

Effects of SSCS Learning Activities With Bar Model on Mathematical Resilience and Learning Achievement in Fraction Word Problems

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Abstract

The goals of this study were to examine two different aspects of learning accomplishment and mathematical resilience in Grade 6 children after they received learning management skills using the SSCS with bar model in fraction word problems. A group of 147 sixth-grade pupils in the first semester of the 2021 school year was the study's target population. Lesson plans utilizing the SSCS with bar model, a questionnaire on mathematical resilience, and a test of students' achievement to apply what they had learned to solve fractional word problems made up the research tools. Relative increase score, mean, standard deviation, percentage, and content analysis were used to examine the data. 1) The target group exhibited stronger mathematical resilience after the intervention, according to this study's findings. 96.60 percent of the target group. After the intervention, no student's math resilience was less strong than it was. 2) Student accomplishment in fraction problems was higher than the required 70%, and 3) 57.82% of the students showed relative gain score improvements in the fraction word problem of more than or equal to 50%.

Keywords: SSCS Learning Activities, Bar Model, Relative Gain Score, Learning Achievement, Mathematical Resilience

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1. Introduction

1.1 Theoretical Background

Mathematics is a highly abstract subject. Many students are not good in mathematics, but some students in this group can succeed and be able to understand the content that they have to learn because they have mathematical resilience. My students have a belief about human development (growth belief) that is related to the ability to learn mathematics. When students encounter difficulty in understanding some mathematical topics, they will still have confidence and be able to learn it successfully. Finally, they will know that there are a lot of resources that can support them in their learning. They will still have a positive attitude towards learning mathematics. Students will be able to overcome obstacles in their mathematical learning. In addition, students can ask for help from other people. Coaching will help promote and support the development of their mathematical skills (Johnston-Wilder, et al. 2013).

The researcher is studying the students who are learning mathematics. It has been found that students do not listen to what the teacher is teaching. They talk and play with their friends. Some students bring other work to do in mathematics class. When they have to do mathematics worksheets, they do not want to do them. They try to avoid it by drawing some pictures. They try not to join in group activities by doing things such as asking permission to go to the restroom. Some students copy their friend's answers so that they can submit that work to their teacher. Moreover, the researcher also has the opportunity to talk with some of the students about their lack of work. A large number of students say that mathematics is a difficult and boring subject, and after studying it they still do not understand. They think that they will not be able to use it in their daily lives. They do not see the relevance in studying to improve their mathematical skills. They also feel anxious and stressed when they have to calculate using mathematics. Students can suffer psychological damage when studying and practicing mathematics, and being pressured and looked down upon by others. These things are an indication that students have a fixed mindset because they believe that their intelligence cannot be changed (Blackwell, et al. 2007). Research by Ricci (2013) found that the number of students who study at higher levels have a more fixed mindset. Mercer (Mercer and Howe, 2012) stated that, "If students still have a fixed mindset they cannot learn or develop their abilities". Even though there are good teaching methods, teachers cannot help students to develop fully, because students will not make effort to study what the teacher has taught.

The results of the National Basic Education Test (O-NET) in mathematics for Grade 6 found that their scores in algebra for the academic years 2018-2020 (Table1) were 52.48 points, 52.94 points, and 59.05 points respectively. Fraction word problems are part of algebra, and it is very important and necessary for further study at a higher level. Moreover, the school of the researcher expects that the average academic achievement of students in algebra will be at least 70 points, so the researcher must develop the mathematical skills of the students to reach that goal.

Table 1: The Average O-NET Score for the Academic Years 2018 – 2020 for Grade 6 Students in Algebra.

Year	2018	2019	2020
The average O-NET score	52.48	52.94	59.05

The researcher found a research paper on learning management using Search, Solve, Create and Share (SSCS), a method first introduced by Pizzini, et al. (1989). SSCS is a teaching model that provides opportunities for students to think, brainstorm, analyze, and gain knowledge in solving problems whilst enhancing their problem-solving skills and self-efficiency. There are four learning stages in the SSCS model, namely searching, solving, creating, and sharing. In the initial phase, students will experience the process of searching for ideas which are involved in the process of collecting materials, then inquiring and formulating ways of solving the problems assigned to them. In the next phase, students are involved in the problem-solving process. Then, they move on to the create phase, where they are involved in finding and summarizing the answers to the problems. The last phase is the share stage at which students are required to present the result of their responses interactively to the other students in their class. Implementing the SSCS teaching model empowers students with a role that encourages them to think critically, creatively, and independently.

