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RESEARCH OF VISUAL CONTEXTUAL SUPPORT FOR THE SUBJECT OF CIRCLE ON MATHEMATICS TEACHER CANDIDATES

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Abstract:
The purpose of this study is to research the effects of visual contextual support for the subject of circle in geometry education. The study was conducted by using one of the qualitative research methods, special case study. The sampling of the research was formed by 72 teacher candidates who are studying in Necmettin Erbakan University Ahmet Keleşoğlu Faculty of Education Elementary School Math. Teaching Program. As data collection tool, an evaluation consisting of verbally asked problems regarding the subject of circle was used. Questions were selected according to the relevant subject among the Olympics questions. When selecting the questions, care was taken to contain most basic information about the relevant subject but include the attributes that are having difficulties in transferring of concepts into shapes. As a result of the study, it was observed that teacher candidates were having difficulties in transferring the question into a shape while solving the questions that are directed to them without a visual contextual support and reaching the correct answer. In conclusion, it is seen that questions provided with visual contextual support could easily be solved by students but prevents their spatial thinking skills.

Keywords: geometry education, circle, mathematics teacher candidates, visual contextual support

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1. Introduction

One of the most basic difficulties in the process of teaching mathematics is revealed during the process of making a connection between the representation in the mind of a student and abstract nature of mathematics. It is not easy to find concrete examples for each mathematics concept. Graphics, diagrams, pictures and geometrical shapes or models are visualization tools for abstract concepts in mathematics. People can make a connection between the physical or external world and abstract concepts through these (Konyalıoğlu, 2003). The discipline that focuses on this connection is geometry. Students can analyze the abstract world by using geometry knowledge; utilize visual elements to better understand the abstract concepts (Nemirovsky & Noble, 1997).

Geometry is one of the most important fields of mathematics education containing space and shape concepts (Fidan & Türnüklü, 2010). Tapan and Arslan (2009) have expressed that one of the most important objectives of geometry is to develop the visual perceptions and rational thinking skills of students. Thanks to geometry, students start to express and understand the world around them, analyze and solve problems (Erdoğan, Akkaya & Akkaya, 2009). Thus, they can comprehend the shapes around them and make a connection between the daily life and geometrical shapes. In geometry teaching, understanding the mathematical definition, making and proving assumptions, visualization and solving problems is essential (Jones, Mooney and Harries, 2002). According to Shield and Swinson (1997), after a concept is examined and discussed in all aspects, providing the development of a definition for this concept by students is considerably useful in the process of students deeply understanding this concept.

The teacher utilizes visual representations when explaining a mathematical concept to student. These representations are, in a sense, the tools ensuring communication in mathematics. Mostly, representation and demonstration are utilized in geometry teaching. Poincare divides the science of geometry into two parts as geometrical space and representation (shape) space (Mesquita, 1998). For example, while the definition of a triangle that is independent of the shape in the science of geometry falls within the field of geometrical space, demonstration of that triangle by drawing on a paper falls within the field of representation space. In our country, representation space is used mostly in geometry teaching. Davis and Bamford (1995) have found out that contextual support increases the correctly answering ratio of students to mathematics questions. Also, Threlfall (1993) has shown in a study that visual contextual support increases the answering ratio of students to geometry questions. When the verbal expression of a shape is told, the student has to remember this shape; however, it is easier when the shape is given. Not giving the shape forces the students to be productive. Transferring verbal text into shape mostly forces the student to think and produce.

Hacısalihoğlu (1998) has pointed out that learning is a perception issue and a stronger perception in mathematics can be ensured through three important sense organs such as touching, hearing and seeing (writing, telling and drawing) and concept, drawing and proofs will help the development of thinking system of students.

In geometry teaching, memorizing the attributes of shapes, not supporting with sufficient examples is causing the students to have difficulties in learning geometrical concepts (Fujıta and Jones, 2007). In this context, to realize the meaningful learning, students must being able to transfer the geometrical concepts into shapes is of great importance.

Problems containing verbal definitions transferred into shapes are very important for studying on this subject due to no studies being available in the literature regarding the identification of circumstances requiring distinguishing of new shapes formed as a result of drawings made.

