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Characteristics of Students Sensory Mathematical Imagination in Solving Mathematics Problem

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ABSTRACT

This study aim to investigate the characteristics of students' sensory mathematical imagination of in solving mathematics problems. This study includes qualitative research with two students of VIII grade junior high school used as subjects. To determine the characteristics of students sensory mathematical imagination who appeared in solving mathematics problems, researchers use the problem sheet as a supporting instrument in this study. The problem sheet consists of a question item that serves to stimulate appear of students sensory mathematical imagination. For accuracy of data using triangulation method of observation, students answers, and interviews. The results showed characteristics of students sensory mathematical imagination in solving mathematics problems is appear of the idea based on perception due to stimulate of the problem, actualization information by analogy according to what people think, the activity involves body movement (sensory motor), can be seen through visual representation.

KEYWORDS
Perception; sensory mathematical imagination

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Introduction

Research related to imagination in learning mathematics ever done by Wilke (2010), Chapman (2008), and Nemirovsky & Ferrara (2008). The results showed the importance of mathematical imagination in solving mathematics problems can help students develop their thinking. Similarly, research Swirski (2010), Samli (2011), Kotsopoulos & Cordy (2009), van Alphen (2011), shows the results of these studies strongly support the involvement of imagination in

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learning. Without imagination, anyone can not imagine an event in history or verbal problem in mathematics (van Alphen, 2011).

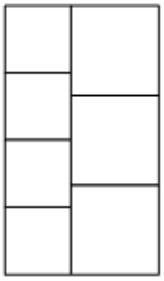
Samli (2011) says, imagination is ability to form images and ideas about things never seen or experienced before. While van Alphen (2011) considers imagination as ability of the mind to evoke a mental picture of what is not present, they experience as if they were real. In this case, imagination is ability of the mind which serves to form an image or certain ideas. So mathematical imagination in this research is ability of the mind to form ideas in solving mathematics problems. The based assumption is when students in face of mathematics problem, mathematical imagination can help thinking of students in finding solution ideas to solving the problem.

Wibowo & As'ari (2014) divides three types of students mathematical imagination in solving mathematics problem, namely sensory mathematical imagination, creative mathematical imagination, and recreative imagination mathematical. Sensory imagination basically is perception such as the stimulation of problem (Currie & Ravenscroft, 2002). From perception can appear of idea for solving mathematics problems. This idea is a form of imagination that is appeared by students. Wibowo & As'ari (2014) said, sensory mathematical imagination can be seen through appear of the idea based on perception after receiving stimuli of the problem. How characteristics of students sensory mathematical imagination in solving mathematics problems? In this paper will describe characteristics one type of mathematical imagination namely sensory mathematical imagination. So the aim of this study to determine characteristics of students sensory mathematical imagination in solving mathematics problem.

Research Methods

This study used a qualitative approach. A qualitative approach was chosen because it fits the characteristics possessed, ie scientific environment, researchers as a key instrument, qualitative methods, inductive data analysis, design develops and nature interpretation (Creswell, 2014). The object of research is characteristics of students sensory mathematical imagination in solving mathematics problem. The subjects were 2 students of VIII grade junior high school were taken by considering students ability in solving mathematics problem sheet. Problem sheet consists of a question item that serves to explore appear of students sensory mathematical imagination. Here problem sheet is used in this study.

QUESTION
See the picture below!



The image is consist of four congruent square and three congruent square. Find the length of square side possible (as much) on each square in order to fill the image!

Figure 1. Problem Research

The data collection technique using answer sheet of test, observation and interviews. The data collected in this study a descriptive data were then analyzed by inductively. Analysis of data using qualitative analysis techniques developed by Creswell (2014), which includes reducing data, presenting data, and draw conclusions. For accuracy of data using triangulation techniques ie observation, students answers, and interviews.

Research Result

Analysis characteristics of students sensory mathematical imagination assessed based on appear of students sensory mathematical imagination in solving problem. Here's exposure data and analysis appear of students sensory mathematical imagination in each subject.

