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The Investigation of Effects of Modelling and Computer Assisted Instruction on Academic Achievement

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Abstract
This study aimed to investigate the effects of modelling and computer assisted instruction (CAI) on students' academic achievement. For this purpose, this study was conducted with 132 second grade students from 19 Mayıs University, Faculty of Education, Department of Science and Technology. Students were grouped as control, modelling and computer assisted instruction group and "cell division" was taught using three different methods. Pre-test and post-test results revealed that there were significant differences between the groups in terms of academic achievement. While control group (traditional method) was the less successful group, modelling group was the most successful group. Study results also revealed that students learned better by doing and were more successful when supplementary tools were used.

Keywords: Cell Division, Modelling, Computer Assisted Instruction (CAI).

1. Introduction

Biology, as an exact science, is hard to learn due to its abstract concept and heavy curriculum. Teacher-centred or old-fashioned teaching methods and strict adherence to the course books make biology courses boring and make it difficult for the students to learn abstract concepts (Yaman & Soran, 2000; Tekkaya et al, 2000). Similarly although it has been taught repeatedly in the educational process, "cell division" has been considered difficult and cannot be comprehended thoroughly by the students (Bahar, Johnstone & Hansell, 1999; Tekkaya, Özlem & Sungur, 2001; Güneş & Güneş, 2005).

As "cell division" can only be imaged at microscopic level, some conceptual errors may occur during learning process and it may be hard for the students to grasp the subject thoroughly (Kindfield, 1994; Lewis, Leach & Wood-Robinson, 2000). Atılboz (2004) stated that teaching through concrete concept with supporting materials at microscopic level may help preventing conceptual errors by making abstract knowledge formed as concrete. True and permanent learning can only be achieved when teaching method involves more than one sense (Demirel, 2002). Therefore, in order to achieve an easy and permanent learning, it will be helpful to use supporting teaching materials in education process. Educational technology tools play an important role in concretizing such abstract concepts according to the students' level and presenting as if alive, meaningful learning and observing incidents repetitively (Akpınar, Aktamış & Ergin, 2005).

In previous studies, it was suggested that using computers as supporting teaching tools, affect students' understanding and performance positively and helps students to develop their mental configuration (Akarsu et al, 1988; Sezgin & Köymen, 2002; Atılboz, 2004). Computer assisted instruction (CAI) is a teaching method which is formed by combining interactive learning principles and computer technology in which computer is used as a supporting device for the teacher in teaching. It strengthens teaching process and students' motivation and makes it possible for the student to learn according to his/her learning speed (Şahin & Yıldırım, 1990; Uşun, 2000). Students can configure the concepts which they have difficulty in understanding with the use of CAI applications with computer assisted software especially using simulations of abstract concepts and animations which allow students to participate in learning process interactively (Karamustafaoğlu, Aydın & Özmen, 2005).

Modelling is one of the most important methods used in concreting abstract concepts. The term of modelling refers all the processes used for illustrating a new subject and the term of model refers to the product of these all processes (Harrison, 2001; Treagust, 2002). Models and modelling

are the inseparable parts of science teaching. Especially, the abstract concept of science expands function and usage of models in science teaching. Sometimes it may be hard for the students to learn some abstract concepts. The term of modelling refers all the processes used for illustrating a new subject and the term of model refers to the product of these all processes (Güneş, Gülçiçek & Bağcı, 2004). Models provide a learning process through living and experiences. Making a model requires using both hands and eyes and stimulates more than one parts of brain and improves meaningful learning (Haury, 1989; Lavoie, 1993). According to Justi and Gilbert (2000), the most important function of models is "the ability of simplifying the most complex context".

The aim of this study was to investigate the effects of the use of CAI applications on academic achievement in teaching "cell division" which is hard to learn by the students and to determine the most efficient method in improving academic achievement. This study also compared the instruction methods in terms of their efficiency. It is thought that this finding would be helpful in Biology education.

2. Method

2.1. Subjects

The population of the study is the students of 19 Mayıs University, Faculty of Education, Department of Science and Technology Education. The sample included 132 second grade students from the same department. The study was carried out with one control and two experimental groups to whom "cell division" (mitosis-meiosis) was taught within the context of Biology I courses.

2.2. The Instrument

While "cell division" was taught to the control group students using traditional instruction method, computer assisted instruction was used in experimental group. Topics were taught to forty four students in the second experimental group using traditional instruction methods and then students were asked to make models. Topics were taught to control group students in accordance with the curriculum via traditional instruction method. Computer assisted instruction were performed in computer laboratory. PowerPoint presentations and animations were used to instruct the subjects. At first, subjects were taught to the students in second experimental group using traditional instruction method and then students were asked to create their own models which were related to "cell division". Students were asked to consider and point out some difficult concepts such as homologous, chromosome, chromatid, chromatin, chromatin fiber, tetrat, synapse, and crossing-over.

