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Research Article

Temperature and Heat Learning Through SSCS Model with Scaffolding: Impact on Students' Critical Thinking Ability

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Abstract
Lately, the industrial revolution 4.0 has become an important issue in all countries, including Indonesia. Indonesia responds quickly to this issue, especially in the field of education. The Directorate General of Research and Technology Resources of the Ministry of Higher Education (*Kemristekdikti*) provide actions to face the industrial revolution 4.0 through critical thinking, creativity, communication, and collaboration (4C). Critical thinking is important to be applied in all subjects, one of which is physics. Physics learning requires search, solve, create, and share learning model (SSCS) to stimulate critical thinking. The aim of this research is to investigate the impact of SSCS model with scaffolding toward students' critical thinking. This research was done through quasi-experimental research with non-equivalent control group design at Al-Huda Vocational High School, Jati Agung, Lampung, Indonesia. Based on the results of the statistical analysis, the SSCS learning model with Scaffolding is influential in increasing students' critical thinking.

Keywords
critical thinking, scaffolding, SSCS model, temperature and heat learning

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Introduction

The industrial revolution 4.0 has recently become an important issue of the world community (Crnjac, Veža, & Banduka, 2017; Janíková & Kowaliková, 2017; Selamat, Alias, Hikmi, Puteh, & Tapsir, 2017), including Indonesia. Some experts have studied the preparations for facing the industrial revolution 4.0 in various fields(Anwar, Saregar, Hasanah, & Widayanti, 2018). In the education domain, the Directorate General of Research and Technology Resources of the Ministry of Higher Education (*Kemristekdikti*)states its preparation by applying 4C (critical thinking, creativity, communication, and collaboration) (Ditjen Sumber Daya Iptek Dikti, 2018). The success of critical thinking in learning is influenced by many factors, including the teacher's ability to choose learning strategies and learning models(Fathurohman, 2014; Irwandani & Rofiah, 2015; Munawaroh, ., & ., 2018; Saregar, Latifah, & Sari, 2016; schreglmann & Karakuş, 2017; Su, Ricci, & Mnatsakanian, 2015; Usdiyana, Purniati, Yulianti, & Harningsih, 2009; Wulandari & Nurhayati, 2018; Yazdi, 2012).

Based on previous research, Solve, Search, Create, and share (SSCS) learning model is able to train critical thinking (Hatari et al., 2016) because this model provides opportunities for students to explore their thinking independently (Mulyono & Indah Lestari, 2016). The steps that need to be done in the SSCS learning model include: (1) search (searching for topic); (2) solve (designing research)(Satriawan, 2017); (3) Create (creating a product); and (4) Share (disseminating the product)(K.Abeli & G.Lederman, 2007; Milama, Bahriah, & Mahmudah, 2017).

The students' success rate of the SSCS learning model are varied, some can be trained quickly, and some are rather slowly(Dilekli, 2017). Therefore, teachers need to provide treatment in the form of assistance (scaffolding) in accordance with the difficulties faced by each student(Abdurrahman, Saregar, & Umam, 2018).

Scaffolding allows students to solve problems with the help of teachers or peers to achieve the zone of proximal development (ZPD) (Alan Deta, 2017; Belland, 2017; Reynolds, 2017; Salma Dewi P & Eveline, 2012). The scaffolding concept by Wood, Bruner, and Ross provides full assistance in the initial stages,and gradually the assistance is reduced until eventually the students are released and able to complete by themselves(Anghileri, 2006). The students who have high or low abilities can solve problems properly(Cheng et al., 2015). This is why scaffolding is considered significant in maximizing the application of SSCS learning model. The scaffolding gave consists of several types and forms designed to suit the learning situation.

One field of study that needs to apply scaffolding is physics. Physics studies natural phenomena related to everyday life such as temperature and heat(Lestari & Rahayu, 2015; Saregar, 2016). However, not all temperature and heat material could

be understood by students(Rahmayani& Hutahean, 2017; Triyuni, 2016). Therefore, this study aims to apply the SSCS learning model with the help of scaffolding to foster students' critical thinking ability.

