

# Analysis of Road Thinking of Students of Sma Negeri 1 Panyabungan Timur in Solving Spatial Problems in the Problem-Based Learning Model

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**Abstract** This study aims to: 1) Determine the spatial ability test results of students in problem-based learning models 2) determine the trajectory thinking SMA Negeri 1 Panyabungan East in solving spatial problems on a model of problem-based learning. Subjects in this study is a class XII MIA SMA Negeri 1 East Panyabungan as many as 30 people. This research was qualitative descriptive. The research instrument is a test of spatial ability and interview guidelines. Subject to interview selected as many as 6 people based on the mathematical level of spatial ability. The results showed that: 1) The level of spatial ability in high-ability students have the highest proportion as many as 10 students, followed by the ability students were 14 students and their poor performance as much as 6 students. So, the percentage level of spatial ability students with the ability to 'high' as much as 33.3%; the ability to 'moderate' as much as 46.6%; and the ability to 'low' as much as 20%. 2) Stages of the thought process that is owned by the learners as well as results and findings of this research were the visualization, analysis, informal deduction, deduction and rigor that will be passed as a track point thinking of students.

**Keywords:** *spatial capabilities, problem based learning, students' thinking path*

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## 1. Introduction

According to thinking [1], including learning activities, to think people are getting a new invention, at least people are understanding of the relationships between things. A student with his way of thinking is expected to find its answer to the problems that the teacher thus further expected that students will know and understand the material given by the teacher.

Based on the above definition, thinking can be interpreted as the beginning of knowledge that can be gained by connecting in the form of a concept, an idea, or notion so recently formed a conclusion.

Van Hiele theory is a theory about the level of thinking of students in studying the geometry of one of them in the wake of the flat side room, where students can not rise to a higher level without passing through the lower level. Van Hiele writes that the level of thinking can be seen from the following levels: Base Level (Visualization) assess a form of appearance, First Level (Analysis) shape viewed from nature, Second Level (Informal Deduction) to connect a variety of forms based on nature, Third Level (deduction)

think is associated with the meaning of deduction, and Fourth levels (Rigor) understanding and reasoning of the system without using the example of the model geometry, The thought process can be influential in resolving a problem [2]. The thought process is a process of thought in completing their nets problem [3]. Jalan solving trajectory that's called thinking. With the path traversed think students would pose questions to students in solving a problem. One of the capabilities that can enhance students' way of thinking is that spatial ability. Spatial ability can be defined as the ability to generate, maintain and retrieve and change the visual image [4]. Just like Linn and Petersen [5] suggested that spatial ability in the ability to represent, transform, and recall the symbolic information. The ability of spatial thinking leads to students' mental skill set that allows students to think about space and the relationship of an object with another object.

This spatial ability itself requires a high level thinking skill in perceiving and imagining geometrical forms, therefore requires high imagination [6]. This is also [7] students with the ability of high spatial performed significantly better than students with low spatial, if the spatial ability math students have high, the ability of these

students to mathematics generally too high. Likewise expressed by [8] that he found a positive relationship between mathematics achievement and spatial abilities. The indicators of spatial ability is divided into five components, namely: 1) spatial perception: way of looking at an object from the vertical and horizontal viewing angle. 2) Spatial Visualization: the ability to show a change or displacement of constituent a good wake-up three-dimensional to two-dimensional, or vice versa. 3) Mental Rotation: the ability to rotate objects two-dimensional and three-dimensional and accurately. 4) Spatial Relationships: the ability to understand the structure of an object and its parts and their relationship to one another. 5) spatial orientation: the ability to observe an object from different angles. The ability to understand the structure of an object and its parts and their relationship to one another. 5) spatial orientation: the ability to observe an object from different angles. The ability to understand the structure of an object and its parts and their relationship to one another. 5) spatial orientation: the ability to observe an object from different angles [9].

Students perform a series of processes of thinking in solving geometry problems. In the thought process, there are several grooves or path traversed students, such as students who should be able to visualize or illustrate images of geometry in his dreams. This is closely related to spatial intelligence possessed by each individual. A student with high spatial ability is possibly more successful in the process of visualization when compared with students with moderate or low spatial ability. Thus the importance of spatial ability so that teachers are required to provide more than enough attention so that spatial skills are taught in earnest following the mandate of the curriculum [10].

