Scaffolding learning model to improve habits of mind students

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Abstract. Habits of Mind (HoM) consisting of critical thinking, creative thinking, and self-regulation to build the character of students. The course syntax of scaffolding learning model consisting of orientation phase, training, task support, conceptual and procedural scaffolding, and metacognition and strategy scaffolding was discovered. This study aims to improve habits of mind students through scaffolding learning model. The research design used qualitative and quantitative data as mixed methods analysis. This research involves 92 participants of Physics Education Students taking Waves and Optic course, 46 students in the experimental class and 50 students in the control class. The result of this research, it can be concluded that the scaffolding lecture program is effective to improve students' habits of mind.

1. Introduction

Research related to Scaffolding has been widely carried out shows the result that the scaffolding learning program can motivate student learning, encourage students to be interested in the topic being taught, improve learning outcomes, lead to optimism, confidence and appreciation from students, self - regulating learning, and risk taking [1]. If we look at the positive impacts of the scaffolding learning program, the above aspects are things that are also developed in the habits of mind [2]. Thus, it can be ascertained that there is a connection between the scaffolding learning program and habits of mind [3]. Various forms of learning models that have been discussed previously can be applied to students in developing their habits of mind.

The recommended learning solution for students is learning that gives students the opportunity to build their knowledge of mind knowledge through providing step-by-step assistance which then releases students independently to develop new concepts. The learning should 1) prioritize the process, 2) prioritize learning that is real in the relevant context, 3) instil learning in the context of social experience, and 4) be done in an effort to build experience [4]. This is in accordance with Vygotsky's theory of constructivism which emphasizes the essence of social learning culture which essentially is the application of the technique of exchanging ideas between individuals. In constructing knowledge, students or students often need scaffolding to reach the Zone of Proximal Development (ZPD). Assistance provided through scaffolding can be in the form of instructions, warnings, encouragement, describing problems to other forms that allow students to be independent [5]. Lecturer encouragement is needed so that the achievement of students to a higher level becomes optimum.

In this study developed a Wave Scaffolding and Optics Program based on scaffolding which was adapted and adopted from scaffolding learning [6] to improve habits of mind of students [7-8]. This lecture trains students' thinking habits in constructing knowledge with the guidance of people who know more in their fields so that optimal learning outcomes are obtained.

2. Methods

2.1. Data analysis techniques for implementation of scaffolding-based lectures

This analysis was conducted to answer research questions about lecture implementation by lecturers and students. The data obtained are observation data in the form of qualitative answers "yes" or "no" and observer notes. In order to calculate the category of lecture implementation, the percentage of learning activities is calculated according to the lecture syntax. The formula used is as follows:

$$PK\ (\%) = n / N \times 100\% \quad (1)$$

Information:
PK (%) : percentage of lecture implementation
n : number of activities carried out in the lecture
N : the total number of activities in the lecture

Interpretation of percentage data on lecture implementation is obtained from the results of calculations using the formula (1) used in categories as shown in Table 1.

Table 1. Categories of implementation of lectures based on scaffolding [9].

Percentage of implementation (%)	Category
0	None of the activities were carried out
0 < PK ≤ 24	A small part of the activity is carried out
25≤ PK ≤ 49	Almost all activities are carried out
50	Half the activity is carried out
51≤ PK ≤ 75	Most activities are carried out
76 ≤ PK ≤ 99	Almost all activities are carried out
100	All activities are carried out

2.2. Data analysis technique habits of mind

The purpose of this data analysis is to determine the effectiveness of scaffolding-based lectures on increasing habits of mind. Increasing habits of mind is calculated by increasing the mean of N Gain from the experimental class and the control class by using the formula:

$$N\ Gain = (pretest\ score - posttest\ score) / (pretest\ score\text{-}maximum\ score) \quad (2)$$

Interpretation of N Gain data obtained from calculations is categorized in Table 2.

