Preservice primary school teachers' performance on rotation of points and shapes

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In this study, the purpose was to reveal thinking styles and different points of view of pre-service primary school teachers about the concept of "rotation" in mathematics. The study was conducted with undergraduate students who are studying in the department of primary school teacher education. The subject of "rotation" in this study has two sub-topics which are rotation of points around a point and rotation of shapes about a point in a coordinate plane. A test about rotation was applied to 44 students and then interviews were made with 5 students. Results of the study include an analysis of correct and incorrect answers of students.

Keywords: preschool mathematics teachers, education, rotation

Overview

According to Pehlivan (2008), knowledge, skills, attitudes and habits gained at the primary level are highly influential on individuals' later lives. Accordingly, it is stated that the importance of classroom teachers who undertake a major part of individuals' education at this level and their qualities cannot be ignored.

In Turkey, in order to respond to social upheaval, education systems and accordingly teacher training institutions are in the process of reconstruction (Alkan 2000; cited in Karaca 2008). These configurations also bring the necessity for teachers who have to find a balance between modernism and traditional methods to have some qualifications. These qualifications can be classified as in the following (Delors et al. 1996, cited in Karaca 2008).

- Teachers should constantly be investigative in order to help students to construct knowledge personally.
- Teachers should constantly keep students' individual thinking capacities awake during learning by going beyond their own disciplines.
- Teachers should commit themselves to educate students in accordance with objectives.
- Teachers should teach students how to learn and which cognitive tools can help them to get more useful outcomes.
- Teachers should be able to use new information-communication technologies which are developing rapidly and which increase the quality of teaching process.

According to Pırasa (2009), knowledge of teaching mathematics has components which are still discussed and which are evolving. This knowledge which was seen as unary and which was recently considered as if it consisted only of subject knowledge, was redeveloped together with the completion of the definition of the subject education. At first, in classroom teacher training programs, student teachers'

knowledge of teaching mathematics was developed by providing two different knowledge types: professional knowledge (about teaching) and subject knowledge (about mathematics). Later, the program was reorganised to add a course concerned with teaching mathematics, requiring an extensive and comprehensive editing of the original program content (Pırasa 2009). The content of the teacher education programmes in Turkey was changed with the new curriculum which was put into practice in 2005-2006, taking constructivist learning theory as a base (Ministry of Education, 2005). According to Selim (2009) constructive learning theory is a teaching and learning approach which is based on relating new knowledge to the existing knowledge of individuals. In constructivist learning, when the learners process the knowledge which is obtained through observation, experience or transfer from external sources in their minds, then this information becomes meaningful. In this study, we analyse the performance of student teachers on rotation tasks typical of this new constructivist curriculum.

The 'rotation' topic includes sub-topics such as rotating points around points or rotating figures around points. With this research, it is intended to understand pre-service primary school teachers' thinking skills and different viewpoints about the subject.

Methodology

A 'scanning model' was used in the study. The scanning model is an approach which aims to define a present or past case as it exists today (Arlı and Nazik 2001). Qualitative and quantitative data collection instruments were used in this research. For collecting quantitative data, a test about rotation was conducted by researchers. In order to collect qualitative data, some students were interviewed and detailed questions were asked about their solutions.

Study Group

This research was carried out with 44 students who are studying in the department of primary school teacher education in a state university in Istanbul from Marmara region.

Implementation

The test about "rotating a point or figures around a specific point in the coordinate system" was applied to students. Students were asked to complete this test in one lesson. During this time, they were asked both to solve the questions and to write explanations about their solutions. A semi-circular protractor was given to students while they were solving questions. After this test, face-to-face interviews with five students were conducted to get detailed information about their thinking while solving the test questions. Five students were determined according to their papers. Especially students who made interesting solutions were chosen. In these interviews, students were asked how they made their solutions and how they thought while they were making solutions.

Data Collection Instruments

The test which was used during research was created by the researchers and included six questions. Each question was expressed and asked on a coordinate plane. Enough

space next to questions was provided to students for making calculations and writing explanations about the solutions. Questions included the following processes:

- Rotating a point around the origin.
- Rotating a point around a point.
- Rotating figures around a point inside them.
- Rotating figures around a point outside them.
- Rotating figures around a point on the figure.

Findings

The first question was to rotate a point given in a coordinate system by 90 degrees around an origin. When the answers were analysed it was seen that students mostly found the correct solutions by using 'using a protractor' and 'counting squares' techniques. Students who got wrong solutions had mistakes mostly because they thought they must take symmetry. So, they drew the 90 degree arc incorrectly.

