An Action Research for Improving Spatial Reasoning Ability of Grade 7 Students

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Abstract.

Curriculum has identified a number of skills that students need to acquire such as reasoning, questioning, critical and reflective thinking, spatial reasoning, problem solving. However, it is recommended that educators can use materials or technological tools to create learning environments. In the mathematics curriculum of our country, it is addressed that the 7th grade students should transform 2D and 3D representations and make geometrical drawings. In order to have such skills, students need to develop spatial reasoning skills. In this direction, the purpose of the study was to develop the spatial reasoning skills of 7th grade students. In this study, the students' spatial reasoning skills were examined with the focus of spatial visualization and spatial orientation components. Action research method was used as a research methodology. The tasks designed on the basis of the Geocadabra Dynamic Software were practiced interactively in computer environment. In this process, observation, interview, document analysis, Bandicam recording and voice recording were used as data collection tools. The students were observed according to the contents of spatial visualization and spatial orientation skills. The analysis of this study is still ongoing. The observations in the classroom implementation indicated that the students enjoyed using the software and the software affected their three-dimensional thinking positively.

Keywords: Secondary Education; Dynamic Geometry Software; Spatial Visualization; Spatial Orientation

1 Introduction

In recent years, important organizations, such as the National Council of Teachers of Mathematics (2010), have supported "spatial" approach to the teaching and learning of curriculums increasingly [4]. We use spatial reasoning in activities such as reflecting, origami, art, map reading, navigation tasks, placing objects in wardrobe or luggage, parking cars, placing dishes in the dishwasher, playing games etc.

According to Clements and Battista (1992), spatial reasoning consists of the set of cognitive processes by which mental representations for spatial objects, relationships, and transformations are constructed and manipulated [2]. Obviously, spatial reasoning and comprehension in geometry are strongly related, and most educators have inclination to include spatial reasoning as part of the geometry curriculum.

Dynamic geometry software enables students to reach some conclusions with drag-and-drop operations on geometric forms through guide questions and structuralist activities [10]. In addition, dynamic softwares enable students to visualize many geometric objects in a virtual environment and help them build scaffolding to make inferences by using these relationships [9]. The aim of this study is to design a learning environment that will improve spatial reasoning skills of 7th grade students with the support of Geocadabra software and to examine how this environment affects spatial visualization and spatial orientation skills of students.

1.1 Theoretical Frameworks

The meaning of information and how it is structured is one of the research areas of the scientists, and the conclusions about it lead to new teaching methods. According to radical constructivism, the structuring of knowledge varies from person to person, and perception of reality is a subjective concept [6]. Von Glasersfeld (1995) point outs that an individual constructs information through subjective experiences [6]. Radical constructivism went beyond cognitive constructivism and made the individual fully active in the act of structuring. The individual reaches the information as a result of his / her efforts and makes meaning according to the inferences obtained from his / her own experiences. The individual reaches the learning product as a result of his or her efforts by creating his own reality.

1.2 Spatial Reasoning and Components

There are various definitions of spatial reasoning and its components. Spatial reasoning consists of the set of cognitive processes by which mental representations for spatial objects, relationships, and transformations are constructed and manipulated [2]. McGee (1979) states that spatial reasoning is divided into two components as “spatial visualization” and “spatial orientation [3].

- Spatial visualization involves ability to “mentally rotate, manipulate and twist two and three dimensional objects” ([3]:896).
- Spatial orientation contains “the comprehension of the arrangement of objects within a visual pattern, the aptitude to remain unconfused by the changing orientations in which a spatial configuration may be presented, and the ability to determine spatial orientation with respects to one’s body” ([3]:897).

Maier distinguished five components of the spatial reasoning: spatial perception, visualization, mental rotation, spatial relation, and spatial orientation [1].

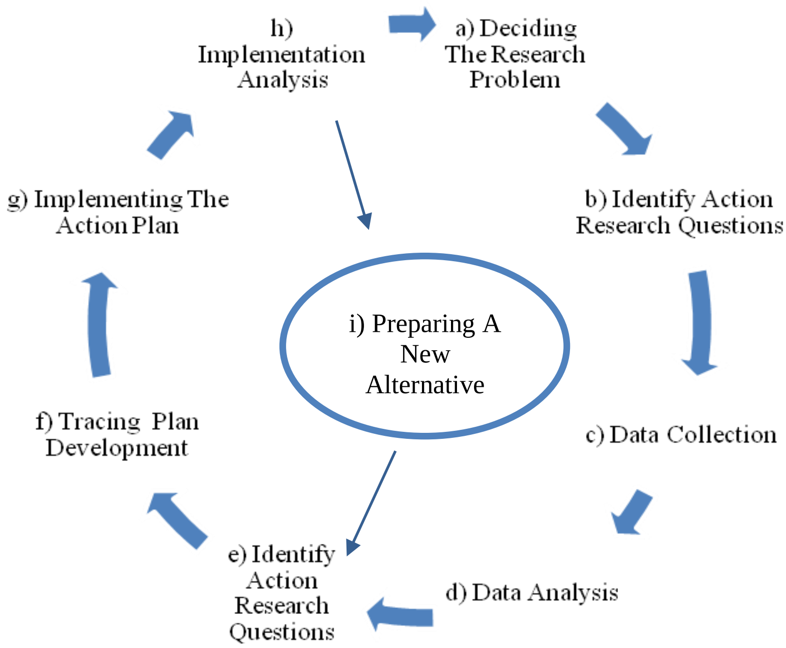
- Spatial perception involves the location of the horizontal or the vertical in spite of distracting information.
- The visualization requires the ability to visualize a configuration in which there are a movement among parts of configuration.
- Mental rotation requires the ability to quickly and accurately rotate a two or three dimensional shapes.
- Spatial relation means the ability to understand the spatial configuration of objects or parts of an object and their relation to each other.
- The spatial orientation means a person's own orientation in any special spatial situation.