Based on the information above, teacher candidates were aimed to be researched in terms of transferring problems containing verbal definitions to shapes in this study. According to this common objective, answers were searched in the study for the following sub problems:

1. How are the resolution processes of mathematics teacher candidates in transferring diameter chord concepts into a shape?
2. How are the distinguishing all circumstances and drawing skills of mathematics teacher candidates in transferring a problem containing verbal definition into shape?
3. Are the mathematics teacher candidates having difficulties in transferring center concept into shape for the subject of circle?
4. How are the distinguishing the shapes formed during transferring the problem asked by verbal definitions into shape skills of mathematics teacher candidates for the subject of circle?

1.1 Circle

For $r \in \Re^+$, the set of points that have the distance of r to point M on a plane is called a circle with M center and r radius. If we show this set with C

C=$\{P: P \in \Re^2,\ |PM| = r\}$.

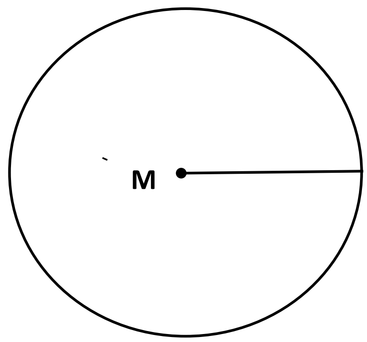

Figure 1.1.1

The required and sufficient condition for a variable P point to be on the circle is $|PM|$=r proposition is being correct. P= (p_1, p_2) and M= (a_1, a_2) and (x_1, x_2) on a plane. Circle equation is shown by:

$$(x_1 - a_1)^2 + (x_2 - a_2)^2 = r^2$$

(Sabuncuoğlu, 2000).

1.2. Tangent of a Curve

A curve and a line intersecting means having at least one common point. In both of the circumstances shown in the figures below L line and ß curve has a common point.

Figure 1.2

We can say that the intersection of L line and ß curve at point Q and at point T is different than each other. Let's take an L line that intersects ß curve at a two different points such as P and T. If the lines obtained when P point is approached to T point while kept on the curve approach to a certain line passing through T point, the line is tangent to the T point of curve (Sabuncuoğlu, 2000).

Figure 1.2.1

1.3 Chord of Contact

Let's take a C circle with its center being M and radius being r. Q point being a point outside the C circle, the contact points of tangents drawn from Q point to C circle are T and K. The TK line is called chord of contact of Q point (Sabuncuoğlu, 2000).

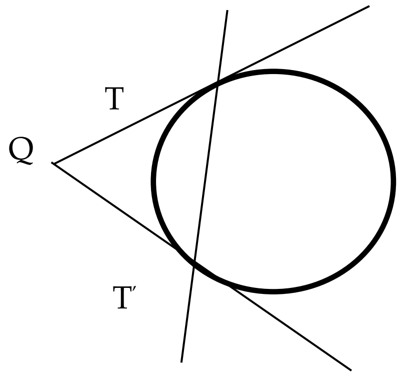

Figure 1.3

2. Method

The study was conducted by using one of the qualitative research methods, special case study. As is known, the measurements can ensure us to understand how many people acts how; however, can't answer to the question why. Researches towards understanding of the "why?" of human and group behaviors are called qualitative researches. Therefore, the basic objective is to provide a descriptive and realistic picture regarding the subject of research, rather than achieving generalizable results through numbers as in the quantitative approach based researches. Since there is no concern of generalization, the obtained findings are limited with only the teacher candidates participating in the research (Baştürk, 2011). In the qualitative researches, validity and reliability of the findings are being tried to be ensured by presenting of obtained data in as detailed and direct as possible (Yıldırım and Şimşek, 1999). Case studies are researches where one entity is defined based on time and space and customized (Büyüköztürk, Çakmak, Akgün, Karadeniz and Demirel, 2008).

2.1 Research Group

The sampling of the research was formed by 72 students who are studying in Necmettin Erbakan University Ahmet Keleşoğlu Faculty of Education Elementary School Math. Teaching Program. The questions were asked to these mathematics teacher candidates at the end of 2015-2016 spring term which they took the Geometry lesson.

2.2 Data Collection Tools

As data collection tool with in scope of research, an evaluation consisting of verbally asked problems regarding the subject of circle was used. Questions were selected according to the relevant subject among the Olympics questions. When selecting the questions, care was taken to contain most basic information about the relevant subject but include the attributes that are having difficulties in transferring of definitions into shapes.

2.3. Findings and Interpretation

In this section, detailed research findings, which are obtained as a result of statistical analyses made according to the answers of mathematics teacher candidates participating in the research and interpretations made regarding these findings were given.