To support the improvement of spatial skills the students will be given learning support students to conduct activities involving real objects varying geometry and draw it. The involvement of these elements must be sought in learning to be selected or designed. Therefore, the author chose to use a model of problem-based learning. It is one of the ways that make the learning model contextual problems as a trigger of learning through the stages to orient students to the problem, organizing students to learn, Guiding investigation of individual or group, develop and present work, analyze and evaluate the problem-solving process.

To learn more about the link between the level of spatial ability to track students' thinking in solving spatial problems on a three dimensional model of problem-based learning, the researcher intends to mentality about "Analysis Tracks Thinking Students of SMA Negeri 1 Panyabungan East in Solving Spatial Model Problem-based Learning".

## 2. Research Methods

This research was qualitative descriptive. Qualitative description is intended to construct or describe the phenomena that occur on the track thinking SMA Negeri 1 Panyabungan East in solving spatial problems on a model of problem-based learning.

Subjects in this study involved students of class XII who were treated a model of problem-based learning in

the first semester of the school year 2018/2019 the number of students 30 people. Then based on the test results of the tested spatial ability students will have several students as a subject to be subjected to an interview.

Appointment subject to an interview subject raised by the analysis (observation) on the classification level of spatial ability of students and visits from student activity data. We will have 6 students who will be interviewed. Results of tests and interviews the six students were then analyzed through triangulation. Data analysis techniques in this research are data reduction, data presentation subsequently deduced.

## 3. Results

### 3.1. Spatial Ability Test Result Data

After implementing the learning using Problem Based Learning Model in three-dimensional material for 3 (three) meetings then continued tests on the students to see the students' mathematical spatial ability.

The results of tests that have to be corrected (Appendix 10) presented a mathematical spatial ability level of students in Table 1.

Table 1. Spatial Ability level Mathematically Students

No.	Interval Scores	Total Students	Percentage	Category
1	$0 \leq SK < 65$	6	20%	Low
2	$65 \leq SK < 80$	14	46.6%	Moderate
3	$80 \leq SK < 100$	10	33.3%	High

The interview stage will have some students who will be subjected to interviews by the level of students' abilities and views of student activity data. The subject of research will have adjusted to the indicators of spatial ability students were grouped into three categories: high, medium and low. The third category of students each were analyzed to obtain patterns of student answers. In each category will be selected every 2 students. Students will be interviewed based on the answer sheet for each student. So that would be obtained of how the thinking of students in solving spatial problems that triangulated based on the answers students work on LAS and video during the learning.

Answer all of the students then are grouped by components of spatial ability. In Figure 1, which described the spatial components of the highest percentage to lowest percentage. The spatial component obtained percentage of all students having completed spatial problems are: 1) spatial visualization component is the highest of 89.9%; 2) component spatial perception has a percentage that is counted 74.4%; 3) The percentage component of spatial orientation has as many as 72.2%; 4) mental rotation component obtained by 56.6%; 5) component of the spatial relationship of 17.7%.

Based on the results of tests of the spatial ability of students has been corrected following the scoring guidelines, then 30 students have as many as six students who form the subject of this study by the criteria of ability level.

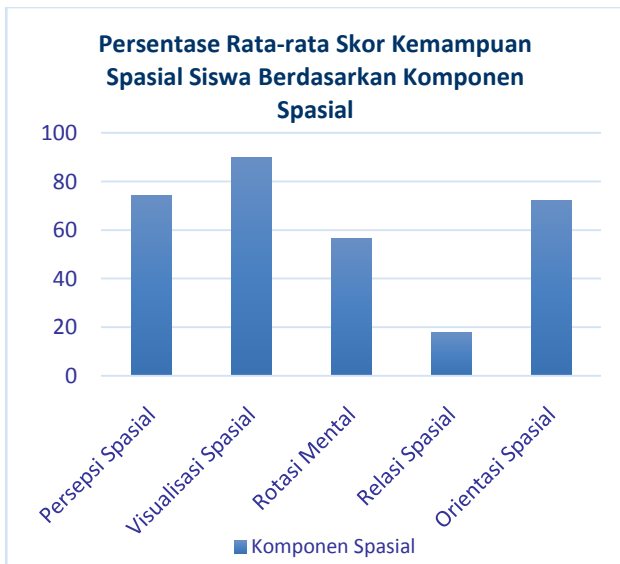


Figure 1. Diagram Persentase average Spatial Ability Students Score Based on Spatial Capabilities Component