Based on the aim of this study and the activities performed on the software, two of the components were used.

2 Methods

In this study, action research, which is a form of qualitative research, was used to improve the spatial reasoning skills of 7th grade students in terms of components. Action research is the process of working on classroom or school situations to improve the quality of teaching [8]. The action research stages defined by Yıldırım and Şimşek (2016) were followed as shown in Figure 1 [7].

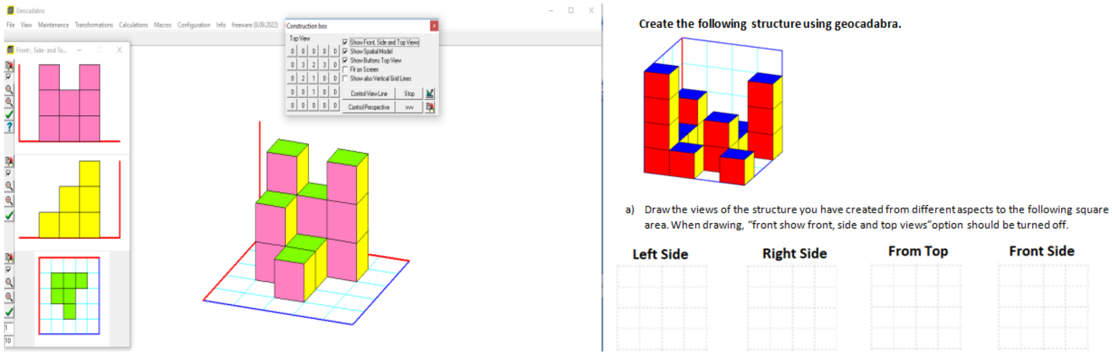
Figure 1: Action Research Stages



Source: Yıldırım, A. and Şimşek, H. (2016) [7]

Spatial reasoning is learnable and can be taught at all levels in the education system [5], and studies are needed to improve the skills of students with difficulties. The first researcher carried out the research by taking into consideration the issues that the students had difficulties in accordance with the inferences obtained from the four years teaching experience. Related studies in the literature were examined. During the interviews with the second researcher, it was decided to design a Geocadabra dynamic software based learning environment. Two different worksheets were prepared on the basis of Geocadabra. Prepared worksheets are included in the curriculum relation to the subject of "Views of Objects from Different Aspects". The visual of the Geocadabra interface and an image from worksheet is given in Figure 2.

Figure 2: Geocadabra Interface and An Image From Worksheet



Source: Geocadabra Dynamic Software and Worksheets were prepared by the researcher.

The designed worksheets were practiced four times with different students. After the practices, the plans were arranged. The stages shown in Figure 1 were followed throughout the process. The data collection tools used during the course plans are given in Table 1.

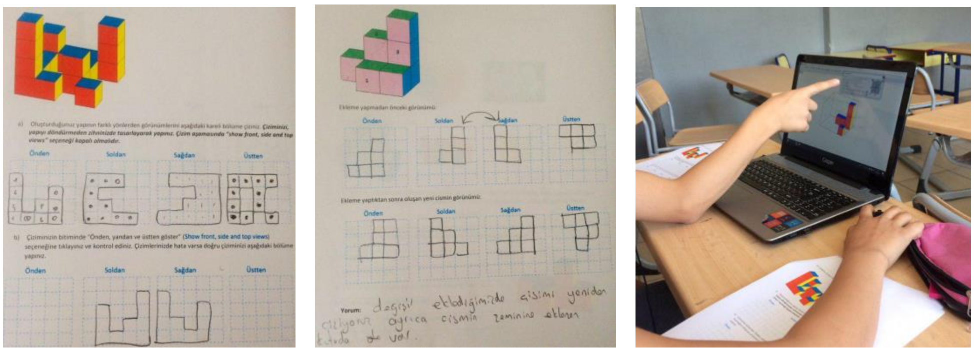
Table 1: Data Collection Tools

Observation	Students were observed according to the instructions of spatial visualization and spatial orientation skills.
Interview	After the practice, an interview was conducted to reveal the mental processes experienced by the students.
Document Analysis	Students' worksheets were examined.
Voice Recording	The talks of the students were recorded.
Bandicam Recording	The screen movements on the dynamic software were recorded.

3 Conclusion and Discussion

The observations in the classroom implementation indicated that the students enjoyed using the software and the software affected their three-dimensional thinking positively. The analysis of this study is still ongoing. It was observed that students practised spatial orientation and spatial visualization contents in classroom activities. Figure-3 shows the image on the student worksheet. In this figure, it is indicated that the student corrected the mistake made after the feedback and correction received from the Geocadabra.

Figure 3: Student Worksheets and An Image From Study Environment



Source: The worksheets were prepared by the researcher.

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