In organizing learning activities to develop mathematical resilience, Lee & Johnston-Wilder (2013) mentioned four factors that affect the development of student mathematical resilience in the classroom. The first factor is “Value”, which means that students recognize that mathematics is a valuable and interesting subject to study. Moreover, they see the benefits of applying mathematics to everyday life, including expanding on other matters. The more students think that mathematics is valuable, the more they will be motivated to learn. The second factor is “Struggle”, which means that students accept that effort in learning mathematics is common among those studying mathematics. Even students who have high mathematical resilience must put in effort to learn mathematics too. The third factor is “Growth”, which means that students are ensured that they can develop their mathematical skills. Mathematical ability is not related to the intellectual ability of any student. The fourth factor is “Support”, which means when students encounter negative situations in learning mathematics, the teacher must help and create positive encouragement for students, so that they can get through those situations.

Another process which can be used for solving mathematical problems is the Bar Model, a strategy for solving problems that requires drawing a Bar Model. A Bar Model is drawn in the shape of a block or bar. It is rectangular and is called the Singapore Bar Model, or the Singapore Block Model, or for short, the Bar Model (Yeap Ban Har et al, 2008). Solving problems using the Bar Model process can make students think and analyze the message from the problems, connecting them to student mathematical and analytical thinking. Drawing the results out as a Bar Model helps students understand and create knowledge by themselves, so that they can solve problems correctly.

SSCS Learning Activities with Bar Model will help in developing student mathematical resilience. In the “Search” process, students will see the value of what they are learning and connect it to their daily lives, even transferring this knowledge to other subject areas. Additionally, students must make an effort in choosing how to solve problems and write down their ideas. Even if at first, they do not know about this, they can talk to their friends or ask their teacher for good advice (Solve + Bar Model technique). Students may feel that writing an explanation is very difficult, but because they have friends and teachers who provide good advice and encouragement, they will eventually be able to write a complete a summary, thus developing skills in how the process “Create” works. Finally, students must make an effort to present their ideas on how to solve problems to their friends. In the case of students who volunteer to write the solutions to their problems on the board, even with mistakes, the teacher reinforces and encourages the fact that making mistakes is not a big

problem in learning mathematics. When they make a mistake, they can always correct it. The most important thing that they learn in this “Share” process, is the point that their mistakes are a good lesson for their friends to learn from.

For this reason, the researcher has studied the effects of SSCS learning activities with Bar Model on mathematical resilience and learning achievement in the area of fraction word problems. This is a guideline for improving and developing the teaching of mathematics that focuses on students being more effective, and this process involved a variety of mathematical concepts that can be applied as a guideline for organizing teaching and learning for other teachers in the future.

2. Implementation and Results

The experiment was conducted with a population of 147 sixth-grade students. Lesson plans utilizing the SSCS with Bar Model, a questionnaire on mathematical resilience, and a test of student achievement to apply what they had learned to solve fractional word problems made up using the research tools. The experiment comprised data collection by requesting the cooperation of 147 sixth-grade students, the target group of this research, the classes taught by the researcher. Then, the researcher explained to the students about SSCS Learning Activities with Bar Model in Fraction Word Problems, so that they could manage the activity correctly, by doing the twenty-three questionnaire items on mathematical resilience, and two items testing student achievement. The researcher then recorded the results as a pre-test score. The researcher organized SSCS Learning Activities with Bar Model in Fraction Word Problems by teaching according to the lesson plan, eight periods, each lasting 40 minutes. When they were completing the SSCS Learning Activities with Bar Model, the students did the same questionnaire on mathematical resilience and the test of student achievement. The researcher recorded the results as a post-test score. The researcher brought all data analyzed according to statistical methods, thus checking the hypothesis.

2.1 Results of Analysis of Mathematical Resilience Data

The analysis of data obtained from the questionnaire on mathematical resilience was created to measure attitudes and beliefs about studying mathematics. In this case, the researcher referenced questions from the mathematical resilience scale (MRS), 23 items in the form of a 5-level rating scale: strongly agree (5 points), agree (4 points), not sure (3 points), disagree (2 points) and strongly disagree (1 point). Three issues were studied: Value, 8 items, Struggle, 8 items, and Growth, 7 items. The mathematical resilience scores obtained by the students from this questionnaire can be calculated by adding together the scores for each question. The minimum possible mathematical resilience score for the students is 23, and the maximum possible score is 115.

