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BLIND STUDENTS' UNDERSTANDING OF QUADRILATERAL

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Abstract

This study was conducted to know blind students' understanding of two-dimensional geometric shapes particularly quadrilateral. A purposive sampling method was chosen to get the research subject. The subjects of this research are two blind (totally blind) students, in which one of them is blind since birth, and the other is blind since she was in elementary school. Both of them are in grade 12 of Special Senior High School in Surabayawhohavethe highestscoreof mathematics compare with their classmates. They were taught about geometry especially two-dimensional shapes when they were in elementary school and they were classmate at that time.Data were collected through informal unstructured interview.Regarding to the findings, the subject who is blind since birth have difficulty in recognizing the shapes and already forgot some concepts about two-dimensional shape. On the contrary, the subject who got the blindness in her period of life, find it easy in recognizing the shapes.She is not only could define the characteristics of quadrilateral and each types of them, but also she could connect it into the real life by giving the example of the object.Moreover, she could show how to make a quadrilateral by cutting a rectangle paper.

Keywords: *Blind Students, Geometry, Planar Shape, Quadrilateral, Students' Understanding, Two Dimensional Shape*

INTRODUCTION

In our everyday life, without realizing it, everything that we see has a shape and is connected to geometry. Thus, in order to learn geometry, visualization is a main ability to be had. Eye as a sense of vision in the human body is very important in receiving and absorbing information from outside. Just by seeing, people can distinguish many objects that have different shape or size. Even if the object is far away or cannot be reached, through their eyes people still can define what kind of object is that.

However, it will be different if the people have a visual disability. Since blind people have limitation or even inability to see, the acceptance of stimulation can only be done through the use of other senses. To understand an object, firstly blind people observe that object by using their sense of touching, then the imaginations or reflections that they formed by touching will be combined as unity, so that the concept of that object is gained (Moerdiani, 1987). It also happens when they learn about geometric shapes.

Visually disabled person is a person who has limited or even total inability of vision. Based on the degree of blindness, people with visual disability can be classified into two groups; namely, total blindness (or blind) and low vision. While based on the age at the onset of blindness, there are people

who get blind from birth and people who get blind in his/her period of life. Since blind people have limitation or even inability to receive stimuli or information from outside through the senses of sight, the acceptance of stimulation can only be done through the use of other senses beyond the senses of sight. Here sense of hearing and touching will become an alternative to receive the information (Erin and Koenig, 1997).

Although both senses of hearing and touching have made significant contribution as a substitute for the loss of vision, there are still limitations. For example, sense of hearing cannot give more information about size, quality, shape, depth, and colour. Second, the sound which is captured is often distorted with the other sounds. In addition, noise characteristics are limited by time and temporal. Therefore, in order to not miss the important moments of the sound that is captured through the senses of hearing, blind people should carefully listen to every sound they heard. Similar to the sense of hearing, sense of touching also have limitations. The main limitations are the distance and range. If the object has a very large size (such as an elephant, ship, and train) or if the place of the object is far away from the blind people, then they will get difficulties to reach and touch it.

In mathematical subject, when the blind students learn about geometry particularly in two-dimensional shape, they will use their sense of touching more. For example, in order to understand the figure of a shape, they have to analyse each part of it using their fingertip carefully; such as: how does its sides? Are there any sides that have the same length? What about its angles? What types of angle are there?

There are two ways to introduce some object to the blind people (Moerdiani, 1987). First is by synthetic perception. Here, the object will be observed as a whole, either to be with one hand or both hands, and furthermore, each part of it will be described. Second is by analytic perception. In this case, the object is not touched as a whole because its size is too big. Usually, if the object is too big or too far away to touch, one gives a model that has similar characteristic to the real object. It also helps them to explain the abstract assumption become concrete (Mandola cited in Efendi, 2006).

After the object was introduced by using those two perceptions, there will be a mental process in their mind. That is, where the imaginations or reflections that they formed by touching will be combined as unity, so that the concept of that object is gained. In mathematics class, the teachers usually use the shape models to introduce the two-dimensional geometric shape to their blind students. By giving the concrete object of the shape, the students will observe each part of it as a whole, and then by using their synthetic perception they form the concept of two-dimensional shape in their mind.

Because many of visually disabled people have no experience related to sight and seeing, their conception in visualizing some object might be different from mainstream people. Hallahan and Kauffman (1991) said that the difference of visualizing the object especially for physical object between visually disabled people and mainstream people is based on their experiences. For visually disabled people, they use their tactual experiences to develop their conception. While for mainstream people, they will use their visual experiences. In other word, people with visual disability will use their sense of touch more to identify the object, while people with no visual disability will use their sense of sight.

