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A sample of active learning application in science education: The thema "cell" with educational games

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Abstract

In the present study, the purpose is to develop an application within the context of active learning methods and techniques by using educational games to teach the topic "cell" in elementary school science and technology course and evaluate its impacts on academic achievement. In the study, "Achievement Test" was used in line with pretest-posttest design to collect data. The control group consists of 72 sixth grade students and the experimental group consists of 121 sixth grade students, totally 193 students make up the study group. In the analysis of the data, Two-Way ANOVA for Mixed Measures test was employed. The analysis revealed a significant difference between the mean achievement score of the experimental group and that of the control group favoring the experimental group.

Keywords: science and technology, cell, active learning, educational game

1. Introduction

The topic "cell" is on of the most difficult topics to teach in science and technology course at elementary level because as known well, second stage in elementary level is a period of transition from concrete operations to abstract operations (Şaşmaz Ören & Erduran Avcı, 2004). The topic "cell" on the other hand includes some abstract concepts. Therefore, there is a need to make this topic more concrete while teaching it. One of the most important ways of making this topic more concrete is educational games. Educational games are one of the more successful methods complying with active learning methods and techniques. Today, it is almost possible to teach all courses through games and drama. Children gain experiences, develop tactics, find solutions, and make many decisions while playing. In this way, all the target skills, values and objectives can be achieved through games (Akandere, 2004; Aliyeva Esen, 2008; Demirel, 2002; Joyce & Weil, 1992; Mangır & Aktaş, 1993; MEB, 2006). Including games in learning-teaching processes is believed to make lessons more enjoyable and interesting; hence, motivate students more (Ün Açıkgöz, 2006). According to Kaptan and Korkmaz (1999), through educational games, the topics can be rendered more interesting and new concepts can be taught more easily, misconceptions can be corrected and information can be made more permanent. As the topic "cell" includes some abstract concepts, students may have learning difficulties and some misconceptions may be developed (Dikmenli & Çardak, 2004;

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Eyidoğan & Güneysu, 2002). Educational games can be great help in reducing learning difficulties and misconceptions.

Therefore, the purpose in the present is to develop an application within the context of active learning methods and techniques by using educational games to teach the topic "cell" in elementary school science and technology course and evaluate its impacts on academic achievement. For this purpose, sub-problem of the study is as follows:

a. Is there a significant difference based on "cell model" between the pretest and posttest mean scores of the experimental group and control group in relation to the topic "cell"?

2. Methodology

2.1. The research model and application

The present study was carried out according to pretest-posttest control group experimental design and while in the experimental group, it was conducted in line with active learning methods and techniques making use of educational games, in the control group, the lessons were taught according to teaching program.

The application called "cell model" was developed by the researcher based on educational game approach. The application covers totally four lesson hours and in the first lesson hour, pretest was administered and introduction to the topic was made and activities to be carried out in the following lesson hours were summarized.

In the second lesson, the students were divided into groups and the cell organelles to be animated were assigned to the students. The students were asked to write the names of the organelles on A4 sheets of paper with colorful pencils. Then the students were distributed the main functions of the cell organelles and they were asked to learn these functions.

In the third lesson, the students attached the names of the organelles to be animated on their front and back in such a way as to be seen by all the students and the students were let to school garden. The teacher assumed to role of nucleus managing the cell and then the students were asked to organize around the nucleus in such a way as to create a model of a plant cell. The students were asked to carry out conversations in pairs about the functional interactions between the nucleus and organelles and organelle and organelle and their own duties as an organelle to learn and fortify the learning. The dialogues among the students were carried out as two-staged process. Some sample dialogues are given below:

In the first stage;

Nucleus: Mitochondria! The cell needs energy, generate energy!

Mitochondria: The required energy has been generated.

Nucleus: Chloroplast! The cell needs food, carry out photosynthesis!

Chloroplast: The food has been produced by carrying out the photosynthesis.

……

In the second stage;

Nucleus: Mitochondria! What do you do?

Mitochondria: I generate the energy needed by the cell.

Nucleus: Chloroplast! What do you do?

Chloroplast: I produce food and give the plant its green color by making photosynthesis.

……

After that, the students having the role of cell wall and chloroplast were asked to depart from the model and then the student acting centrosome was included into the cell and an animal cell was created and similar conversations carried out for the plant cell were also performed for the animal cell. In this way, the concepts concerning the plant and animal cells, the differences between them and the duties of the organelles were elaborated. In the fourth lesson, a general evaluation was made and the students were administered the posttest. The study was recorded step by step, and enriched with visual materials such as photos, posters etc. to draw the attention of the participants.

2.2. Study group

The study group comprises 72 students (2 classes: the control group) from Ankara-Seymenler Elementary School, and 121 students (3 classes: the experimental group) from Ankara-Nazım Akcan Elementary School attending to the 6th class in both groups. However, during the evaluations, the control and experimental groups were combined and treated as one group. Of the students participating in the present study, 47% (N=90) are females and 53% (N=103) are males.

2.3. Data collection tools

In data collection, "Achievement Test" was used to collect data. This test was used in line with pretest and posttest procedure, and before the study it was administered as a pretest and after the study, it was used as a posttest.

The scale developed by the researcher consists of 16 multiple-choice questions having four options for each question. For the scoring of the scale, 1 is assigned to correct answer and 0 is assigned to wrong answer. The score to be taken from the scale ranges from 0 to 16.