Analysis Appear of Sensory Mathematical Imagination in Subject 1 (S1)

S1 started to work on the problems with reading the question with think aloud for 80 seconds. S1 then moving the fingers over the matter, it indicates subject tried to examine and understand the question. This activity lasted for 120 seconds, but subject has not been able to understand the question. It is seen S1 repeat to reading the question for getting information, corresponding to statement following subjects.

S1 : *The length is not known*.

Subjects were informed that the length of each square on the matter is not known. From this information then S1 see images more carefully in order to obtain information:

S1 : *The length of four small square sides equal to the length of three large square sides*.

Subjects can know that the length of four small square sides equal to the length of three large square sides by drawing square contained in the matter. It shows S1 has been able to understand the intent of the question.

Furthermore S1 trying to find the solution of the problem. S1 moving the fingers on the table, it shows subject uses his thinking process to find the solution of the problem. This activity lasted for 70 seconds, then subject says:

S1 : *The length of all 12*.

Subject inferred the length side of all square is 12 cm. Although subject can determine the length side of all square 12 cm, but subject look still difficulties in determining the length side of each square. After contemplate a moment, subjects have perception that the length side of small square 3 cm and large square 4 cm. This is consistent with statement of subject:

S1 : *The length of small square 3 cm and large square 4 cm*.

This idea appear on based subject perception after received stimulus of the problem in question. Stimulus is the order in the matter to determine the length side of each square that fill the image. These stimulus arising to subject perception which then appear the idea to determine the length of each side of square. This idea is a form of students mathematical imagination in facing of such problems or so-called sensory mathematical imagination. This is reinforced by the answers of subject that demonstrate this.

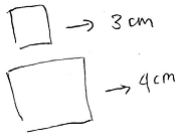


Figure 2. S1 Drawing of Square With the Length

As confirmed why subject determines the length side of small square 3 cm and large square 4 cm, subject is not able to disclose the reason. This reinforces the notion that sensory mathematical imagination is closely linked to perception of student. To reinforce this case the researcher (P) conducted interviews with subject:

P : *Why is 3 cm and 4 cm, instead of 3 cm and 5 cm*?

S1 : *Silently*.

Subject is not able to disclose the reasons why choosing the length side of square 3 cm and 4 cm not others. This indicates that subject determines the length side of square 3 cm and 4 cm is perception by looking at relationship between total length of 12 cm with the length of each square.

Above description shows S1 is able to appears of sensory mathematical imagination in solving the problem, but can not appear another type of mathematical imagination. Structure of sensory mathematical imagination processes S1 can be illustrated in the diagram below.