2.3.1 First Sub Problem

For the "How there are solution processes of mathematics teacher candidates in transferring diameter chord concepts into a shape?" *first sub problem*, the results of descriptive analysis are given in Figure 1.

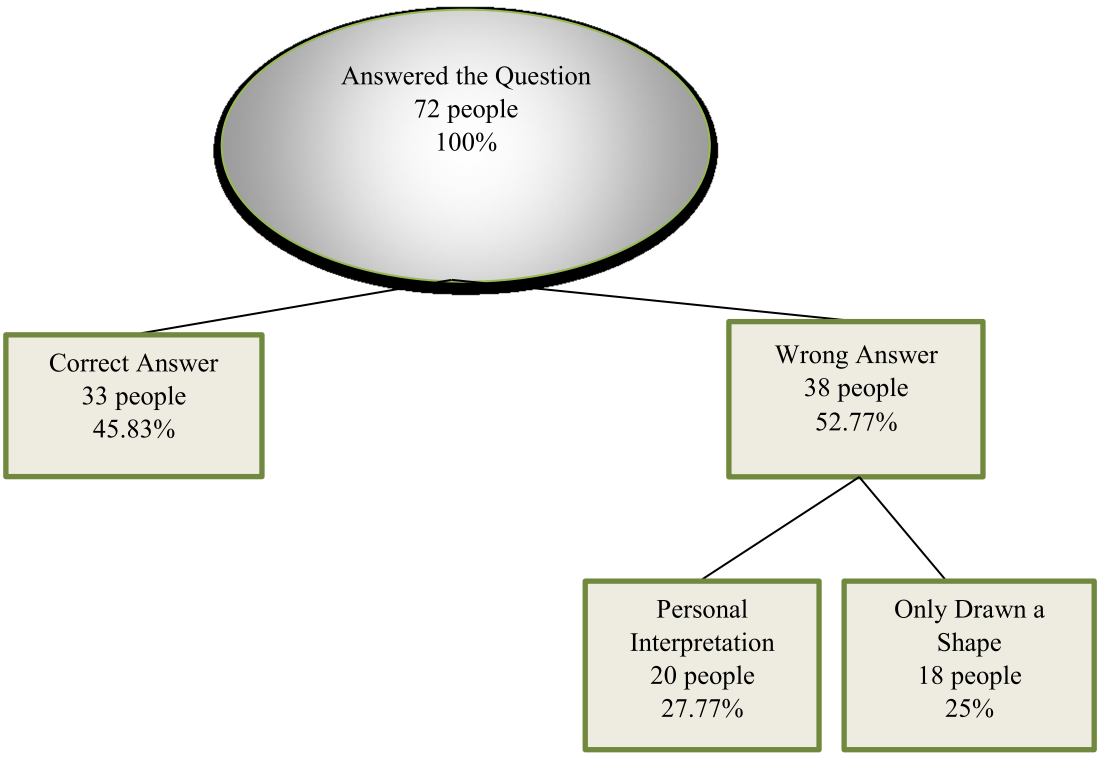

Figure 2.3.1

As seen from the figure above, the majority of the teacher candidates participating to research could not achieve the correct solution for the questions directed to them. The majority of these teacher candidates have obtained the correct solution to the questions in the required direction. However, some teacher candidates went to obtain the solution by only drawing a shape. Also, about half of the teacher candidates who could not provide a correct answer to these questions ended the solution by making a personal interpretation. For example, to the question of "prove that the longer chord is closer to center in a circle", they have given answers similar to "length increases as the center is approached, since the longest chord is the diameter and diameter passes through center, the long chord is closer to center" or drawn a shape like the given below that tries to explain such definitions.

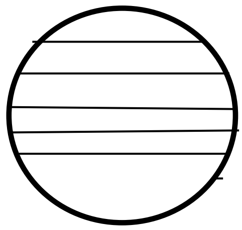

Figure 2.3.1.1

2.3.2 Second Sub Problem

For the "How are the drawing skills of mathematics teacher candidates in transferring a problem containing verbal definition into shape?" *second sub problem*, themes, percentage and frequency values regarding the answers given by teacher candidates are given in figure 3.