Table 2. N Gain category [10].

N Gain	Category
0.7 < N Gain	High
0.3≤ N Gain ≤ 0.7	Medium
N Gain < 0.3	Low

After that a statistical test consisting of normality test, homogeneity test, difference test, and impact test using SPSS 21 program software with SPSS book instructions [11].

Impact test by calculating the effect size to determine how much effect is given by a scaffolding-based lecture program on mastery of concepts. This impact measure is calculated using the effect size calculator with the categories presented in Table 3.

Table 3. Category effect size [12].

Effect size (r)	Category
$0.8 < r \leq 2.0$	High
$0.2 < r \leq 0.8$	Medium
$0.0 \leq r \leq 0.2$	Low

3. Result and Discussion

3.1. Implementation of scaffolding-based lectures

During the implementation of the lecture, observations were made to find out how much the implementation of scaffolding based lectures could improve habits of mind. This observation was carried out by two observers using an observation sheet. Recapitulation of observations on the implementation of scaffolding-based lecture programs can be seen in Table 4.

Table 4. Recapitulation of the results of observations of lectures.

Scaffolding phase	Activity No.	Percentage of implementation (%)		Average	Criteria
		Lecturer	Student		
Orientation	1	100	100	100	All activities are carried out
	2	100	100	100	All activities are carried out
	3	100	85.7	92.9	Almost all activities are carried out
Training	4	100	71.2	85.6	Almost all activities are carried out
	5	100	92.9	96.5	Almost all activities are carried out
Task Support	6	100	85.7	92.9	Almost all activities are carried out
	7	100	92.9	96.5	Almost all activities are carried out
Conceptual & procedural scaffolding	8	100	85.7	92.9	Almost all activities are carried out
	9	100	100	100	All activities are carried out
Scaffolding metacognition and strategy	10	100	100	100	All activities are carried out
	11	100	92.9	96.5	Almost all activities are carried out
	12	100	85.7	92.9	Almost all activities are carried out
	13	100	100	100	All activities are carried out
	14	100	7.6	89.3	Almost all activities are carried out
Average		100	90.8	95.4	Almost all activities are carried out

Based on the recapitulation of the results of the lecture implementation stated that almost all activities were carried out with a percentage of implementation of 96.2%. The observation was carried out fourteen times face to face and each time there were fourteen times of activity.

In the orientation phase, all lecturer activities are carried out, while there are twice the student activities that are not carried out, ie students cannot plan actions effectively to achieve learning. In the training phase, all lecturer activities were carried out well, but there were two student activities that were not carried out. Students are not paying attention to explanations and asking the lecturers well. There is one activity that is not carried out when students listen to the worksheet settlement procedures, because students are still confused by the explanation of the lecturer. In the task support phase, all lecturer activities are carried out well. Four times student activities are not carried out in receiving samples and have new alternatives in completing assignments, and one-time student activities are not carried out in making targets to complete tasks. In the conceptual and procedural scaffolding phase, all lecturer activities are carried out well. There are two times student activities are not carried out in doing the tasks contextually well. In the scaffolding metacognition and strategy phase, all lecturer activities are carried out well. One-time student activity is not carried out in receiving and discussing feedback because students do not discuss learning topics but discuss other topics.