Factor analysis was carried out for the construct validity of the scale. And KMO (Kaiser-Meyer-Olkin) value of the first dimensions of the scale calculated at 0.001 level was found to be 0.630 and the value of Barlett Test was found to be 309.835 and considered to be significant. It was found that the 16 items evaluated are subsumed under four factors having an eigen value higher than 1. The variance explained by these four factors in relation to the whole scale is 41.576%. The common variance defined in relation to two factors relating to the items was found to be ranging from 0.307 to 0.663. Moreover, when the analyses were examined, it was seen that the first factor loading values of the items are 0.371 or higher. The varimax analysis revealed that the loading values of the items in the first factor range from 0.519 to 0.702, that the loading values of the items in the second factor range from 0.495 to 0.679 and that the loading values of the items in the third factor range from 0.398 to 0.585 and from 0.375 to 0.713.

The content and face validity of the scale was determined through expert opinions. For the reliability analysis of the scale, Kuder Richardson 21 (KR-21) coefficient was calculated and found to be 0.74.

2.4. Data analysis

The data obtained from students' achievement pretest and posttest were statistically evaluated by SPSS program. Variance homogeneity of the groups was tested with Levene test and for co-variance equality, Box's M statistics was employed. For the data analysis Two-Way ANOVA for Mixed Measures test was used.

3. Findings

In this section, the difference between the academic achievement level of the students participating in "cell model" application designed based on active learning methods and techniques and that of the students not participating in this application was descriptively evaluated and the significance of this difference was statistically tested.

3.1. Findings concerning the achievement scores of the experimental and control groups

Table 1. Descriptive statistics relating to pretest and posttest scores of the experimental and control group students

	Groups	**N**	**Mean**	**Std. Deviation**
Pre-test	Control	72	4.89	2.192
	Experimental	121	5.66	2.393
	Total	193	5.37	2.344
Post-test	Control	72	7.56	2.556

Experimental	121	12.72	2.310
Total	193	10.79	3.467

As can be seen in Table 1, a significance of 0.77 was found between the pretest scores of the students ($M_{(Control)}$=4.89 and $M_{(Experimental)}$=5.66). On the other hand, the difference between the posttest scores of the groups was found to be 5.16 ($M_{(Control)}$=7.56, $M_{(Experimental)}$=12.72).

Two-Way ANOVA for Mixed Measures test was conducted to determine whether the score differences between the groups is significant or not and the results are presented bellow:

Equality of Covariance Matrices of the groups was tested to find out the suitability of the variance analysis to be carried out to determine the significance of the change seen between the scores and it was found that co-variances are homogenous ($F_{(3\text{-}796461.341)}$=2.010; p>.05) (Table 2).

Table 2. Box's test of equality of covariance matrices

Box's M	6.106
F	2.010
df1	3
df2	796461.341
Sig.	.110

In order to test the hypothesis that the variances of the groups are equal, the results of Levene statistics were evaluated and it was observed that the hypothesis was supported for both variables ($F_{(1\text{-}191)}$=.582 and .276; p>.05, respectively) (Table 3).

Table 3. Levene's test of equality of error variances

	F	**df1**	**df2**	**Sig.**
Pre-test	.582	1	191	.447
Post-test	.276	1	191	.600

As can be seen in Table 4, as a result of the "cell model" carried out by using active learning methods and techniques with the experimental group, significant difference emerged between the posttest scores of the experimental and control groups, favoring the experimental group. On the other hand, the $F_{(1\text{-}191)}$=69.543 and $F_{(1\text{-}191)}$=162.071 values are significant at the level of 0.001, showing that a significant difference occurred between the pretest scores and posttest scores of the participants.

Table 4. ANOVA results concerning academic achievement pretest-posttest scores

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between subject	1732.347	192			
Group	795.202	1	795.202	162.071	.000
Error	937.145	191	4.907		
Within subject	3764.858	193			
Measure **Group*Measure**	2134.355	1	2134.355	341.055	.000
Error	**435.205**	**1**	**435.205**	**69.543**	**.000**
	1195.298	191	6.258		
Total	5497.205	385			

In addition to above-mentioned findings, the results also show that there is a significant difference between the total pretest and posttest scores of the experimental and control group students, which is believed to be based on the

"cell model" program enriched with active learning methods and techniques, favoring the experimental group ($F_{(1-191)}$= 341.055; p<.001).

As a result of the analysis between the experimental group and control group, a significant average achievement difference was detected in favor of the experimental group. In addition to that, during the study, more student interest in the lesson has been observed. Moreover more effective information exchange as well as more cooperation between group friends have been observed.

4. Conclusions

The present study conducted to develop an application for 6th grade students to learn the topic "cell" more easily and look at the effects of this application on academic achievement revealed these results:

In the present study, a significant difference between the academic achievement mean score of the experimental group and that of the control group favoring the experimental group was found. That is, the achievement scores of the experimental group significantly increased due to "cell model" application carried out with the experimental group students. This finding indicates the positive effect of "cell model" activity designed based on educational games on teaching one of the challenging topics to be learned; that is, the topic of "cell"

Parallel to this finding, Şaşmaz Ören and Erduran Avcı (2004) argue that teaching through games is more effective in enhancing academic achievement in science teaching when compared to traditional teaching. Moreover, there are many studies from different fields reporting the effectiveness of educational activities in teaching (Doğanay, 2002; Keleş, 2003; Keleş, Uşak & Aydoğdu, 2006; Moğol ve Özçiftçi, 2003; Yurt, 2007).

As a conclusion, the carried out educational game based activity increased the students' interest by ensuring their active participation and their academic achievement significantly. Therefore, this activity provides some support for the effectiveness of the recently most accepted active learning method in Turkey. For this reason it should be frequently utilized for topics hard to comprehend like "cell" and "cell topics"

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