The second question was to rotate a rectangle by 180 degrees around a point on that rectangle. When the answers analysed it was seen that all the students with correct answers rotated the corner points of the figure around the asked point which is one of the corners. Then, they formed the rotated image rectangle by combining newly formed points accordingly. The following mistakes were frequently made by the students who got wrong solutions. Some students specified the required point in the figure and then drew a 180 degree arc starting from that point. They drew the rectangle with one corner at the end point of the arc that they had drawn. While solving the same question, some other students rotated the figure apparently randomly or intuitively. Some other students rotated the figure around the origin or reflected in the y-axis.

The third question was to rotate a point by 270 degrees around a point different from the origin. When the answers were analysed it was seen that students mostly used 'drawing by using a protractor' and 'drawing a 270 degree arc' methods. In drawing by using a protractor; firstly they drew a line segment by combining point and reference point. Then they drew another line segment of the same length to form a 270 degree angle whose corner point was a reference point. They placed the image point on the other end of this line segment. Some students answered this question correctly by drawing a 270 degree circular arc. For this, they drew a 270 degree arc centered at the reference point and with one end at the point to be rotated (the object). They placed the image point on the other end of the arc. Nearly half of the students' wrong answers also tried to solve this question by drawing a 270 degree arc. However, they specified the centre of this arc incorrectly, and so their solutions were also incorrect. The remaining incorrect answers did not pay attention to the distance between the object point and the reference point. That is, the distance between the object point and the reference point and the distance between the image point and the reference point were not drawn equally.

The fourth question was to rotate a point 180 degrees around a point that is different from the origin. When the answers were analysed it was seen that most of the students who gave correct answers to this question found their solution either by using a protractor or by taking symmetry. When the solutions of the students with incorrect answers were analysed, drawing mistakes can be seen originating from the misuse of protractor or not drawing equally the lengths which should be equal between object point-reference point and image point–reference point. Besides,

students thought that they needed to get symmetry of the point for rotating 180 degree operation, but they used one of the horizontal or vertical axes of the reference point as a reflective symmetry axis.

The fifth question was to rotate a point 90 degree around a point outside a triangular figure. When the questions were analysed it was seen that this question has the lowest percentage of correct answers. Four students, who found the correct answer for this question, rotated the corner points of the figure by applying the rotation rules correctly and made their drawings according to this. Approximately one third of the students who gave incorrect answers tried to solve the question by reflecting the figure in a vertical axis through the reference point. Some students specified a point in the triangle; they rotated this point around reference point at desired amount and direction. Later on, they drew the triangle 'by eye' so that the point would stay inside. Also some students generally rotated the figure 90 degree inferentially by taking one edge of the figure into consideration and completing the triangle by eye.

The sixth question was to rotate a figure 270 degree around a point inside itself. When the answers were analysed it was seen that students mostly rotated the figure around the reference point by specifying the corner points of the figure, and then they drew the rotated form of the figure according to this. Besides, there were also students who got the correct figure by rotating the rectangle 90 degree three times. When the incorrect solutions were analysed, it was seen that most of them had attempted rotation but drew the rotated figure incorrectly. In addition to this, students who reflected or translated the figure were also identified. Some students tried to find solution by drawing a 270 degree arc from the reference point. And three of the students made operations such as rotating the figure 3-dimensionally.

In the research, the data which was collected after implementation through face to face interviews with students were evaluated. In these interviews, students who made incorrect solutions stated that they do not have enough information about using a protractor. They showed this as the reason of their mistakes in most of the questions. Especially they had difficulties in deciding which point (the object point which will be rotated or the reference point) to place at the centre of protractor.

While some students were making drawings, they did not paid necessary attention to the equality of lengths which should be equal. When the reason of this was asked, they showed the involvement of millimeters. They stated the difficulty of making millimetric measurements. Figure 1 gives an example of this kind of solution.

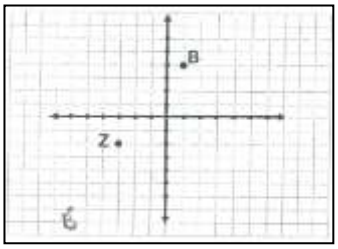


Figure 1: A student's solutions without equality of lengths

Some of the students expressed the fact about their drawings that instead of using a protractor or making mathematical drawings they made mental and imaginary rotations.