Table 2: Analysis of pre- and post-scores from the questionnaire on mathematical resilience of the 147 sixth-grade students, with a full score of 115 points.

	Minimum	Maximum	Mean	Std. Deviation
Pre-scores	67	112	92.14	10.13
Post-scores	72	113	97.50	9.70

From the analysis of the pre- and post-scores from the questionnaire on mathematical resilience (Table 2), it was found that the scores obtained from the questionnaire on

mathematical resilience of 147 sixth-grade students after having completed SSCS Learning Activities with Bar Model has a mean of 97.50 points, equivalent to 84.78 percent, standard deviation of 9.70, showing that the students have higher mathematical resilience.

Questionnaire score changes:

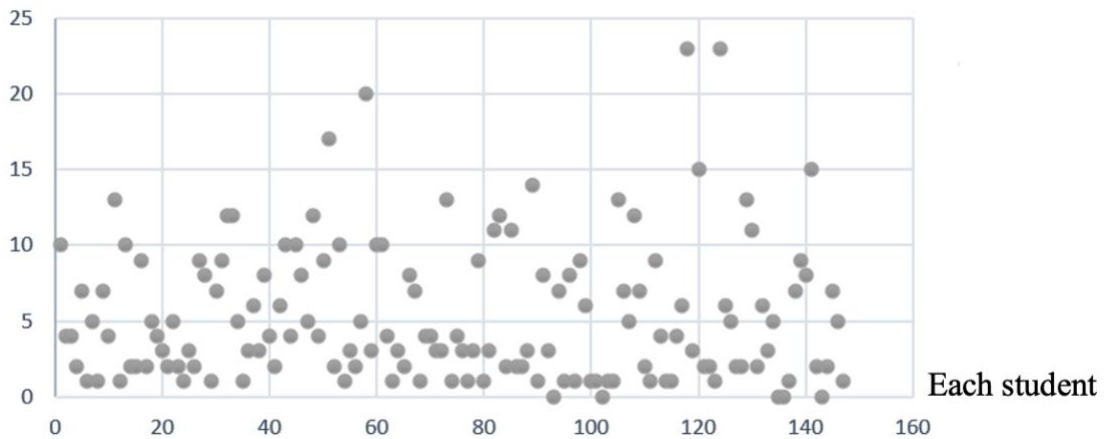


Figure 1: Difference between scores before and after studying and doing a questionnaire on mathematical resilience for each sixth-grade student after receiving learning SSCS Learning Activities with Bar Model.

From Figure 1, it was found that the difference in scores before and after studying and doing the questionnaire on mathematical resilience of sixth-grade students after receiving learning SSCS Learning Activities with Bar Model had a non-negative value, indicating that the scores of 142 students after studying were higher than before studying, accounting for 96.60 percent of all students. No student had a lower mathematical resilience score after studying than before.

Table 3: Comparison table of scores of sixth-grade students who have Mathematical resilience at higher levels before and after receiving SSCS Learning Activities with Bar Model.

Mathematical Resilience level	Number of students (percentage)	
	Pre studying	Post studying
From the highest level	89.80	95.23

From Table 3, it was found that before studying, 89.80% of students had mathematical resilience at a higher level. However, after receiving SSCS Learning Activities with the Bar Model, there was an increase of 5.43 percent of students who had mathematical resilience at the higher level, which is 95.23 percent. In addition, the researcher interviewed a selection of sixth-grade students. They said that the bar model technique makes it easier and faster for them to find answers to fraction word problems, so they don't have any misunderstandings about whether they have found the correct answer or not. Moreover, they said that they wanted to practice doing fraction word problems by themselves more and more, so that they could check their understanding. They liked the classroom atmosphere which helped promote understanding and learning much better because the teacher taught well and explained logically, so that they could do the fraction word problems.

Table 4: Analysis table of scores obtained from the questionnaire on mathematical resilience. Considering each aspect of the factors of mathematical resilience of sixth-grade students after receiving SSCS Learning Activities with the Bar Model.

	Scores obtained from Questionnaires			Mathematical Resilience
	Value	Struggle	Growth	
Mean	34.22	35.80	27.49	97.50
SD	4.90	3.44	4.99	9.70

From Table 4, it was found that overall, sixth-grade students, after having received SSCS Learning Activities with the Bar Model, have high averages in Value and Struggle. This was determined from scores of 34.22 and 35.80, respectively.