Generally, people with no visual disability can perceive many kinds of object and the parts of the object all at once. While for sightless people, they have to sense each part one by one before they integrated into a concept. In order to describe an object, especially the object that is little enough to be held by one or two hands, visually disabled people tend to use synthetic touch where the object will be observed as a whole (Moerdiani, 1987). But, if the object is too big to be perceived by using synthetic touch, then it needs analytic touch. Analytic touch means that the visually disabled people will sense each part of the object successively, and then mentally they will construct the image of the object by combining their imaginations or reflections as unity (Moerdiani, 1987).

Another difference between touch and sight is that touching requires more awareness to make it works. As what Lowendfeld (1973) said that sense of touch can work if it is used actively, while sight will automatically work and be active as long as an eye opens. Therefore, to enrich their cognition, visually disabled children should be encouraged to use their sense of touch more.

The general finding was reported from the survey undertaken by Hatton, Bailey, Burchinal, and Ferrell (1997), that children who were blind were delayed in many areas of development, but there

were wide individual differences (Campbell, 2006). Some factors that might influence it are the cause of vision loss (etiology), severity, age of onset, intellectual ability, environment, and presence or absence of other disabilities (Lechelt and Hall, 1999). Dick and Kubiak (1997) stated that the conceptual development of visually disabled children strongly depends on the degree of blindness and the age at the onset of blindness. For example, children who got blind after birth would have at least some visual experiences and they can use it to help them to understand the new concept (Dick and Kubiak, 1997). Children who got blind from birth totally rely on their tactual sense (Warren and Rossano, 1991).

METHODOLOGY

The research approach is qualitative aiming to identify blind students' understanding of quadrilateral. Data were collected through informal unstructured interview with two 12th grade students of Special Senior High School who has already taught about geometry especially two-dimensional shape. With the aim of answering the research question, the selection of the subject in this research will be based on the age of onset of blindness. The subjects in this research should be totally blind in which the one is blind from birth while the other is blind after birth. Both of the research subjectshavethe higher scoreof mathematics compare with their classmatesas determined by the mathematics teacher in that school and they also had good communication skills as a requirement by the researcher for their selection.

The areas of understanding that were observed in this research are adapted from the standard competences and basic competences in mathematics subject for Special Junior High School, which is shown in Table 1 below:

Table 1.The Indicators of Students' Understanding of Quadrilateral

Areas of Understanding	*Students' Activities*
Basic Shapes	- Name the types of planar shape
	- Give examples of the shape in real object
	- Classifying the shapes into triangle, quadrilateral, and others
Quadrilateral	- Define the quadrilateral
	- Show the figure of quadrilateral
	- Name the types of quadrilateral (including rectangle, square, parallelogram, trapezium, rhombus, and kite)
	- Explain the characteristics of each type of quadrilateral
	- Show the figure of each type of quadrilateral
Symmetry	- Define fold-symmetry and rotational-symmetry
	- Show the fold-symmetry and rotational-symmetry of a shape
	- Find the number of symmetries in a shape

RESULTS

Here, two subjects will be represented by S1 and S2. The subject who starts blind since she was elementary school is represented by S1, while the subject who is blind since birth is represented by S2.

There are three areas of understanding that were observed in this research as shown in table 1 above. The first one is about basic shapes. S1 mentioned the types of planar shapes are triangle, quadrilateral, and circle. And then, when she was asked to classified the shapes models, she showed her consistency by classifying them into: triangle's group, quadrilateral's group, circle's group, and the last one is mix group. In order to classify them, she observed the shapes' sides. It is not only by looking at the number of its sides but also how the sides form. If the shape has three sides then it will be included in the first group (group of triangles); if the shape has four sides then it will be included in the second group (group of quadrilaterals); if the shape has curve sides then it will be included in the third group (she called it group of circle); if the shape does not fit in that three previous groups then it will be in the last group. Different from S1, S2 mentioned the planar shapes in more specific such as rectangle, square, parallelogram, isosceles trapezium, right-angled trapezium, rhombus, kite, and triangle. Next, there is an activity that they were asked to give the example of the shape in the real object. There are objects that S1 mentioned that cannot be observed by synthetic perception such as door and window. Even though she cannot touch the door as a whole (because the size is too big), but she knows that door's shape is rectangular. That information might be gotten before she became blind. While S2 only gave the example in an object that she could touch as a whole such as book and table.

The second one is quadrilateral. Both S1 and S2 mentioned the types of quadrilateral are: rectangle, square, parallelogram, isosceles trapezium and right-angled trapezium, rhombus, and kite. When they were asked to define and show them in the shape models, S1 can explained each of the characteristics that the shape has, she also can showed them in the shape models. When defining the shape, she mentioned how those shape form, in which she understands them in a straight position.