Table 2. Subject Selected for Interview Spatial Ability Students

No.	Student Code	Appointment Subject Judging From Aspect
1	S-4 and S-29	High Performance
2	S-15 and S-22	capable of Being
3	S-8 and S-26	Bluetooth Low

Of the interviews on the subject carried out on each classification pattern of responses raised by the criteria of ability (high, medium, and low). Analysis of data from the test data spatial ability students triangulated by identifying the problem that is solved by the students. Analysis of the student's thinking process on spatial ability was found the appropriate level of spatial ability students.

### 3.2 Tracks Thinking Students in Solving Spatial Model Problem Based Learning

The initial phase is done by all students is almost the same, only the time needed to understand the problems of some students are relatively different. For example, students S-4 and S-29, which according to the researchers that two students had higher levels of mathematics compared with more friends. Based on interviews with students that two students are daily more quickly understand the problem than other students. It is also justified by their math teacher, where time is needed for students in solving problems require a different time. This happens because the level of the students thinks differently from each other.

In the early stages, based on interviews of the student researcher S-4 and S-29 related to the activities of thinking when students were asked about spatial problems on some 1 to 3. Students do not necessarily directly understand what to do to resolve the problem. Students should try to understand the problem. They must understand and recognize what they were told in a matter of numbers 1 to 3 and what they should do to solve the problem (the interview).

In the second stage, students made preparations to gather the information they will get to assist them in resolving problems. Students will create a strategy to plan, think of ways to analyze what exactly the problems that

occur on these issues. In this second phase, the students try to locate and recall problems ever given by a teacher to them. From the previous question, they will find the relationship between the known and questioned as well as coping strategies that will be used to resolve the problem that is being done by the students (interviews and observations).

Based on observations, some students just stood and watched, clutching his sheet. Some students asked his friend and teacher. It asked the students is what additional information they need to understand and search continue their activities in solving spatial problems.

In the third phase, students do activities that they should do to get new ideas. Students gave sorting what to do first to proceed to the next stage. They relate relationships will occur related to spatial problems given. At this stage, students also have doubts about the answers he got. At the time of the doubt the student to reflect, where they rested for a moment the brain to not think. Most students do activities reread to add insight into understanding the issue eg students with the code S-4, S-29, S-15 they perform the same activities are reread. There are also students do activities such as student muses S-8 and S-26.

Based on observations, the students undertake other activities such as silent, dreamy, bullying, calm down which makes them take off for a while to think. For example, S-8 students in solving seemed to have weight problems were thinking but did not do anything. Students S-29, to distract him from the problems faced by other activities.

In the fourth stage, a way of thinking deduction students begins to grow. Students at this stage conduct prove a problem by using a logical reason. Students also get an idea that had been obtained at the stage of informal deduction. The idea gained more be emphasized again in this fourth stage is the stage of deduction. For example, students S-4, when complete spatial problems. Students S-4 proved results aqua answer by imagining his glasses were purchased at school. At the time the test is given, students S-4 and using aqua glass remembered it as a tool to help understand if the beam position in the tilt (the interview). While the S-29 students a different way of proof with students S-4, S-29 where students imagine a beam position by leveraging its pencil box.

In the fifth stage, the students perform the accuracy of evidence that has been done. This means that students check the answers that have been done. This is done so that if something goes wrong student on student answer is still time to correct answers. For example, students S-4, S-22, S-29, the three students are doing a re-examination will be done and solidify answers on the answers with the correct answer. However, unlike the students of S-26, S-26 where students know there is a fault on the answer sheet but students S-26 did not change overdo its answer. This is because the student is already saturated and her brain could not think any more (interviews).

#### 3.2.1. High Spatial Capabilities

Students are students coded S-4 and S-29. Students S-4 states that the learning model of problem-based learning makes him more excited and pleased to learn that more understanding and understanding of learning. This is evident from the results of tests of spatial ability mathematical been done properly.