Several other researchers have examined the application of sscaffoldings and the SSCS learning model, among others: the application of sscaffoldings with discussion methods(Alan Deta, 2017), the influence of constructivism-based Scaffolding (Indrawati, 2017), designing sscaffolding to solve problems(Cheng et al., 2015), metacognitive scaffolding (Huertas, Lo, & Sanabria, 2016; Jumaat & Tasir, 2016), the application of Scaffolding to achieve independence (Nurhayati, 2017), the application of sscaffoldings in Investigation Group Learning (Rahmatiah, H, & Kusairi, 2016), SSCS integrated with metacognitive strategies (Yusnaeni, Corebima, Susilo, & Zubaidah, 2017), the effectiveness of SSCS and Cooperative Problem Solving (CPS) (Reahanah, 2016).

Although there have been many studies on the application of Scaffolding and SSCS, there has been no research that collaborates the following factors: (1) the SSCS learning model collaborated with Scaffolding; (2) scaffolding to be given is metacognitive scaffolding in the form of orders to conduct an experiment and conceptual scaffolding in the form of questions, material summaries, question sheets, video or image phenomena related to material, and ZPD that will be inserted in the steps of the SSCS model on the heat and temperature learning material of the physics subjects.

The stage of SSCS learning model with Scaffolding on critical thinking ability can be seen in Figure 1;

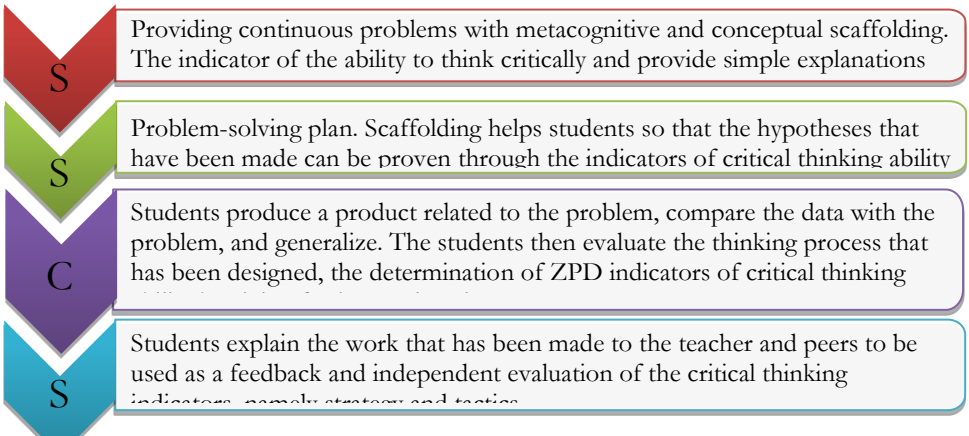

Figure 1

The Framework of the SSCS Learning Model with Scaffolding on Critical Thinking Ability. Source: modification (Assidiqi, 2015)

Method

This study was conducted at Al-Huda Vocational High School, Jati Agung, Lampung, Indonesia using quasi-experimental with nonequivalent control group design. This design involved a control group and an experimental group as the sample. The experimental class applied the SSCS learning model with scaffolding and the control class applied inquiry learning. The sample of the experimental class consisted of 34 students, and the sample of the control class consisted of 24 students. The instruments used in this research were observation, interview, and written test of heat and temperature. The observation and interview were used to analyze the problems in the learning process qualitatively, and the test was used as an instrument to analyze the improvement of students' the critical thinking ability quantitatively. The test instrument analysis were used the normality test, homogeneity test, and the t-test.

Before given the treatments, the control group and the experimental group were given a pretest aimed to determine the level of initial ability(Hardianti & Kuswanto, 2017; Sanjaya, 2013). SPSS 18.0 was used to test the validity and reliability of the Instrument. Validity test was calculated using product moment formula, and Kuder-Richardson formula was used to calculate the reliability. The result of the validity and reliability tests indicated that the test was highly valid and reliable. The result of pretest on the control and experimental groups did not differ significantly, but in this design, the experimental group and the control group were not chosen randomly (Sugiyono, 2015). Different treatments were given to the control and experimental groups. The experimental group was treated by SSCS model with scaffolding, and the control group was treated by the inquiry learning model. The following are the steps of treatment using the SSCS learning model with scaffolding given by the teacher.