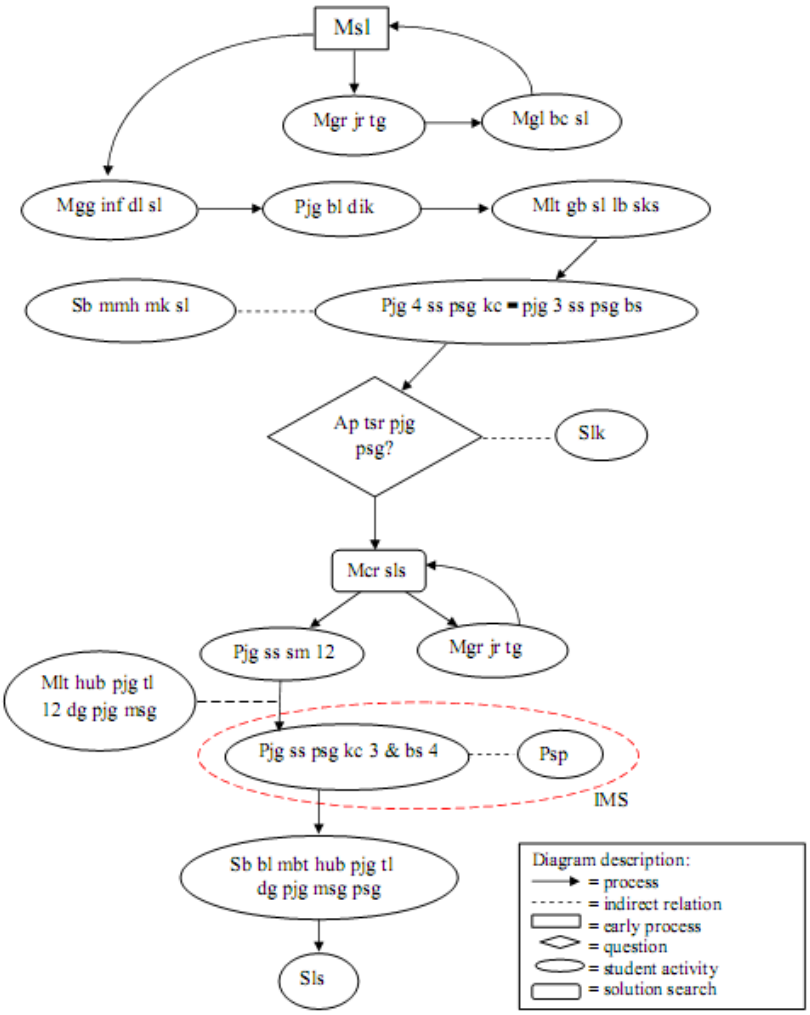


Diagram 1. Process Appear of Sensory Mathematical Imagination S1

Table 1. Term Code Process of Mathematical Imagination S1

Term	Code
Problem	Msl
Moving the fingers	Mgr jr tg
Repeating reading the matter	Mgl bc sl
Digging information in the question	Mgg inf dl sl
The length unknown	Pjg bl dik
Seeing pictures of the matter more carefully	Mlt gb sl lb sks
Length 4 side of small square = length 3 sides of large square	Pjg 4 ss psg kc = pjg 3 ss psg bs
Subject able to understand of intent the matter	Sb mmh mk sl
Do up the length of square sir?	Ap tsr pjg psg?
Please	Slk
Finding solutions	Mcr sls
Moving the finger	Mgr jr tg
The length side of all 12	Pjg ss sm 12
See relationship between total length of 12 cm with the length of each square	Mlt hub pjg tl 12 dg pjg msg psg
The length side of small square 3 cm and large square 4 cm	Pjg ss psg kc 3 & bs 4

Perception	Psp
Sensory mathematical imagination	IMS
Subject has not been able to make a more distant relationship between total length with the length of each square	Sb bl mbt hub pjg tl dg pjg msg psg
Finished	Sls

Analysis Appear of Sensory Mathematical Imagination in Subject 2 (S2)

S2 begin work on the problem and read aloud for 70 seconds. S2 redoing read the problem to understand intent of the problem. After a while S2 to make a square on the answer sheet as an image problem with a large size. Then S2 make the lines on the image horizontally or vertically. The images obtained looks like this:

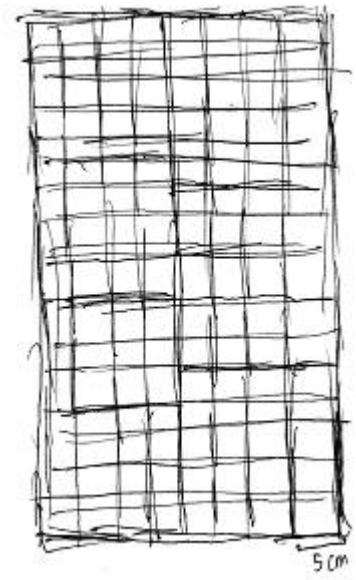


Figure 3. The Square Image that done S2

Then the researcher questioned on subject:

P : *How the length sides?*

S2 : *5 cm*

Subjects have perception that the length side of small square is 5 cm. Then the researcher ask further:

P : *How can 5 cm? Why not 3 cm?*

S2 : *if 3 cm smallness.*

This perception appear from the image be done by subject. Subjects did not link between the length of a small square with a large square that actually have different lengths. This perception such allegations of subject saying 3 cm too small. This perception appear due to the stimulation of issue in the problem to determine the length of square, that is equal to 5 cm. This is a realization of sensory mathematical imagination produced by subject. Furthermore, the researcher ask:

P : *How length sides of the small square and the large square?*

S2 : *The length of small square 5 cm and the length of large square 20 cm.*

P : *Why 20 cm?*

S2 : *Because there are 4 square.*

Subject suspect the length of one square is 20 cm, which is subject say a big square. Each square divide into four a small square vertically and also horizontally (as shown in Figure 3). The small square has a length of 5 cm, with reason that there are four small square that meets a length of 20 cm. Although it looks quite logical, but this step is actually not right. Because two square image in question has a different size and length difference is not so great. Furthermore, the researcher asks:

P : *This is made of small squares for what purpose?*

S2 : *to fill the image.*

Subject making small squares as shown in Figure 3 with the purpose to fill the image.