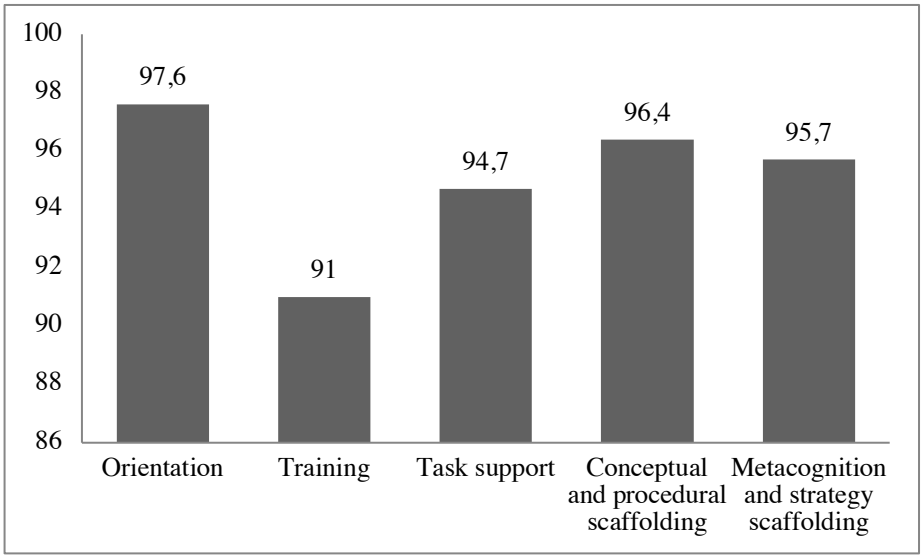

Figure 1. Percentage of implementation of the scaffolding phase.

Based on Figure 1, the order of the implementation of scaffolding-based lecture syntax from the lowest to the highest is the training phase (91%), task support phase (94.7%), metacognition and strategy scaffolding phase (95.7%), conceptual scaffolding phase and procedural (96.4%), and orientation phase (97.6%). In general, the implementation of the lecture syntax is in good category. The training phase and task support need to be improved because these two phases are an important factor in determining the success of learning. In particular, student activities paying attention to explanations and asking lecturers in the training phase of 71.2% need to be improved. This happens because the causal relationship, namely the method of giving material is not attractive to students so it needs to be sought to find a solution.

In addition to these data, observers also noted things that happened during the lecture process to improve the quality of learning. The motivation given by the lecturers to students at the beginning of learning is very interesting and varied so that students are enthusiastic to carry out these motivational activities, for example by picking guitar, observing and listening to physic figures, observing rainbow phenomena, and so on. Automatic apperception activities in answering prerequisite questions after motivational activities can be carried out well. Submission of material at four meetings using the lecture method, this is what causes students to feel bored and unattractive towards learning. But finally, this can

be resolved by changing lecturers using mixed methods, namely lecture and discussion methods and other methods so that students do not get bored.

3.2. Effectiveness of Wave and Optics lectures based on scaffolding in improving the habits of mind of students

Habits of mind students are measured through habits of mind questionnaires given at the beginning and end of the application of this scaffolding-based lecture model. To find out the increase, N Gain calculation is used as shown in Table 5.

Table 5. Increase in average N Gain habits of mind.

Class	N	Pretest	Posttest	Percentage (%)	Ideal Score	Average N Gain	Category
Experiment	46	2.24	3.16	23	4	0.52	Medium
Control	50	2.11	2.76	16.25	4	0.34	Medium

The increase in the average N Gain of students' habits of mind in Scaffolding-based Wave and Optics lectures in the experimental class was 0.52 in the medium category which came from the initial score (mean = 2.24, 56%) and the final score (mean = 3.16, 79%) with an ideal score 4. The percentage of the increase is 23% overall. The increase in the average N Gain of students' habits of mind in the Waves and Scaffolding-based Optics classes in the control class was 0.34 in the medium category which came from the initial score (mean = 2.11, 52.75%) and the final score (mean = 2.76, 69%) with an ideal score 4. The percentage of the increase is 16.25% overall. So it can be concluded that the increase in the mean N Gain in the experimental class is higher than the control class. The distribution of the number of students who experienced an increase in N Gain is shown in Figure 2. The increase in the average N Gain of students' habits of mind in Wave and Optics based scaffolding lectures in the experimental class was 0.52 in the medium category derived from the initial score (mean = 2.24, 56%) and the final score (mean = 3.16, 79%) with an ideal score 4. The percentage of the increase was 23% overall. The increase in the average N Gain of students' habits of mind in the Waves and Scaffolding-based Optics classes in the control class was 0.34 in the medium category which came from the initial score (mean = 2.11, 52.75%) and the final score (mean = 2.76, 69%) with an ideal score 4. The percentage of the increase is 16.25% overall. So it can be concluded that the increase in the mean N Gain in the experimental class is higher than the control class. The distribution of the number of students who experienced an increase in N Gain is shown in Figure 2.