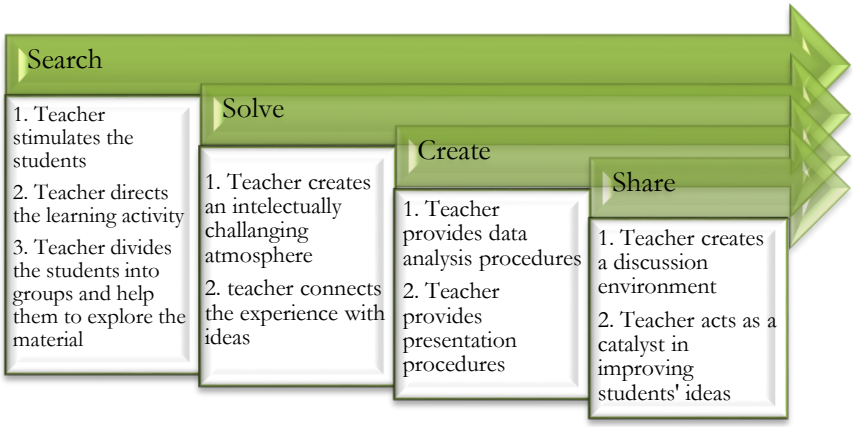

Figure 2
The Teacher's Steps in Applying the SSCS Model with Scaffolding

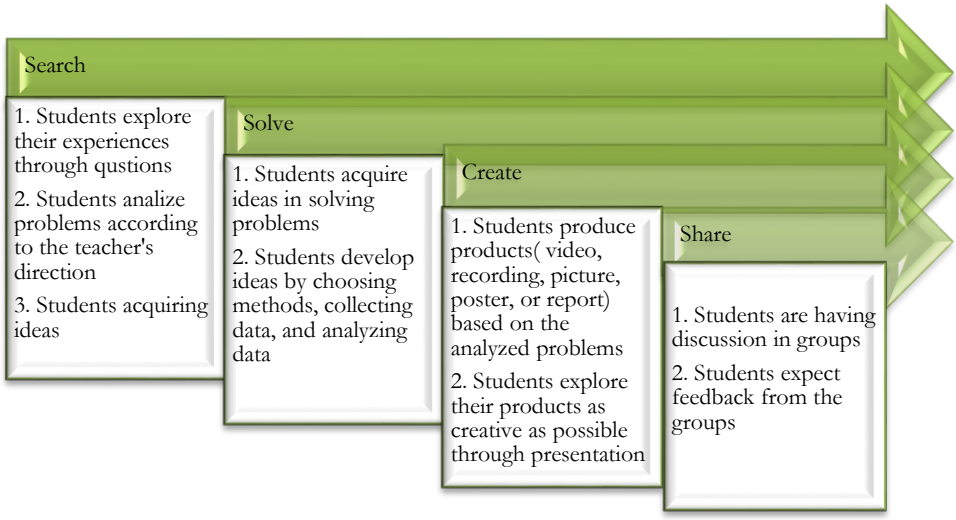

Figure 3.
Students steps in learning using the SSCS model with scaffolding

Data calculation employed in this research was the normality test (Kolmogorov-Smirnov), homogeneity test (Fisher test) and t-test (parametric statistics). The tests were used since the analyzed data were normally distributed, and the variance was homogeneous(Yuberti & Saregar, 2017). The t-test was calculated using SPSS18.0 with significance$\alpha = 0.05$.

Hypothesis:

H_0: there is no difference in students' critical thinking ability before and after the implementation of the SSCS learning model with Scaffolding;

H_1: there is a difference in students' critical thinking ability before and after the implementation of the SSCS learning model with scaffolding

The criteria are as follows:

If sig. ≥ 0.05 then $H_1$is accepted

if Sig. <0.05 then $H_0$is rejected

Result and Discussion

The recapitulation of pretest and posttest score in the experimental group and the control group can be seen in Table 1,

Table 1
Recapitulation of Pretest and Posttest

Group	Pretest		Posttest	
	Highest	Lowest	Highest	Lowest
Experimental group	35	0	75	53
Control group	48	0	75	46
Experimental group average score	20,4412		62,5588	
Control group average score	19,6765		56,2941	

Based on table 1, the average score of students' pretests of critical thinking in the experimental group and the control group shows a not too significant difference. In the posttest,students' critical thinking in the experimental group and control group shows a significant difference.