Working result matter by the students coded S-4 as follows in Figure 2 below:

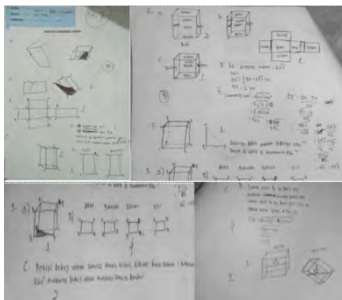


Figure 2. Results Answer Student S-4

From the results of an interview on the matter of the number 1, students S-4 was able to think of the familiar geometrical based on the nature and characteristics and relate them to objects that exist nearby, can analyze a wake room if the room woke played with  $270^\circ$  and can position wake of a room a different angle on the play after  $270^\circ$ .

From the results of an interview on Question 1, I found that the way to think S-4 and S-29, the same is to understand the problem and connect it to the surrounding objects that are used as a tool. Only students S-29 requires a fair amount of time compared to students S-4 in analyzing a wake room if the room got up and played back to  $270^\circ$  can be positioned wake of a room a different angle on the play after  $270^\circ$ . Working result about the S-29 students coded as follows in Figure 3 below:

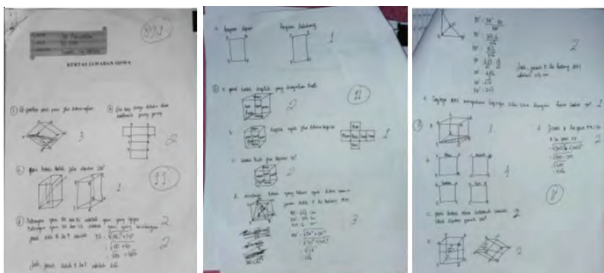


Figure 3. Results Answer Student S-29

**3.2.2. Spatial ability Medium**

Students are capable of being that students coded S-15 and S-22. Students S-15 and S-22 at the time of the interview stated that learning with problem-based learning models made himself motivated to learn more so that more understanding and understanding of learning. This is evident from the results of tests of spatial ability that has worked quite well.

The working result about the S-15 students coded as follows in Figure 4 below:

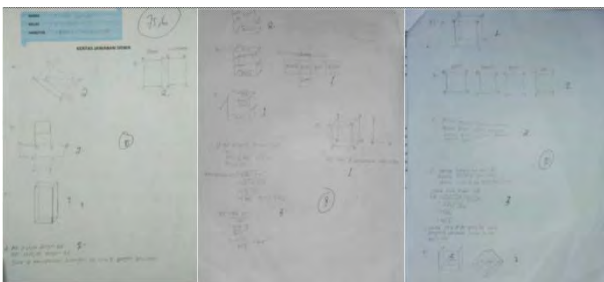


Figure 4. Results Answer Student S-15

From the results of an interview on Question 2, the students of S-15 was able to think of the familiar geometrical based on the nature and characteristics and connect it with props that are designed to better understand the issue and can analyze a structure of space if the wake-up space is being played with  $90^\circ$  and can position wake of a room a different angle like Dad want the white color so the pedestal and Rudi wanted a yellow color into the base. However, students of S-15 is not good at counting process.

From the results of an interview on Question 2, I found that the way of thinking of S-15 and S-22 there is a difference, where students S-15 in the counting was not smart enough while students S-22, still no effort to be able to resolve the issue though constrained because of time. Both students can understand a problem and connect it to the surrounding objects that are used as a tool. Only S-22 students need the help of friends. Also, both can analyze a wake room if the room woke played with  $90^\circ$  and can be positioned wake of a room at a different angle after the swivel  $90^\circ$ . Working result matter by the students coded S-22, in Figure 5 as follows:

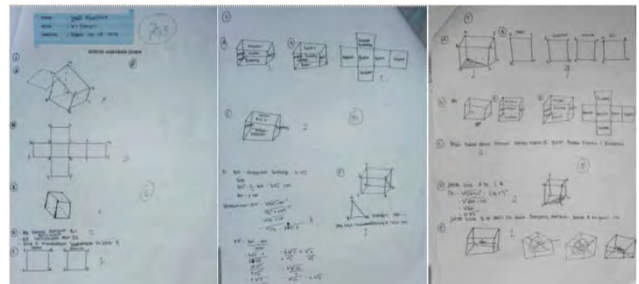


Figure 5. Results Answer Student S-22

**3.2.3. Spatial Ability Low**

Subject to the student code S-8 and S-26 is a subject that has a low spatial ability test results. Interview excerpt presented as follows. Working result matter by the students coded S-8 in Figure 6 as follows:

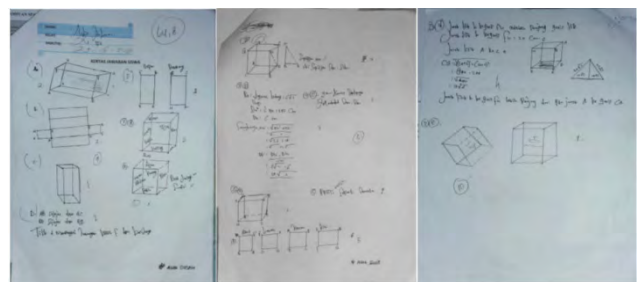


Figure 6. Results Answer Student S-8

From the results of an interview on Question 3, the S-8 students can visualize the image of the form webs into a perfect box shape. Besides, S-8 students are also able to determine the position of each side of the box from a different part of both front, rear, right, left, up and down. Only on the spatial relationships of students can not solve the problem because there is pretty good at counting. S-8 students could analyze a wake room if the room woke rotated by  $360^\circ$  counter-clockwise, but at about the 1 and 2 students S8 can not fantasize about the position of objects if in the play in  $270^\circ$  and  $90^\circ$ .

From the results of an interview on Question 3, the S-26 students where students S-26 also was able to visualize the image of the form webs into a box shape that is perfect as S-8 students. Also, the S-26 students can determine the position of each side of the box from a different part of both front, rear, right, left, up and down. Only on the spatial relationship of S-26 students can not solve the problem because there is pretty good at counting but still no attempt to resolve the problem by considering the way of solving the same problem. Students S-26 is not at all good at dreaming up a position wake the room if the room woke played with  $360^{\circ}$ ,  $270^{\circ}$  and  $90^{\circ}$  different thing with S-8 students who still can fantasize geometrical position if played  $360^{\circ}$ . Working result matter by the students coded S-26, in Figure 7 as follows:

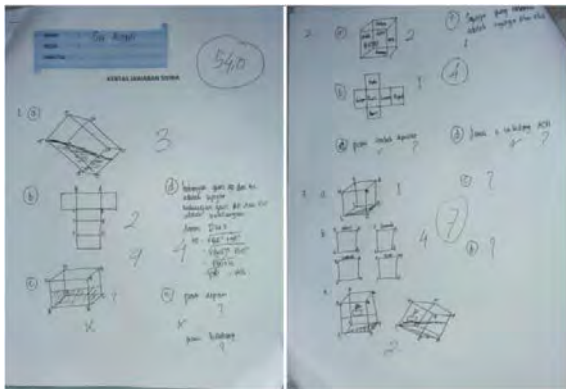


Figure 7. Results Answer Student S-26

## 4. Discussion

The discussion conducted with several stages, namely: to interpret the research findings by using logic and relevant theories exist; compare research findings with theoretical and empirical findings more relevant; and analyze / assess the new theory or modification theory.

### 4.1. Students Spatial Ability

The application of problem based learning models that are used as a benchmark in learning can enhance students' thinking to the spatial direction. The zero point to see an increase in spatial ability students are comparing the value of students before and after the study is done. This is also supported by other studies that [11] in his research found that the approach of Problem Based Learning in Class XII Science Semester Program 4 SMAN 1 Sukabumi City Academic Year 2017/2018 very good and positive, and indicate that students increased spatial ability, Problem based learning model is able to build a way of thinking students in imagining an object so that all students have a spatial kamampuan, but with the ability to spatially different for each student.

Based on the results of tests of spatial problems, students can build a lot of ideas in him, including the idea that rare or unique. One of the unique ideas of students are students discover the answers of the given problem by creating a web of a cube of paper used books, then the paper is marked as determine the position of points A, B, C, D, E, F, G, and H. in addition, the unique idea of

students are students connect any nearby objects with the given problem such as pencils and erasers box that resembles the shape of the beam. Students can also build capabilities and the ability to connect with the delusional other sciences. Students solve problems mathematically integrated with arts (drawing). Students calculate the distance between the point of the point, the point to the lines.

Each student has the answers represent the spatial component is 5 to spatial perception, spatial visualization, mental rotation, spatial relations and spatial orientation, but many of the answers given to the different results. The problems solved by students from number 1 to number 3 on the aspects of the spatial component that spatial visualization and spatial perception is a matter of the most easily done by students. While aspects of the spatial component that mental rotation and spatial relation is a difficult problem done by all students.