P : *How as much as possible?*

S2 : *Do not know*.

Subjects do not know the length of square side as much as that in asking the question. Answer students when it appeared the length of square side 5 cm is a perception which is a form of students sensory mathematical imagination in solving the problem. The above description shows, S2 is able to appear sensory mathematical imagination in solving the problem, but can not appear another mathematical imagination. Flow appear of sensory mathematical imagination S2 can be illustrated in the diagram below.

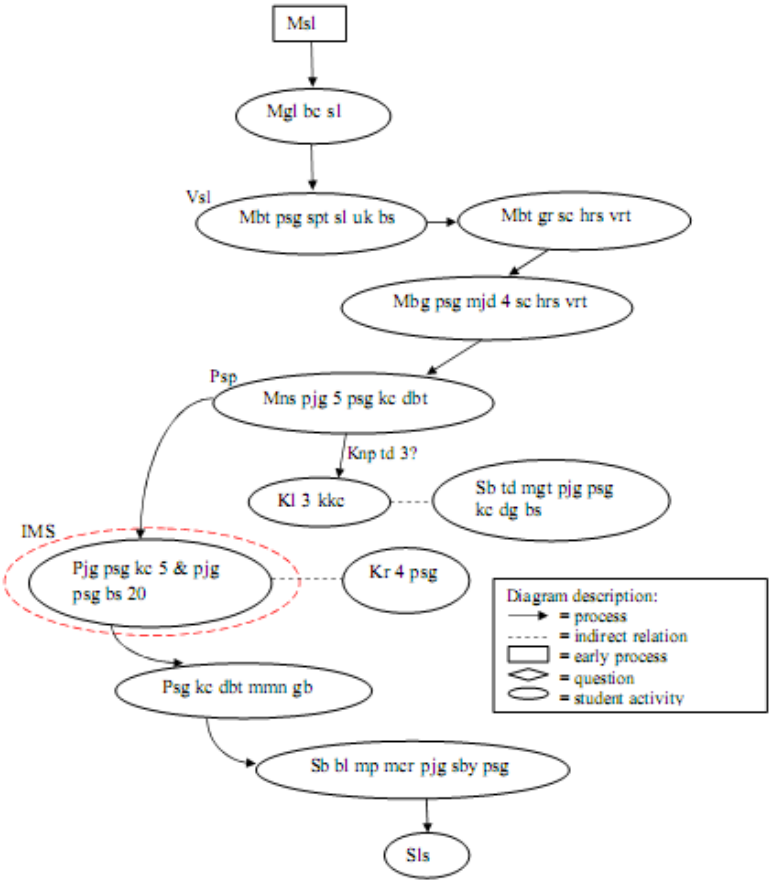


Diagram 2. Flow Appear of Mathematical Imagination S2

Table 2. Terms Code Process of Mathematical Imagination S2

Terms	Code
Problem	Msl
Repeat reading the problem	Mgl bc sl
Make of square such the problem with great size	Mbt psg spt sl uk bs
Visualization	Vsl
Make of lines horizontally or vertically	Mbt gr sc hrs vrt
Dividing each square into 4 square horizontally or vertically	Mbg psg mjd 4 sc hrs vrt
Writing a length of 5 cm on a small square made	Mns pjg 5 psg kc dbt
Perception	Psp
Why not 3 cm	Knp td 3
If 3 cm smallness	Kl 3 kkc
Subjects did not link between the length of small square with the length of large square	Sb td mgt pjg psg kc dg bs
The length of small square 5 cm and large square 20 cm	Pjg psg kc 5 & pjg psg bs 20
Sensory mathematical imagination	IMS
Because there are four square	Kr 4 psg
Small squares made to fill the image	Psg kc dbt mmn gb
Subject has not been able to search the length as many of the square	Sb bl mp mcr pjg sby psg
Finished	Sls