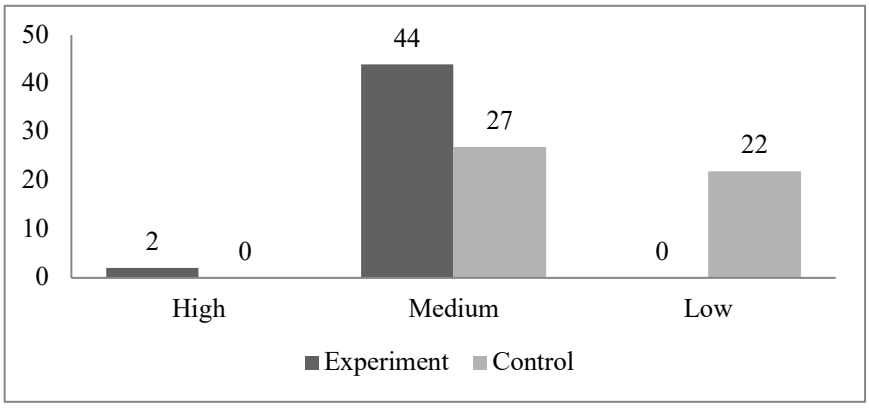

Figure 2. Distribution of N Gain categories of students' habits of mind.

In the experimental class there were 2 students in the high category, 44 students in the medium category, and no students in the low category. Whereas in the control class there were 22 students in the low category, 27 students in the medium category, and none of the students were in the high category.

Overall it can be said that the average N category of the habits of mind of students in the experimental class is better than the control class.

Table 6. The results of N Gain normality test habits of mind of students.

Score	N	*Mean*	SD	Distribution (α=0.05)	
				p_n	Information
Initial	46	2.24	0.66	0.43	Normal
Final	46	3.16	0.31	0.39	Normal

Table 6 shows the normality test of N habits of mind of students. The results of the normality test from the initial score data (mean = 2.24, SD = 0.66) students' habits of mind were normally distributed because of the significance level of 0.43> 0.05. Likewise, the final score data (mean = 3.16, SD = 0.31) students' habits of mind were normally distributed because the significance level was 0.39> 0.05.

Table 7. Homogeneity and the difference test between the initial and final scores of habits of mind.

Score	N	Mean	SD	T	df	Variance (α=0.05)		Difference test (α=0.05)	
						P_h	Inf.	P_b	Inf.
Initial	46	3.16	0.31	54.20	90	0.00	No homogeneity	0.00	There is difference
Final	46	0.51	0.11						

Table 7 shows the homogeneity test and the difference test scores of the beginning and end of the habits of mind of students. The results of the homogeneity test stated that the score data of the beginning and end of the habits of mind of students with a significance level of 0.00 <0.05 was considered to be homogeneous in variance. This happens because habits of mind are related to different student characters from each other. While through the T test, there was a significant difference between the initial score and the final score, t (90) = 54.20, p_b <0.05. Initial score (mean = 3.16, SD = 0.31) and final score (mean = 0.51, SD = 0.11). Based on the test for normality, homogeneity, and difference test it can be stated that the Wave and Optics based scaffolding courses can improve students' habits of mind. To find out how much impact the lecture program has on students' habits of mind, an impact test is performed using the effect size calculation as can be seen in Table 8.

Table 8. Effect size of lecture program based on scaffolding on students' habits of mind.