When defined the quadrilateral, S1 used the attributes such as side, angle, and vertex. S1 defined the quadrilateral as a shape that has four angles, four sides, four vertices, and its angle sum is 360°. S1 understands various types of quadrilateral, such as rectangle, square, parallelogram, trapezium, rhombus, and kite, she even differentiate trapezium into isosceles trapezium and right-angled trapezium. Next is about the characteristics of each type of quadrilateral, the first thing that she mentioned about the characteristics of each shape is about their form. She knows exactly about the figure of the shape (the scheme that already held before she became blind), therefore she could describe about its form. But still, her understanding of the shape is in straight position as shown in Figure 1 below.

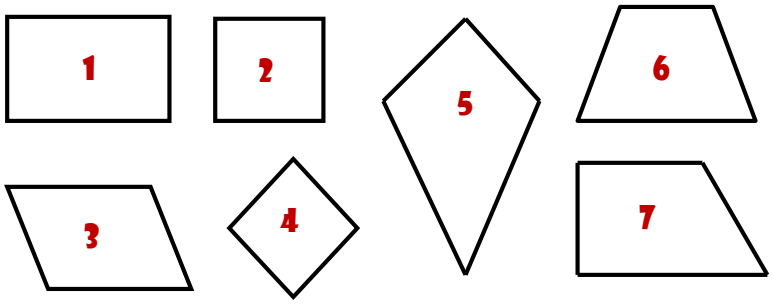

Figure 1.The quadrilaterals in a straight position.
(1) Rectangle, (2) Square, (3) Parallelogram, (4) Rhombus, (5) Kite, (6) Isosceles Trapezium, (7) Right-angled Trapezium

Here is what she mentioned when describing the form of the shapes: a).Rectangle has two horizontal lines and two vertical lines.b).Square has two horizontal lines and two vertical lines. c). Parallelogram has two horizontal lines and two slope lines. d). Isosceles trapezium has two horizontal lines and two slope lines. e). Right-angled trapezium has two horizontal lines, one vertical line, and one slope line. f). Rhombus has four slope lines. g). it has four slope lines

By looking at how she describes the form of the shapes, she did not differentiate the direction of the slope lines. For example, she defined both parallelogram and isosceles trapezium as the same that is has two horizontal lines and two slope lines, even though its direction is different.

Besides the form of the shapes, she understands each of its other characteristics well. Moreover, she knows which sides that have the same length, and which angles that have the same measurement. S1 defined parallelogram as a quadrilateral that has two horizontal lines and two slope lines which are equally each other, four vertices, and four angles where the two angles are obtuse and the other two are acute angles. Rectangle as a quadrilateral that formed by two horizontal lines and two vertical lines, where the two horizontal sides have the same length and the two vertical sides also have the same length. It has four vertices and four right angles. Square is a quadrilateral that formed by two horizontal lines and two vertical lines. All the sides have the same length. It has four vertices and four right angles. Rhombus is formed by four slope lines. It has four vertices, four angles and four sides. The angles consist of two acute and two obtuse angles. Kite is a quadrilateral that formed by 4 slope lines. It has four vertices and four angles. The two angles are acute and the other two are obtuse. The obtuse angles are equally each other. Isosceles trapezium is a quadrilateral that has two slope lines and two horizontal lines, where the slope lines are having the same length. It has four vertices and four angles where the two are obtuse angles and the other two are acute angles. The obtuse angles are equally each other, and so do the acute one. Right-angled trapezium is a quadrilateral that formed by two horizontal lines, one slope line, and one vertical line. It has four angles. Two of them are right angles, while the other two are obtuse angle and acute angle.

In the other hand, S2 knows many kinds of quadrilaterals, but when she was asked to explain the characteristics, she only knows some of them. She understands the characteristics of a rectangle, a square, and a parallelogram well. For trapezium, she does not really understand its characteristic. While for kite and rhombus, she felt confused in differentiating the two shapes because she feel that the shape of those two shapes are similar.

Next is about symmetry. The symmetries that will be discussed here are fold-symmetry and rotational-symmetry. After explained what fold-symmetry and rotational-symmetry are, S1 could mentioned the number of symmetry in quadrilateral shapes correctly and also showed how to fold it. While for S2, she has difficulty in defining them by word, even worse, she forgot about the number of symmetry in quadrilateral shapes and how to fold it, the only shapes that she remembered about its fold-symmetry and rotational-symmetry are rectangle and square. It is because S2 understand the material by memorizing.

