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A study on developing candidate teachers' spatial visualization and graphing abilities

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Abstract

Spatial abilities are described as the combination of the skills such as creating mental pictures of objects in the universe, recognizing in different ways and budging these objects as a whole or in pieces individually (Bannatyne, 2003). Forming graphics, interpreting graphics forms an important part of science and experimental studies' base (McKenzie and Padilla, 1986). In this study, the effect of computer software on spatial visualization and graphing skill has been examined. For one group, design of the study is pre test-post test research design. Spatial visualization test (Bodner & Guay, 1997) and Test of Graphing Skills in Science (Mc-Kenzie & Padilla, 1986) have been used as medium of data collection. It has been found out in the study that spatial visualization and graphing skills of candidate teacher have increased meaningfully after the application of computer software.

Keywords: spatial visualization, graphing skills, candidate teachers;

1. Introduction

Spatial abilities are described as the combination of the skills such as creating mental pictures of objects in the universe, recognizing in different ways and budging these objects as a whole or in pieces individually. Most of the occupations are dependent on spatial ability rather than verbal ability mainly architecture, astrology, biochemistry, biology, chemistry, cartography, engineering, geology, mathematic, music and physic (Bannatyne, 2003) and in these areas of science success is limited without spatial ability (Hartman & Bertoline, 2005). Chemistry is noteworthy as it is one of visual science (Habraken, 1996). Spatial abilities are important in teaching a lot of chemistry subject especially molecule geometry. According to Keig and Ruba (1993) molecular structure is considered a core concept in chemistry and visualization of molecules and descriptions of their shapes are critical skills for beginning chemistry students. Students are known to have difficulty translating between chemical formulas, molecular representations, and physical models. Forming graphics, interpreting graphics forms an important part of science and experimental studies' base (McKenzie and Padilla, 1986). To explain the experimental data acquired and to reach a specific result, it is necessary to record the data regularly, to classify them and to transform them into graphics making clear connections.

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Computer software is used effectively to create an atmosphere that the students are active. These programs give students the chance of repeating the content and practicing. Computers provide real and beneficial visuality as concrete models do (Clements & McMillen, 1996). While studying with computer software, the students can change the shape and dimension of an object, recreate the object in different dimensions, save it on the computer and repeat this process when necessary. This helps the students to form dynamic shapes.

It is considered that spatial skills that are not developed well, solving graphic problems and lacks in understanding graphics can create serious problems in students' professional and daily life (Rafi et al., 2008; Coştu, 2007). It is stated in literature that spatial abilities and graphic ability can be developed with appropriate instruments and activities (Ben-Chaim, Lappan, Houang, 1988; Mokros & Tinker, 1987). In this study carried out for this purpose, it is aimed to develop spatial visualization and graphic skills of candidate teachers with computer software.

2. Method

One group pre test-post test design from experimental designs has been used in this study. Study group of the research is composed of 22 chemistry candidate teachers who study at Hacettepe University, Faculty of Education. Spatial visualization test and test of graphing skills in science have been implemented as pre test in the study. Application of computer software has been carried out for 3 hour in a week for one semester with candidate teachers in computer course. After the application, spatial visualization and test of graphing skills in science have been implemented again as final test.

The data has been collected with "The Purdue Visualization of Rotations Test (ROT)" and "Test of Graphing Skills in Science" in the study. The ROT exam tell the student to: (1) study how the object in the top line of the question is rotated, (2) picture in your mind what the object shown in the middle line of the question looks like when rotated in exactly the same manner, and (3) select from among the five drawings (A, B, C, D, or E) given in the bottom line of the question the one that looks like the object rotated in the correct position. The reliability of the 20-item of ROT test involved calculating the Kuder-Richardson 20 (KR-20) for Science/Engineering students is 0,80 and for Agriculture/Health Science students 0,78 and split-half reliability coefficients is 0,80 and 0,85 (Bodner & Guay, 1997).

"Test of Graphing Skills in Science" that was developed by McKenzie and Padilla (1986) has been used to measure graphic interpreting and forming skill of students. The study of Turkish adaptation of the scale was done by Oskay, Erdem, Yılmaz and Erdoğan (2008). The test prepared as multiple-choice test includes 26 items. Reliability of the scale has been found out to be 0,83. Test-repeat-test reliability coefficient of the scale is 0,67.

Software of chemistry has been utilized to develop spatial visualization and graphic skills of candidate teachers. Software includes the activities such as molecule shape drawing, bond kinds and length, molecule geometry, data recording and graphic forming.

3. Results

At the end of the practice made using software relating to chemical molecules, dependent variable t-test has been made to determine significance of difference between spatial visualization pre test and post test score averages of candidate teachers. Analysis results are given at Table 1.

Table 1: Paired Sample t-Test Findings Related to Pre and Post Tests Results of the Spatial Visualization Test

Measure (Spatial Visualization Test)	N	$\overline{X}$	S	sd	t	p
Pre test	22	12,5455	3,87	21	-2,40	,026
Post test	22	14,5909	1,76			

It has been observed that there has been a significant increase in spatial visualization abilities of candidate teachers at the end of the application [$t_{(21)}$= -2,40, p<,05]. Before the application, the average spatial visualization scores of candidate teachers was X=12,54, it became X=14,59 after the application. This finding has shown that software application has an important effect on increasing spatial visualization abilities of candidate teachers.