For students - students with high spatial ability has a good thought process. According to his teacher, the students - students also belong to the students, including smart in class. As for students with low spatial ability has a thought process that is not good. The students also have a low academic achievement. This is in line with the opinions [7] which states that students who excel in school have a higher level of creativity than other students, however not necessarily the most intelligent students who are the most creative students.

### 4.2. Thinking Trajectory Math Students

On the results of relevant research track students' thinking in line with the opinion of [12]. Namely, the learners to read and try to understand all the problems; want to get mathematical ideas; discover what information is known and asked of the matter; and look for scraps of information from contextual issues (eg: the size and geometrical formulas to calculate the area).

The first track students' thinking can already be familiar with both the geometrical capable students of high, medium or low. However, there are differences between students in understanding the problem. Where, high spatial ability students can understand the problem with a faster time to question the easiest and also difficult. As for the students who have spatial abilities were almost the same with high spatial ability students. It's just that capable students are trying to understand the questions that are categorized difficult, given enough time faster than low-ability students. Students who have a low level of spatial ability long enough to matter the most easy and difficult.

The second track is the analysis of which students analyze a plan that is used to solve the problem. A highly capable students to find a solution does not require a long time and ideas that had emerged suddenly. Same thing with students who are capable of being, students find ways to solve the problem but with a long enough period compared to students who are capable of high spatial. In contrast to the low spatial ability students who require a long time to be able to analyze the spatial problem.

The idea came, through which the groove is informal deduction phases, namely sorting and linking related relationships between waking up space. High-ability

students can skip this step and connect things associated with waking up space. For example, students S-4 that connects the objects around it are linked to existing problems in a matter of who makes the students better understand and be able to resolve the issue quickly. In contrast to the moderate abilities of students, where students are capable of being anything else is to create a web that resembles a cube each corner marked. While the low-ability students can not connect and imagine new ways of thinking done by medium and high-ability students.

Next stage of deduction, which students prove the results of the answers by using a logical reason. Students are capable of high spatial and was not missed this groove. Where high spatial ability students and is proven on the answers they have done so if there was an error to allow them to change to a more correct answer. Unlike the students who are capable spasia low. These students do not perform these activities because they do not want to complicate itself with the answer she had done.

The stage of rigor (accuracy), students retest matter that has been done with the precision and accuracy within. At this stage the high-ability students to reexamine the answers he got with thoroughness and ketepatan that corresponds to his way of thinking so that if something goes wrong, the student can improve and obtain the correct answer. Likewise with moderate spatial ability students, where students test answers back over there but requires accuracy in comparison with low spatial ability students. While the students are capable of low spatial difficulties in finding an answer, it requires a long time to find the answer.

## 5. Conclusion

Of the 30 students in the mathematical level of spatial ability capable students currently have the highest proportion as many as 14 students, followed by the high-ability students 10 students and their poor performance as much as 6 students. Thus, the percentage of students' mathematical level of spatial ability with the ability to 'moderate' as much as 46.6%, the ability to 'high' as much as 33.3%, and the ability to 'low' as much as 20%.

At the beginning of students' thinking path already be familiar geometrical capable students either high, medium or low. However, there are differences between students in understanding the problem. On the second track is to analyze a problem with making a plan to resolve the problem. Students who are highly skilled and are to find a solution does not require a long time and ideas that had emerged suddenly, in contrast to the low spatial ability students need a long time to be able to analyze the spatial problem. Once the idea came, through which the groove is informal deduction phases, namely sorting and linking related relationships between waking up space.

High-ability students as well as being able to pass through this stage and connect things associated with waking up space. The next stage of deduction, which students prove the results of the answers by using a logical reason. Students are capable of high spatial and was not missed this groove. At the stage of rigor (accuracy), students retest matter that has been done with the precision and accuracy within. At this stage the high-ability students to reexamine the answers he got with thoroughness and ketepatan that corresponds to his way of thinking so that if something goes wrong, the student can improve and obtain the correct answer. The time required to answer different questions for each capability. High spatial ability of time needed to answer the question for a moment and feel confident about the answer. whereas for low spatial ability students, students require a long time to find the answer.

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