After that, they were asked to compare the quadrilateral to find the similarities and the differences between two shapes. By looking at the characteristics of the shape, S1 can easily explained what are the similarities and the differences between two shapes; the thing that she always mentioned is comparing the shape form. In this activity, S2 could also found the similarities and differences in quadrilateral shapes. Afterward they were asked about combining the shapes. Because she exactly knows how the shape forms, then S1 also knows that by adding some specifics triangles, any quadrilaterals can become a rectangle. That information she got when she learned about fold-symmetry that is when the students was asked to find the axis of symmetry of the shape. And then, when she folded the rectangle shape it may become parallelogram. Therefore she knows that by adding two right-angled triangles in the left and right sides of parallelogram, it will become rectangle. Another combination to make a quadrilateral become rectangle that S1 knows are: by adding two right-angled triangles in the left and right sides of isosceles trapezium; by adding one right-angled triangle in the slope side of right-angled trapezium; by adding two equilateral triangles in the upper-left and upper-right, and right-angled triangles in the lower-left and lower-right sides of kite. In this case, because the length difference of the triangle sides in the upper-left and upper-right is not much, then S1 recognize it as equilateral triangle. Moreover, by using the information above about combining the shapes to become rectangle, S1 could make the shape models by cutting the rectangle paper as in the Figure 2 below. In contrast, S2 who felt difficult in recognizing the shape, cannot showed any combination of it. S2 has difficulty in recognizing the shape from many shapes model given. By looking at her difficulties in distinguishing the shapes, then it is possible if she cannot combine the shapes to form another shape.

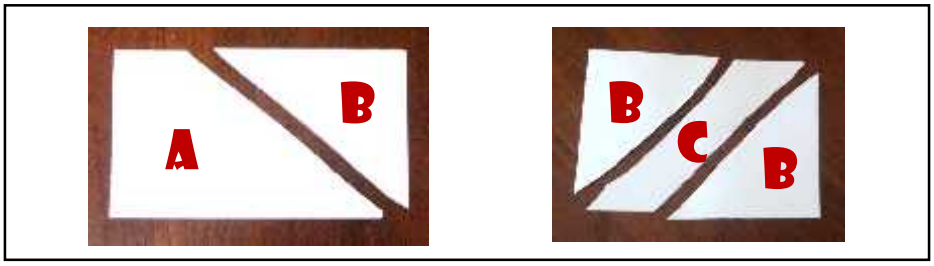

Figure 2.The shapes that S1 made by cutting the rectangle paper.
(A) right-angled trapezium, (B) triangle, and (C) parallelogram

CONCLUSION

As Dick and Kubiak (1997) said that the development of the concept of visually disabled children strongly depends on the degree of blindness and the age of onset the blindness, children who get blind after birth will have at least some visual experiences and they can use it to help them to understand the new concept. While for children who get blind from birth totally rely on their tactual sense (Warren and Rossano, 1991).

Before she got her blindness, S1 studied in normal school where she ever taught about two-dimensional shapes there. The teacher was taught the two-dimensional shapes through the pictures. Therefore, the things that she remembered is how its shape in a straight position (based on what her teacher drawn at that time). By using the information of the shapes figure, S1 can easily differentiate which shapes is triangle and which shapes is quadrilateral. On the other hand, the S2 was totally relying on their tactual sense to find and recognize the shapes. For that reason, she felt difficult in identifying the shapes.

From those examples above, it shows that because the S1 ever got some visual experiences, even though only for several years, it really helps her to understand the concept. While for S2, who blind since birth, she has no visual experiences at all therefore in understand the new concept she will totally rely on her tactual sense. However, if she can link the information she had, it may help her to understand the concept.

On the contrary, S1 not only can define the characteristics of the shapes but also show the figure of them. Because she knows exactly how the shapes figure and their characteristics, then she was able to combine the shapes to form another shape. Moreover, since she knows how to combine the shapes, therefore she can make the shapes by cutting the rectangle. Before she made the shapes, she imagine how its shape and how it may become a rectangle. After she got the idea, she starts to fold the paper, and then cut it.

Overall, by looking at the result of this observation, the understanding about two-dimensional geometric shapes of S1 can be classified into formal understanding. It is because she is not only know what to do but also know why; and she is able to prove or explain why she understand. For example, she is not only could define the characteristics of quadrilateral and each types of them, but also she could connect it into the real life by giving the example of the object. Also, she prove her understanding about fold-symmetry by showing how to fold the shape. Moreover, she could link the schemes that she had all together (such as the figure of the shapes, the characteristics of the shapes) to find the relationship between two shapes. Furthermore, she could make the quadrilateral shape by cutting the rectangle paper. While for S2, she can be classified into rote understanding.

The reason is, because most of the material about two-dimensional geometric shapes she had is only simply implanted in memory not by understanding it meaning. For example, she knows that fold-symmetry of rectangle is two, but when she was asked to show where is the two come from, she cannot explain it. Because S2 understand the material by memorizing, therefore she usually miss-defined one shape to another and the worst thing is she forgot some of it (the only shapes that she remembered about its fold-symmetry and rotational-symmetry are rectangle and square).

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