Dependent variable t-test has been made to determine significance of difference between graphic ability pre test and post test score averages of candidate teachers. Analysis results are given at Table 2.

Table 2: Paired Sample t-Test Findings Related to Pre and Post Tests Results of the Graphic Ability

Measure (Graphic Ability Test)	N	$\bar{X}$	S	sd	t	p
Pre test	22	16,4091	2,48	21	-2,34	,029
Post test	22	17,9091	2,24			

It has been observed that there has been a significant increase in graphic abilities of candidate teachers at the end of the software study [$t_{(21)}$= -2,34, p<,05]. Before the application, the average graphic ability scores of candidate teachers was X=16,40, it became X=17,90 after the application. This finding has shown that software application has an important effect on increasing graphic abilities of candidate teachers.

Correlation analysis has been made to determine the relationship between spatial visualization and graphic ability scores of candidate teachers. Analysis results are given at Table 3.

Table 3: The Relationship Between Spatial Visualization and Graphic Ability

		Spatial Visualization	Graphic Ability
Spatial Visualization	Correlation Coefficient	1,000	,315
	Sig. (2-tailed)	.	,153
	N	22	22
Graphic Ability	Correlation Coefficient	,315	1,000
	Sig. (2-tailed)	,153	.
	N	22	22

The relationship between spatial visualization and graphic ability scores of candidate teachers is positive, it is understood that correlation coefficients are not statistically significant (r=0,315, p>0,05).

4. Conclusion and Discussion

It is aimed to develop spatial visualization and graphic abilities of candidate teachers by using software in this study. Spatial Visualization and Graphic Ability tests applied to candidate teachers as pre test have been reapplied after the application made using software. To investigate the effect of the application on spatial visualization, the data obtained from pre test-post test have been analyzed and it has been observed that scores of post test are high. It can be concluded that application of software prepared for chemistry has an important effect on developing spatial visualization abilities of candidate teachers. This result acquired from the study is consistent with the result of the study examining the effect of virtual environment to the spatial visualization ability, carried out by Rafi et al (2008), which showed a significant improvement in all participants' spatial visualization abilities the result that spatial ability is improved as a consequence of the study by Olkun (2003) which included engineering drawing. In another study, the effect of computer games and "HyperGami" program on spatial thinking has been investigated and it has been declared that the participant have gained the ability of spatial visualization ability at the end (McClurg vd., 1997). Barnea & Dori (1999) have detected that model perception success of experiment group students who were

applied to computerized molecule modeling is higher than that of control group in terms of spatial success test and chemistry. In the frame of the study that Rafi and others did (2005), web base virtual atmosphere was created and the effect of this atmosphere on developing spatial ability was researched. At the end of the study, it was concluded that virtual atmosphere was much more effective than classical class atmosphere in terms of developing spatial ability. Kozhevnikov and Thornton (2006) detected that application of microcomputer based labs created a significant difference in spatial visualization abilities of candidate teachers. The study made by Yıldız (2009) introduced that the use of 3 dimensional virtual atmosphere increased spatial visualization of students significantly. Yolcu and Kurtuluş (2010) aimed in their study to develop spatial abilities of students with computer programs and found out spatial abilities of students increased. When literature is examined, it is noteworthy that there are a lot of studies supporting the result.

In this study, the effect of software programs' application that examines molecules in chemistry at three dimensional platforms on graphic skill has been investigated. This result can be interpreted that application has an important effect on developing graphic skills of candidate teachers.

Positive effect of software on spatial visualization and graphic ability has led us to investigate the relationship between spatial visualization and graphic ability. Therefore, according to the result of correlation analysis, it has been found out that there is not a relationship between spatial visualization and graphic ability. Keys to enhancing spatial skills include sketching, the use of hand-held models, and the reorganization of graphics topics sequencing (Sorby, 1999). Berg and Smith (1994) have determined that, in their study in which they examined the relationship between mental thinking abilities and graphic forming and interpreting abilities, individuals having weak spatial thinking and judging abilities have difficulty in graphic forming and interpreting. Even a relationship between spatial visualization and graphic ability was not found in the study, it can be concluded that individuals having high spatial visualization ability do not have difficulty in graphic forming and interpreting.

It is considered that computer programs are the most effective way in developing spatial visualization. Accordingly, while candidate teachers prepare course plan/syllabus, they can be made to use computer programs adequately in their courses.

In material developing courses, candidate teachers are informed about different computer software by recognizing related internet websites and how application will be done by these instruments in terms of helping the students having difficulty in spatial visualization in molecular symmetry.

Chemistry teachers can be advised to use this kind of applications more in their courses, when students' interest in applications done at three dimensional platforms on computer is taken into consideration.

Graphics are very important and critical concepts for chemistry and other disciplines. Graphic forming and interpreting abilities are important in raising scientifically literate individuals. Hence, while lecturing, candidate teachers can be made to realize how they can use graphics more efficiently and how they can benefit from them.

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