HoM	N	*Mean*	SD	Cohen's d	R	Category
Initial	46	33.54	9.95	1.78	0.7	Medium
Final	46	47.33	4.58			

Based on the calculation of effect size with a value of r = 0.7, which means that the scaffolding-based lecture program is able to have a moderate impact on the habits of mind of students who have pre-test (mean = 33.54, SD = 9.95) and post-test (mean = 47.33, SD = 4.58) with Cohen's d = 1.78. Therefore, it can be concluded that the scaffolding lecture program is effective against students' habits of mind.

Table 9. Average N gain for every aspect of habits of mind.

HoM	Initial	Final	Ideal Score	N Gain	Category
Self-Regulation	2.03	3.22	4	0.60	Medium
Critical Thinking	2.34	3.11	4	0.46	Medium
Creative Thinking	2.34	3.17	4	0.50	Medium

While to find out the distribution of the average N Gain distribution for each aspect of habits of mind which consists of self-regulation, critical thinking, and creative thinking can be seen in Table 9. The increase in the average N Gain of each aspect of habits of mind, the aspect of self-regulation by 0.60, the aspect of creative thinking by 0.46, and the critical thinking aspect by 0.50 with each ideal score. of mind is in the medium category. Distribution of the average category of N Gain in each aspect of habits of mind is shown in Figure 3.

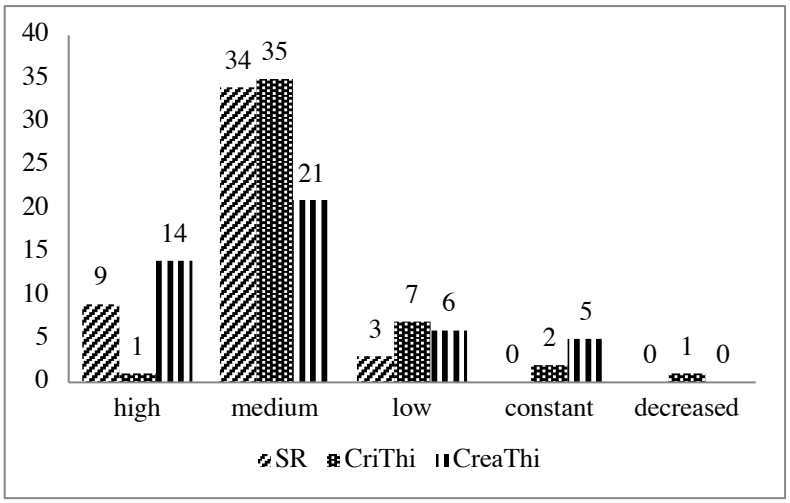

Figure 3. N Gain category for every aspect of habits of mind.

In self-regulation as much as 20% of students experienced an increase in the high category, which is above 0.7 which means that students can manage themselves well. The number of students in the medium category is 73%. While as many as 7% of students are in the low category.

In critical thinking only 2% of students have a high category increase, which means that only a few students are accustomed to thinking critically optimally. The number of students in the moderate category included the most students, namely 76% of students. A total of 16% of students experienced an increase in the low category. And as many as 4% of students did not experience an increase or were in the fixed category. There are 2% of students who have decreased from an average initial score of 2.8 to a final score of 2.7 with an ideal score of 4.

In creative thinking 30% of students are in the high category. A total of 46% of students have an increase in in the medium category. Whereas those who experienced an increase in the low category were 14% of students. And a number of 10% of students are in the fixed category or do not experience an increase.

4. Conclusion

Based on the calculation of effect size with a value of r = 0.7, which means that the scaffolding-based lecture program is able to have a moderate impact on the habits of mind of students who have pre-test (mean = 33.54, SD = 9.95) and post-test (mean = 47.33, SD = 4.58) with Cohen's d = 1.78. Therefore, it can be concluded that the scaffolding lecture program is effective to improve students' habits of mind.

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