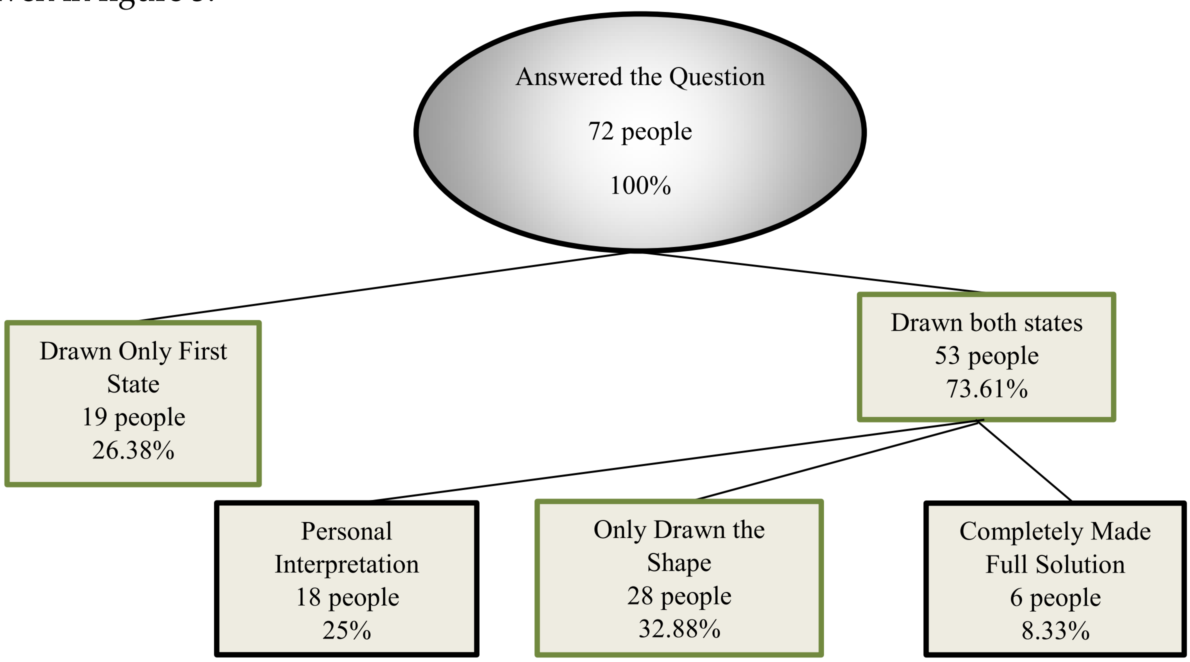

Figure 2.3.2.1

All of the teacher candidates (100%) who are directed the research questions have answered the questions. But more than half of them (73.61%) have tried to answer by thinking both of the states. As for those who only considered one state were 26.38%. Small part of the teaching candidates who considered both states (25%) have tried to provide a solution by interpreting. Again, part of them (32.88%) have only drawn the shape for both states and left it at that. Only 6 people have drawn both states and solved correctly. That is to say, 8.33% of the teacher candidates who answered all the questions.

For example, the number of teacher candidates who considered both of the states shown in the figure below to the question "if two circles are tangential to each other; the line joining the centers of these circles go through the point of contact. Please show." were less than expected.

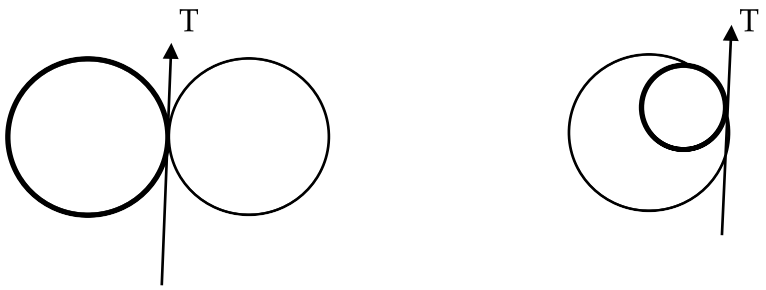

Figure 2.3.2.2

2.3.3 Third Sub Problem

For the "Are the mathematics teacher candidates having difficulties in transferring center concept into shape for the subject of circle?" *third research sub problem*, the sub themes, percentage and frequency values regarding the answers of teacher candidates given are shown in Figure 3.