In addition to the pretest and posttest scores, the researchers also evaluated the learning process in the classroom through the SSCS model with scaffoldings; the following is the percentage of learning management:

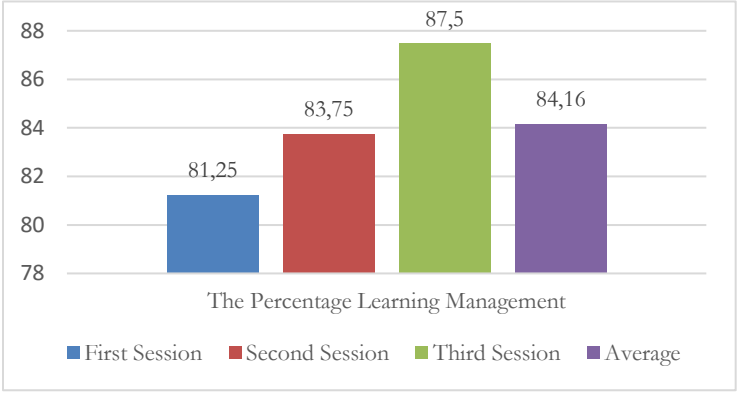

Figure 4
The Percentage of Learning Management

Based on Figure 4, the average score of learning management of SSCS model with scaffolding gained a percentage of 84.16% which is categorized as good, and it is in accordance with the implementation plan of learning. The stages to provide the conclusions of the study must go through several statistical tests as follow:

Prerequisite Analysis Test

After the research data was obtained, the data was then analyzed. Statistical tests were carried out at a significance $\alpha = 0.05$. The requirements must be met first, namely the normality test and homogeneity of variance test. If the data analyzed is

normally distributed, then parametric statistical techniques may be used, whereas if the data were not normally distributed, non-parametric statistics must be used (Saregar & Sunarno, 2013).

Normality

The normality test was done using the Kolmogorov-Smirnov method in the SPSS 18.0. The Kolmogorov-Smirnov test was used because of n <65 respondents. The results of the calculation of the normality test with a significance level of 95% (α = 0.05) of the pretest and posttest of critical thinking in the experimental class and control class are as follows:

Table 2

Normality Test

Groups	**Experimental**		**Control**		**Conclusion**
	Sig	**Description**	**Sig**	**Description**	Normally
pretest	0, 85	≥ 0.05	0.76	≥0.05	distributed
posttest	0.200	≥0.05	0.138	≥ 0.05	Normally distributed

Based on table 2, the pretest and posttest in the experimental class and control class gain Sig. > 0.05 so that the data were normally distributed.

Homogeneity Test

After the data was declared to be normally distributed, then the next step was finding the value of homogeneity. In this study, the value of homogeneity was calculated using the homogeneity of variances with the Fisher test method. Fisher test was done to see the similarity between groups (homogeneous). The following is the recapitulation of the homogeneity test results in the experimental group and control group.

Table 3

Homogeneity Test

	Pretest		Posttest	
	Critical Thinking	*Fisher's*	critical thinking	*Fisher's*
Sig.	0.618	0.190	0.213	0.240
Homogeneity	0.05		≥ 0.05	
Conclusion	Homogeneous		Homogeneous	

Based on table 3, the Sig. values of pretest and posttest in the experimental group and control group is > 0.05. It can be concluded that the pretest and posttest scores are taken from a homogeneous population or the variant of each sample is the same.

T-Test

After it is known that the data were normally distributed and the homogeneous then the hypothetical test was performed using the t-test (parametric statistics). The independent sample t-test was used in accordance with the theory which states that

it can be used if the data analyzed is normally distributed and the variance is homogeneous. The results of the t-test show a significance level of 0.01 smaller than $\alpha = 0.05$ (Sig <0.05) meaning that H_0 is rejected and H_1 is accepted. The results of the statistical test show that there are meaningful differences in students' critical thinking ability before and after learning using the SSCS learning model with Scaffolding. Seeing the average posttest score of the experimental class is higher than the posttest value of the control class, it can be concluded that the SSCS learning model with Scaffolding is influential in improving critical thinking ability.