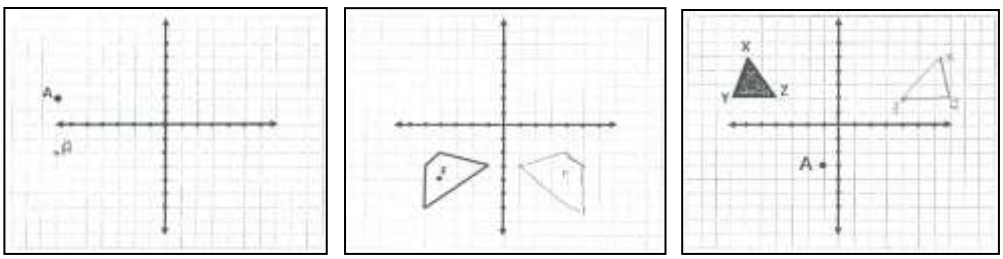


Figure 2: Students' solutions using symmetry of the shape or point

While rotating the point around the origin, there were students who got symmetry according to x-axis as seen in first solution above. When students were asked to explain their solutions, they told that they got symmetry according to x-axis but they could not explain the reason of this. In second solutions above, it was seen that symmetry of a figure, which was asked to rotate 180 degree around F point, was determined according to y-axis. In third solution above, similarly the symmetry of the triangle which was asked to rotate according to point A was determined according to y-axis.

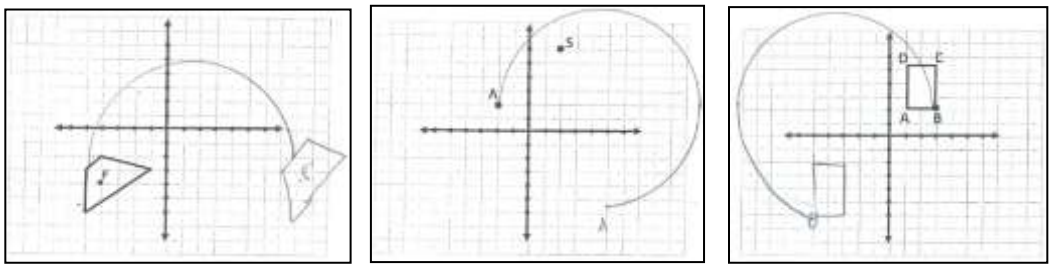


Figure 3: Students' solutions using symmetry of the shape or point

The above solutions related to 180, 270 and again 270 degree rotations respectively. In the all three solutions above in Figure 3, an arc was drawn for the desired angle with a protractor centred at a random point. The students did not recall which point they used as a centre of rotation and they could not make any explanation about this situation. While the centre of the arc which was drawn should be the reference point (point that will be rotated around) they did not pay any attention to that point.

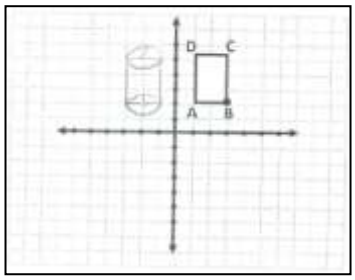
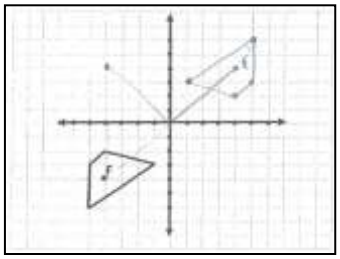


Figure 4 is an example of the solutions of some students who tried to make rotation as 3-dimensional. For the reason of this, they expressed that they thought the figure as 3-dimensional like a book or a notebook but not two dimensional.

Figure 4: Student's solution about thinking 3-dimensionally



One of the incorrect responses to rotate a figure 180 degree around a point inside that figure is seen in Figure 5. When this student was asked about how he or she found this solution, he or she stated that since 180 degree rotation was asked, he or she thought that it was necessary to take symmetry. For this reason, the student made his or her drawing by taking the symmetry of the figure and the point inside that figure, according to origin.

Figure 5: Student's solution about taking symmetry according to origin

Conclusion

When the solutions of pre-service teachers were searched generally, it is possible to make the following comments.
Students who made right solutions have enough basic knowledge about the subject. In interviews these students gave answers with self-assurance. When their solutions were analysed, their drawings show how they reached their answer.

In addition to that there are also students who reached the correct solution by different methods. When these different methods analysed, we can make this comment. Knowing how to use protractor, and doing millimetric drawings may be evidence of that they learned this subject as conceptual when they are in primary school. Although they haven't learned this subject again in the middle school, they can make connections between other mathematics subjects which they learned afterward. This can be a result of that they constructed their knowledge strongly.

For the incorrect solutions, the general result after interviews was that these students don't have enough knowledge about the subject and they have some deficiency about basic concepts. Not knowing how to use protractor may be an indicator of that situation.

Our results show the thinking and misconceptions of some pre-service teachers. We consider that determining this kind of conceptual deficiency amongst so many student teachers is important. By adding this kind of self-assessment and discussion of misconceptions to teacher education programs, quality of teacher education may be increased.

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