2.2 The Results of the Analysis of Learning Achievement Data on Fraction Word Problems

2.2.1 Learning Achievement Compared to the 70 Percent Criteria

Table 5: Analysis of pre- and post-scores from the test of student achievement on fraction word problems of 147 sixth-grade students, with a full score of 10.

	Minimum	Maximum	Mean	Std. Deviation
Pre studying	0	10	4.56	1.97
Post studying	3	10	7.51	1.85

According to the analysis of pre- and post-study scores from the test of student achievement on fraction word problems (Table 5), it was found that the scores obtained by 147 sixth-grade students after learning was organized using SSCS Learning Activities with Bar Model, the mean was 7.51 points, meaning 75.1 percent. The standard deviation was 1.85. All students had higher learning achievement in fraction word problems.

Test of student achievement score changes:

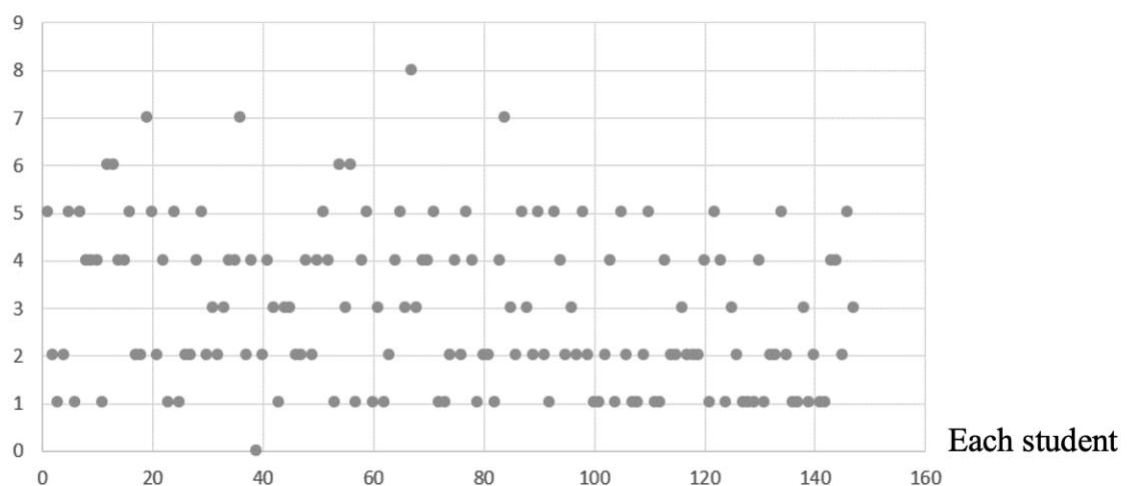


Figure 2: Difference between scores after and before studying from taking the test of student achievement on fraction word problems of each sixth-grade students after receiving learning SSCS Learning Activities with Bar Model.

From Figure 2, it is found that the difference in scores after and before studying from taking the test of student achievement on fraction word problems of 147 sixth-grade students after receiving learning SSCS Learning Activities with Bar Model had a non-negative value, indicating that the scores of 146 students after studying were higher than before studying, accounting for 99.32 percent of all students, which is higher than the 70% threshold. The score of one student remain the same before and after studying. This is because the difference in scores before and after studying is equal to 0, accounting for 0.68 percent of all students.

2.3 Relative Gain Score

The researcher used the test of student achievement to study the relative gain scores of students who received learning SSCS Learning Activities with Bar Model by using pre- and post-scores of students who received learning SSCS Learning Activities with Bar Model on fraction word problems.