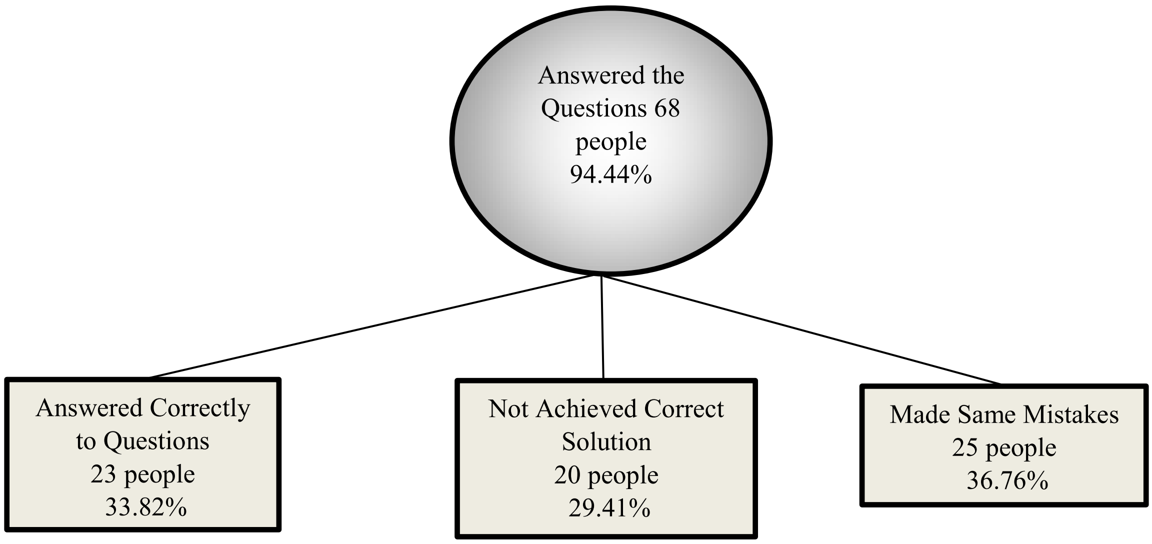

Figure 2.3.3.1

68 of the teacher candidates, i.e. 94.44% of them, have made an effort to achieve the solutions regarding the questions. However, about half of the candidates which tried to solve the research questions have achieved the correct answer by using the correct method. Those who could not use the correct method and solve are 20 people. 36.76% of the teacher candidates who participated in the research have achieved the same results by making the same mistakes. The error here is created by the mistake made when transferring the concept of center into visual shape. Teacher candidates accepting the intersection point of lines as center on the shape without establishing the center attributes were directed to mistake in solution. They continued the solution of question by using center angle and chord angle attribute. But, the solutions of the questions are solved by starting from the equality of angles seeing the same arc. In conclusion, they have achieved the wrong result by incorrectly transferring to shape.

2.3.4. Fourth Sub Problem

For the "How are the distinguishing the shapes formed during transferring the problem into shape skills of mathematics teacher candidates for the subject of circle?" *fourth research sub problem*, the sub themes, percentage and frequency values regarding the answers of teacher candidates given are shown in Figure 6.

