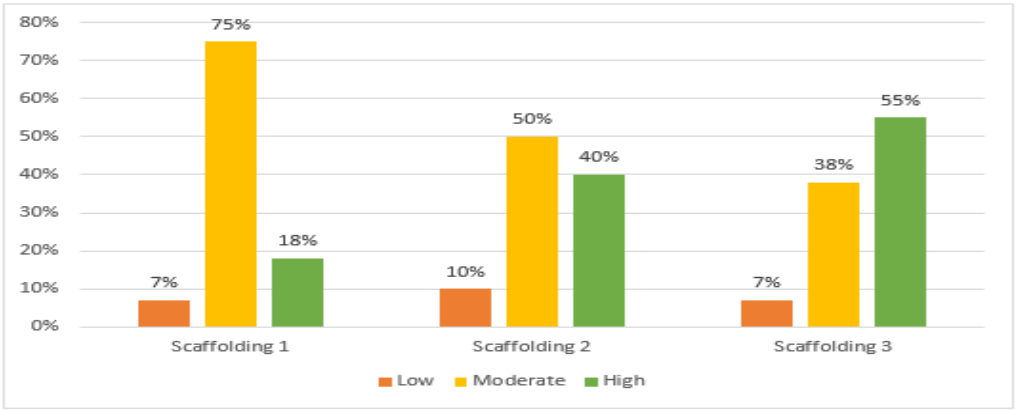

Figure 2. Distribution of Problem Solving Improvement

Based on Figure 2, problem solving ability in the low category both in scaffolding 1, scaffolding 2 and scaffolding 3 is always with the smallest percentage, which is raised 7% and 10%. While problem solving ability in the medium category decreased for scaffolding 1 by 75%, decreased to 50% in scaffolding

2 and finally scaffoloding 3 reached 38%. Problem solving ability in the high category has increased from 18% in scaffolding 1, rose to 40% in scaffolding 2 and finally increased to 55%.

Based on the results of the prerequisite test analysis, the results of the normality test of the scaffolding class one abnormal data, scaffolding class 2 normal data, and datan scaffolidng 3 abnormal data. The results of the homegenity test of the three data are not homogeneous, so the difference between the three classes using the Kruskal Wallis test is shown in Table 4.

Table 4. Results of Anova Test

Classes	Type of Anova Test	Signification	Conclussion
Scaffoding 1 Scaffoding 2 Scaffoding 3	Kruskal Wallis	0.032	There are differences

Based on Table 4 anova test using K independent samples using Kruskal Wallis obtained significance data bessar 0.032 <0.05 so it can be concluded that there is a different increase in learning with the type of scaffolding on problem solving on temperature material.

Discussion

Based on the results of the independent sample anova test using Kruskal Wallis, it shows that there are differences in problem solving skills in each class based on the provision of scaffolding (Table 4). The difference in problem solving shows an improvement in each learning activity indicated that the N-Gain value in scaffolding 1 is 0, 53 with a medium category, rising again in scaffolding 2 to 0, 63 with a medium category, rising again to 0.73 including in the high category. These results are also reinforced by the distribution of the Ngain Scor category in each class. Scaffolding 1 increased problem solving calculated using N-gain score is still dominated in the medium category. Then reflected and improved into a class with scaffolding 2 even though the increase in problem solving is still dominated in the medium category, namely 50% but in the high category experienced an increase initially in the scaffolding 1 class only reached 18% in the second scaffolding class rose to 40%. The results of the reflection continue to improve the form of scaffolding applied to the scaffolding 3 class finally the majority of students in one class problem solving is dominated in the high category. The reason for the difference is due to the scaffolding that continues to be improved based on the learning activities using lesson study. These results confirm previous research that the application of lesson study in English language learning is proven to have an effect on student learning outcomes (Effendi, 2016). In this study, the effect of learning outcomes is due to teachers getting more professional in teaching so that they know what shortcomings need to be improved so that the quality of teaching is getting better.

The increase in learning outcomes in each cycle occurred during research with the lesson study-based PJBL model (Haryadi, R., & Pujiastuti, 2022; Suryanto & Astuti, 2018). The average learning outcomes in cycle I reached 75 and increased in cycle II to 85. Likewise, ADI learning using lesson study concluded that the learning provided was effective for improving learning outcomes (Delfakhria & Solfema, 2022; Siregar et al., 2022).

The improvement of problem solving skills on temperature material obtained through lesson study is inseparable from reflective activities that produce appropriate scaffolding recommendation (Amanah et al., 2017; Saputro, 2018). In this study, there are at least three recommendations that need to be considered, namely optimizing learning media, creating a comfortable learning atmosphere, namely providing opportunities for students to ask questions, and optimizing interactions between students. The design of teaching materials including textbooks is a form of non-human scaffolder (Davis, 2000; Sewart, 2014). The initial teaching materials only contained the philosophical conversion of temperature changes between measuring instruments using only the comparison method. It is evident that students have difficulty when solving problems because the calculated numbers are still included in large numbers. When the teaching materials were added with the donkey bridge, namely using a short equation through the comparison method, students began to be interested and could solve the problem more briefly.

The use of teaching materials as scaffolding can achieve the goal of confirming the results of previous research. Giving examples of problem solving using LKP proved to be more helpful in solving problems using Polya's stages compared to students who followed conventional learning in junior high school physics subjects and very feasible to use to help improve the critical thinking ability of high school students (Asri, 2022; Suryaningsih et al., 2021). Likewise, research on the development of computer-based physics scaffolding called e-scaffolding can help improve physics problem solving (Saputi & Wilujeng, 2016).

Giving pauses and continuing to provide opportunities to ask questions to create a comfortable learning atmosphere is a form of human scaffolder. Activities like this is a form of real scaffolding. This is because secaffolding is interpreted as providing sufficient assistance to students who have difficulty in mastering the material (Coltman et al., 2002; Diani et al., 2019). By continuing to ask and provide assistance to students who are still having difficulty in doing the assignment, the student's burden will be reduced (Kamid et al., 2021; Rahmatiah & Kusairi, 2016). Based on the results of research providing direct scaffolding during the learning process has been shown to increase student knowledge (Badriyah et al., 2017). When optimizing interactions between students is a form of human scaffolding. Strengthening interaction between students begins in scaffolding class 2, namely the formation of groups and strengthened in scaffolding class 3 in addition to forming groups there is also a seat arrangement in the form of the letter U (Table 2). Scaffolding learning is an interaction between students with the aim of helping students who are experiencing difficulties (Amanah et al., 2017; Badriyah et al., 2017). As the results of previous research on analog and digital electronics courses, seating optimization can improve learning outcomes (Saputro, 2018). The increase in problem solving ability in this study at the end of scafflding or scaffolding class 3 with an average of 77.2. This means that if in the new student course curriculum it reaches a score of B +. In the future, scaffolding needs to be developed again by strengthening interaction not only with one group but can interact with other groups that have more understanding. Future research needs to make comparisons with the control class in order to get faster and more accurate results verbally. Suggestions for this research need to be made for interaction between groups and making evaluations with digital applications to measure individual abilities with fast results.

4. CONCLUSION

The provision of scaffolding has an impact on the difference in improving students' problem solving skills in temperature material through lesson study. Reflection activities on the lesson study can find the right scaffolding to improve students' problem solving skills. The form of scaffolding that can improve problem solving skills in temperature material is the provision of teaching materials equipped with menemonic technique approach, try to have a pause to open questions during the learning process, the need for seating rules in the form of the letter U to increase interaction in one group.

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