Relative gain score:

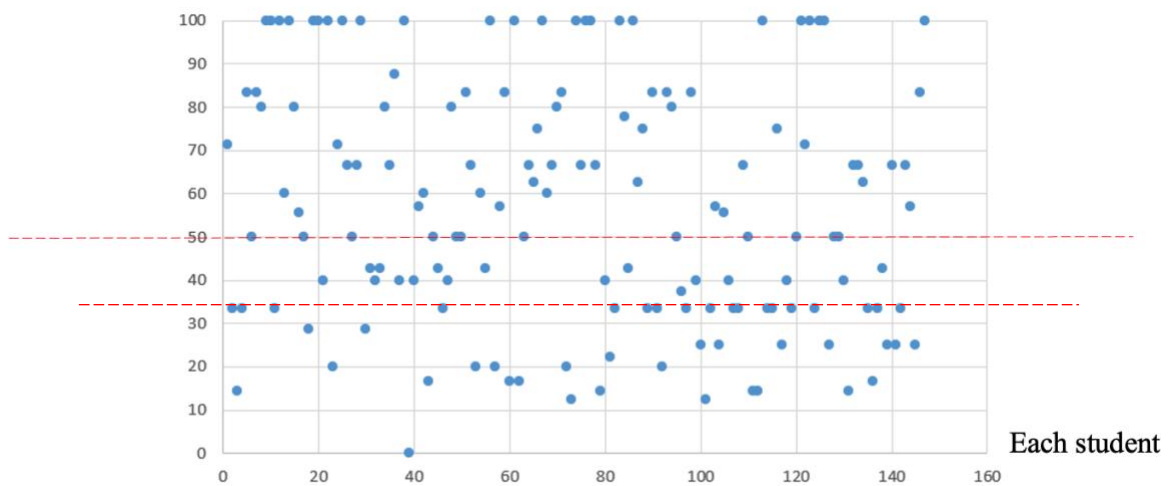


Figure 3: Relative gain score from taking the test of student achievement on fraction word problems of each sixth-grade student after receiving learning SSCS Learning Activities with Bar Model.

From Figure 3, it is found that the relative gain scores from taking the test of student achievement on fraction word problems of sixth-grade students who received SSCS Learning Activities with Bar Model, the relative gain scores equal to or more than 50 percent was a total of 85 students, accounting for 57.82 percent of all students. There were 62 students, accounting for 42.18 percent of all students, with a relative gain scores of less than 50 percent.

3. Conclusions

96.60 percent of the target group. After the intervention, no student's math resilience was less strong than it was. Student accomplishment in fraction problems was higher than the required 70%, and 57.82% of the students showed relative gain score improvements in the fraction word problem of more than or equal to 50%.

Gathering data from a questionnaire on Mathematical resilience that was derived from concepts from Kookan, et al. (2016), it was found that 96.60 percent of the target group after the intervention, no student's mathematical resilience was less strong than it was. This is a result of organizing learning SSCS Learning Activities with Bar Model on Fraction Word problems because in the four steps of SSCS, students developed Mathematical Resilience. In the first step, which is S: Search, students received development in Value because before students can tell about what the problem asks and what the problem specifies in the fraction word problems. Students must be able to answer these questions "Why are fraction word problems interesting? And why do students need to study this?". Students have to give examples that are relatable to their real lives so that they could have a grasp that studying this mathematics topic is valuable and meaningful (Algani, 2019; Pang and Seah, 2021). The second step is S: Solve. Students developed mathematical resilience in Struggle and Growth. Students expressed their ideas by using the Bar Model technique. At first, some of these students don't know on what to write, but they talked and consulted with their friends and asked for a teacher's advice. Based from the interview of some students, the researcher found out that students developed their encouragement within themselves by asking support from people around them (Pieronkiewicz and Szczygiel, 2020; Lee and Simpkins, 2021). The third step, which is C: Create, students developed mathematical resilience in the part of Struggle and Growth because they may find writing difficult but because they have their friends and teachers who provide advice and support until they are able to write a complete demonstration of how to do it (Froiland and Davison, 2016; Middleton et al, 2017; Strati et al, 2017). And the final step is S: Share. Students developed mathematical resilience in Struggle and Growth because students have to put effort into presentations, showing how to do it and find answers from friends and in cases where there are student volunteers who come out and write to show how to solve problems or find incorrect answers on the board, teachers reinforce and encourage that solving problems in the wrong way or getting the wrong answer is not a big problem in learning mathematics. When the students made a mistake, they can always correct it. And most importantly, those mistakes were lessons for others to learn from as well. In addition, when considering the mathematical resilience section after the students received learning activities using SSCS Learning Activities with Bar Model, it was found that the students had the highest level of mathematical resilience, accounting to 95.23 percent, or 140 students, there were 7 students, accounting to 4.77 percent, who had a medium level of mathematical resilience. When the researcher interviewed some students to gain in-depth information, it was found that the anxiety, fear, and insecurity when students had to do difficult fraction word problems disappeared (Zulnaidi et al, 2020) after the students received learning management using SSCS Learning Activities with Bar Model. The students have more confidence, understanding, and learn to have fun solving fraction word problems (Samuel and Warner, 2019). Students can visualize images showing how to find answers to problems easier and faster. Moreover, students are not worried if they do wrong fraction word problems (Dweck, 2000) because the teacher is available to support and explain further. Students are encouraged to take on more difficult fraction word problems. This is from the information obtained from interviews with all students. The researcher further understood that organizing learning using SSCS Learning Activities with Bar Model helped them recognize that mathematics is a valuable subject and see the benefits of applying it to their daily lives, including extending it to other subjects. The more students think mathematics is valuable, the more motivated they will be to learn. This included the fact that students accept that effort in learning mathematics is a common problem for those who are studying mathematics. Even students with strong mathematics skills have to put in the effort to learn mathematics (Johnston-Wilder et al, 2013). Students experience a feeling of hopelessness when solving mathematics problems (OECD, 2013) and students have difficulty