Discussion

This study aims to determine the effect of search, solve, create and, share (SSCS) learning model with Scaffolding on students' critical thinking ability in temperature and heat material. Based on the pre-research results in table 1, the students' critical thinking ability can be seen from the pretest and posttest scores. A pretest was given at the beginning of the meeting before the SCSS learning model was applied to learning the temperature and heat material. The results of the pretest showed that students' critical thinking ability in temperature and heat was low, and both groups had almost the same ability. Based on the results of the pretest in table 1, the researchers considered it was necessary to conduct further research to improve critical thinking ability.

Critical thinking is a reasonable and reflective way of thinking that focuses on deciding what to believe(Fisher, 2008) and is done by analyzing, evaluating, and concluding(Dilekli, 2017). The SSCS learning model provides opportunities for students to explore their thinking independently so that they must be able to write solutions with systematic steps and they also must have an active discussion during the learning process. Basically, the students' critical thinking abilities to analyze and evaluate a problem with each other are varied. Therefore, it is necessary to provide assistance (scaffolding) in accordance with the student's difficulties.

Scaffolding given in this study was metacognitive scaffolding with the command to experiment to find out a problem and conceptual scaffolding in the form of questions, material summaries, question sheets, video or image phenomena related to the material and ZPD that will be inserted in the steps of the SSCS model (see in Figure 1).

The following are the stages in applying the SSCS learning model:

*** Search Stage**

In this stage, each student conducted an investigation in order to find answers to the problems presented by the teacher in the class(Satriawan, 2017). In this case, the teacher (researchers) gave a metacognitive scaffolding command in the form of an experiment about temperature and heat and provided conceptual scaffolding in the form of questions from video displayed related to temperature and heat material, so

that at this stage, the students were able to provide simple explanations and to build basic skills.

*** Solve Stage**

At this stage, the results of the search stage become the basis for solving questions through the research that has been done(Reahanah, 2016). Researchers guided the students to discuss and provide some scaffolding so that the hypotheses that have been made can be proven. The objective of this stage is for the students to have an indicator of critical thinking ability which is making a conclusion.

*** Create Stage**

The students carry out problem-solving in the form of products(Assidiqi, 2015). The students were provided opportunities to make reports on the planning results of problem-solving. The students who had high ZPD were directed to help other students who had low ZPD if the Scaffolding provided was not enough. In this case, the students who had achieved critical thinking indicators should provide further explanation. Thus they would be able to do the strategies and tactics that would be given.

*** Share stage**

Students communicate the resolution of the problems. Researchers provide opportunities for the students to present the results of the discussion (Assidiqi, 2015). Researchers made conclusions about the solution of a given problem, and the material studied. Researchers provided opportunities for the students to improve the results of the discussion. In this case, the student achieved a critical thinking ability indicator by doing a strategy that will be carried out to convey what knowledge they acquired.

Based on table 1, the pretest and posttest scores are significantly different. Posttest score is higher than the pretest. This means that there is an increase in the score after the researchers provide SSCS learning model assisted by scaffolding. The research hypothesis can be proven using t-test analysis. The t-test result shows that there are differences in students' critical thinking ability before and after using the SSCS learning model with Scaffolding. So, it can be concluded that the SSCS learning model with Scaffolding has an effect in improving critical thinking ability. This is in line with Hifni's research that developing SSCS model textbooks can empower critical thinking skills(Carolina, Sutanto, & Suseno, 2017), Yusnaeni's research that states that the SSCS model integrated with metacognitive strategies can shape critical and creative thinking(Yusnaeni et al., 2017), and Niki's research shows that SSCS model is effective in improving students' critical thinking (Hatari et al., 2016)

One of the higher-order thinking skills is critical-thinking. Critical thinking is needed by students as a foundation to understand various things, including understanding concepts in scientific disciplines. Based on this research, one of the

learning models that can be used to deepen students' critical thinking ability is the SSCS learning model with Scaffolding. In addition, by implementing the SSCS learning model with Scaffolding, it can provide a mean to face the revolution 4.0.

Conclusion

There is an influence on physics learning using Search, Solve, Create, and Share (SSCS) learning model with scaffolding in improving students' critical thinking ability. Thus, the application of the SSCS Learning Model with scaffolding is beneficial in the physics learning process so that the students can be more active, resulting in a more effective and efficient learning process.

Further research can apply the SSCS learning model with Scaffolding for different concepts or topics. Future researchers should pay attention to the time allocation in accordance with the learning plan since this research requires a relatively long time, so it is necessary to make the learning time effective.

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