Discussion

Sensory mathematical imagination in this study represented by subject ie S1 and S2 in solving mathematics problem. Sensory imagination related with students perception after receiving stimulation of the problem (Currie & Ravenscroft, 2002). Through stimulation of the problem raises students perception related to the problem. This perception can appear of idea to solve the problem.

Appear of sensory mathematical imagination two subjects can be said is identical, ie subject started to read the questions and then repeat it and move your fingers to understand intent of the question. After reading the question and repeated it, subject digging information of the question. In the process of digging information, subject to do it in different ways. This is accordance with opinion of Muir, Beswick & Williamson (2008), that in problem solving skills needed to interpret information in the question. In an effort to digging information, subject move the fingers on the table. This activity shows a subject using thinking skills to understand the purpose of the question. This motor activity can trigger students mathematical imagination in solving problem. It reinforced the opinion Nemirovsky & Ferrara (2009) who said mathematical imagination involves body movement activity (sensory motor) to develop innovative students in solving mathematics problems. Subjects were then repeated the phrase "find the length of square side possible" to better understand intent of the question.

The next step that done of subject is draw a square as in the problem. Carroll, et al (2010) said through an image can decipher information by analogy according to what people think. Through this image then appeared subject perception to determine the length of square. S2 have perception that the length of small square side is 5 units, S1 have perception total length of all square is 12 units. Perception of subject appears due to stimulus of the problem. Stimulus is order in the problem to determine the length side of each square that meets the image. These stimulus induce subject perception to determine the length side of each square. Through perception appeared the idea for solving mathematics problems. Van Alphen (2011) said imagination appear from perception through the five senses. In other words, the picture and think aloud that done of student (eye & ear sensory) can appeared perception that later appeared the idea to solve the problem. In this case the idea is appear of students in solving mathematics problem is a form of sensory mathematical imagination. On the other hand subjects also done a visual representation of idea based on perception that is appeared. Solso, et al (2008) said imagination can be seen through a visual representation of knowledge. Visual representation that done of subject in this case is a form of sensory mathematical imagination. It reinforced the opinion Wibowo & As'ari (2014) who said sensory mathematical imagination can be seen through appear of the idea based on students perception in solving mathematics problems. In line with that expressed by Currie & Ravenscroft (2002) that sensory imagination can appear through perception such as stimulus of the problem. Reinforced the opinion Ferrara (2006), which said imagination in learning mathematics as the center of perception and motor activity of students.

Based on the above there are some characteristics of students sensory mathematical imagination that appear in solving mathematical problems, namely appear of the idea based on perception due to stimulus of the problem,

expound information by analogy according to what people think, sensory mathematical imagination involves body movement activity (sensory motor) and sensory mathematical imagination can be seen through a visual representation of the student in solving mathematics problems.

Conclusion

The process of sensory mathematical imagination begins from appear of subject perception to determine the length of square. Perception that done of subject appears due to stimulus of the problem. The stimulus is order in the question to determine the length side of each square that meets the image. These stimulus induce subject perception to determine the length side of each square. Through perception appeared the idea for solving mathematics problem. In this case the idea is appear of students in solving mathematics problem is a representation of sensory mathematical imagination. Sensory mathematical imagination can be seen through appear the idea based on students perceptions in solving mathematics problem. This idea can be seen through a visual representation of solving mathematics problem. The visual representation that done of subject in this case is a form of sensory mathematical imagination.

Characteristics of students sensory mathematical imagination who appeared in solving mathematics problem, namely appear of the idea based on perception due to stimulus of the problem, expound information by analogy according to what people think, sensory mathematical imagination involves body movement activity (sensory motor), and sensory mathematical imagination can be seen through a visual representation of the student in solving mathematics problems.

Disclosure statement

No potential conflict of interest was reported by the authors.

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