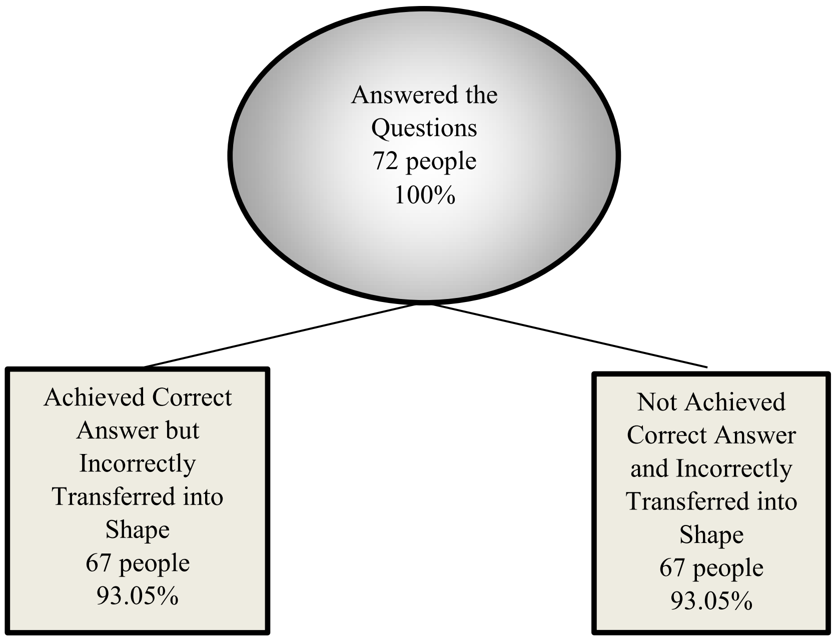

Figure 2.3.4.1

According the research result, all of the teacher candidates have tried to express what they think about the question. However, no teacher candidates were able to transfer the question directed to researchers by verbal definition completely into shape. 5 people have achieved the correct result but made mistakes in drawing. The majority of the remaining teacher candidates (93.05%) has used wrong demonstrations when transferring verbal definition into shape and could not obtain the solution. For example, they have transferred two lines that were not said to be parallels as if they were parallels and made the operations based on alternate interior and exterior angles. However, the inscribed quadrilateral created as a result of drawings give them hints about the solution of the problem.

3. Conclusion and Recommendations

In this research, the knowledge of mathematics teacher candidates, who are studying in Primary Education Mathematics Teacher Department undergraduate program, for the process of transferring problems given as verbal definitions into shape were tried to be determined with the help of open ended questions. A qualitative approach was adopted in the research and there was no generalization concern. Therefore, the obtained findings were limited to teacher candidates participating in the research. As a result of the study, it was observed that teacher candidates were having difficulties in transferring the question asked into a shape and reaching the correct answer.

According to research results, it was revealed that teacher candidates need visual contextual support in question solving. Because, they are having difficulties in transferring the question containing verbal definition into shape. As understood from the answers provided by teacher candidates, showing the generally known attributes of the subject of circle in geometry lesson plays an important role in problem solving. Majority of the teacher candidates have started solving the question after transferring into shape. The result of drawing a shape being an important stage in solution of the question was concluded from this. Questing transferring into shape in geometry lesson may be referred as the first step to question solving. As for transferring the concepts into shape, it results from the clarity of knowledge about those concepts. Therefore, to correctly transfer the definitions given in questions to shapes in geometry lesson, there should not be lack of knowledge about the concepts. That is to say, the reason of a verbal geometry question not being able to transfer into shape is related to definitions of geometrical concepts not being settled in their minds.

Transferring into shape, which is an important step in question, solving, facilitates seeing the operation to be made for reaching the result. This helps those students who correctly transfer into shape to distinguish the new shapes. A mistake made in transferring into shape shows the solution of the question was completely wrong. For example, they have transferred two lines that were not said to be parallels as if they were parallels and made the operations based on alternate interior and exterior angles. However, the inscribed quadrilateral created as a result of drawings give them hints about the solution of the problem. The parallelism view in the shape has prevented the teacher candidates from noticing inscribed quadrilateral and misdirected them about the solution. Thus, the solution was completed wrong.

Within scope of the research, Olympic questions related to the subject of circle were selected by taking the simplest attributes of basic concepts into consideration rather than difficulty. Therefore, all of the teacher candidates were expected to not make mistakes in transferring the questions into shape rather than solution. But the success rate is below the expectation. This result also reveals a preventive role of visual contextual support in geometry education in adequate development of spatial thinking skills of teacher candidates. Also, it can be said that this results from the definitions of concepts not being taught in a manner to form a picture in the minds of students. Geometry lesson explained by without depending much on representations and shapes, with less contextual support and emphasizing more on the definitions of concepts may improve the spatial thinking skills of students more, which is one of the most important objectives of geometry education.

Each concept of the subject given by shape and representation of that concept when explaining the subject to student does not help to the objective of improving the spatial thinking skills of students. Definitions of geometrical concepts demonstrated in a manner as to form a picture in the minds of students has a great importance in geometry education. Thus, it is not appropriate to readily give the shapes together with concept definitions to students. It should be ensured for students to visualize the given definition and concepts. Methods effective in terms of improving the spatial thinking skills, which have important role in geometry education, should be preferred. Effective methods cause permanence of knowledge. Deficiency in the subjects learned during primary education years will not be useful to an individual without completing them, in terms of education. Especially the knowledge of circle is given to students from the third grade of primary education. In this context, the subject of circle is seen among the important subjects in terms of teacher candidates. Teacher candidates should be more equipped when transferring the subject of circle to students and the lesson should be explained in a manner to improve the spatial thinking skills of students when transferring the subject.

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