understanding difficult math topics. However, after having been taught using SSCS Learning Activities with Bar Model, the thoughts of the students changed. Students are given confidence that they will develop their mathematical resilience and be successful. Students know that there are resources available to support their learning. They have a positive attitude towards studying mathematics and are able to overcome obstacles in learning mathematics. This includes requesting help from others when necessary.

Learning achievement about fraction word problems for students in Grade 6, after receiving learning management using SSCS Learning Activities with Bar Model, was higher than the criteria of 70 percent. This may be due to learning management using SSCS Learning Activities with Bar Model, allowing students to practice understanding the problem, analyzing what the question asks and what the question specifies. The students are able to plan and carry out problem solving using the Bar Model technique. They are able to bring the results from solving problems to create their own mathematical problems. It is a sequence of steps for communication with others, including practicing presentations and accepting the options of other people. From this research the results of student learning achievement in fraction word problems was shown to be higher than 70 percent. In addition, 57.82 percent of students had a relative gain score in fraction word problems after receiving learning activities using SSCS Learning Activities with Bar Model of more than or equal to 50 percent, and there were 42.18 percent of students, accounting for 62 students with a relative gain score increase of less than 50 percent. When considering the scores on the test of student achievement on fraction word problems before and after class, the group of students who had a relative gain score increase of less than 50 percent, it was found that 61 out of 62 students in this group had an increase in post-study scores. However, this increase was still not double what the students had learned from what they did not know before arranging the SSCS Learning Activities with Bar Model. In fact, the score of one student did not increase, but stayed the same because this student received a full score of 10 points before studying fraction word problems, and after the re-test, her score remained at 10.

Organizing learning activities using SSCS has the advantage that students get practice in understanding problems, analyzing the problem plan and carrying out problem solving using various methods in order to compile the results to solve the problem. It is a sequence of steps for communication with others, including practicing presentations and accepting the opinions of others, all of which leads to develop in student learning.

SSCS learning activities are suitable for all groups of students. From the post-study results we can note whether students are good, average, or weak. During the first period of organizing this set of SSCS learning activities, most students were not familiar with the learning activity format in which they had to carry out each step by themselves. This means that each step in the first period takes a long time to complete. However, when entering the second period, most students began to understand and become familiar with the SSCS format, causing them to spend less time on activities. Students practice regularly, which results in them developing a systematic learning and problem solving process.

The study also suggests that organizing learning activities using SSCS Learning Activities with Bar Model in the first period is quite time consuming, since students are not yet familiar with learning this method. It can cause confusion among students. Teachers need to organize activities for students to gain sufficient teaching experience. It is useful for them to be trained in using the Bar Model technique. Organizing SSCS Learning Activities with Bar Model in step 2 (Solve) and step 3 (Create), the steps for thinking about answers and composing them

in a sequence, teachers should give appropriate time to think and understand problem solving. If there are students who cannot solve the problems, teachers should provide advice and guidance. When organizing SSCS Learning Activities with Bar Model, teachers should make all students participate in learning activities. Teachers must use questions to encourage students to feel involved in learning activities. In step 4 (Share) of the SSCS Learning Activities with Bar Model process, teachers should provide opportunities for students to express their opinions according to their ideas, without being quick to judge their ideas as right or wrong. Instead, teachers should give students the opportunity to discuss methods for problem solving and finding answers.

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