Students in second experimental group developed models related to "cell division" using plasticine, yarns, wire, buttons and beads. They developed models for each phase of mitosis and symbolized events that occur during that phase. These models were evaluated in the classroom and then errors were corrected.

Success test was used to determine the levels of students' knowledge related to "cell division". A pilot study consisting of 40 multiple-choice questions (5 choice; one is correct answer, other are distractors) was applied to 47 students. Questions with low reliability were excluded and Cronbach-alpha reliability coefficient of the success test (consisting remaining 25 questions) was calculated as 0.839.

2.3. Data Analysis

All groups were applied pre-tests and then applications were administered. After having completed all applications, success test was applied to all groups as a post-test. SPSS (Statistical Package for Social Sciences) was used in the analysis of the data. T-test was used to analyze the level of academic differences between control and experimental groups. Results were shown in tables in results chapter. To analyze t-test results, the significance level of p value was assessed as .05.

3. Findings

According to the control and experimental group students' independent t-test results; the means of first experimental, second experimental and control groups' independent t-test results were calculated as 48.23; 52.27 and 51.68 respectively. According to the results of t-test which was used as a pre-test to analyze the significant differences between the groups with different academic achievement levels, no significant differences between the groups were observed (as $p<.05$ considered

significant). These findings demonstrated that control and experimental group students' achievement levels were close to one another (Table 1).

Table 1: T-test Results of the Control and Experimental Groups' Pre-test Scores

Test	Group	N	M	SD	t	p	Commentary
Pre-test	I. Experimental	44	48.23	12.643			
					1.388	.169	p > .05
	Control	44	51.68	10.618			not significant
Pre-test	II. Experimental	44	52.27	10.823			p > .05
					-0.259	.797	not significant
	Control	44	51.68	10.618			
Pre-test	Experimental	44	48.23	12.643			p > .05
					-1.612	.111	not significant
	Experimental	44	52.27	10.823			

According to first and second experimental groups' post-test results, there were significant differences between the groups in terms of test scores (as p< .05). The means of first, second and control groups were calculated as 81.18; 90.45 and 69.05 respectively. The difference between I. experimental and control groups was in favour of I. experimental group. The difference between second experimental and control groups was in favour of second experimental group. The difference between first experimental and second experimental groups was in favour of second experimental group. There were significant differences between experimental and control groups and between first and second experimental groups. In other words, experimental groups' students were more successful than those in control group; second experimental group students were more successful than those in I. experimental group.

Table 2: T-test Results of the Control and Experimental Groups' Post-test Scores

Test	Group	N	M	SD	t	p	Commentary
Post-test	I. Experimental	44	81.18	6.986			p < .05
					-6.923	.000	significant
	Control	44	69.05	9.296			
Post-test	II. Experimental	44	90.45	6.410			p < .05
					-12.576	.000	significant
	Control	44	69.05	9.296			
Post-test	Experimental	44	81.18	6.986			p < .05
					-6,487	.000	significant
	Experimental	44	90.45	6.410			

The mean of I. experimental group pre-test scores was calculated as 48.23 and the mean of I. experimental group post-test scores was calculated as 81.18; the mean of second experimental group pre-test scores was calculated as 52.27, whereas the post-test score was 90.45. The means of control group pre-test and post-test scores were calculated as 51.68 and 69.05 respectively (Table 3). When pre and post-tests results were analyzed, there was a statistically significant difference in favour of post-test results between experimental and control groups pre and post-test results in terms of mean scores of groups' success test (Table 3).

Table 3: T-test Results of the Control and Experimental Groups' Pre and Post-test Scores

Test	Group	N	M	SD	t	p	Commentary
Pre-test		44	48.23	12.643			
	I. Experimental				-8.933	.000	p < .05
Post-test		44	81.18	6.986			significant
Pre-test		44	52.27	10.823			
	II. Experimental				- 21.676	.000	p < .05
Post-test		44	90.45	6.410			significant
Pre-test		44	51.68	10.618			p < .05
	Control				-9.187	.000	significant
Post-test		44	69.05	9.296			

4. Discussion and Conclusion

In educational process, abstract concepts are not easy to instruct and mental restructuring is becoming a great problem. Therefore, visuals aids such as computer animations, posters and models that enable perception and visualisation have been used in teaching abstract concepts. These kinds of visual aids stimulate more than one sense and students do not forget these experiences easily and thus more effective learning is achieved (Friedler & Tamir, 1990; Yiğit & Akdeniz, 2000). Students have some difficulties in learning some topics and some conceptual errors occur in the process of education (Kindfield, 1994; Bahar, Johnstone & Hansel, 1999; Clark & Mathis, 2000; Wood-Robinson, Levis & Leach, 2000).). It has been suggested that using computer assisted instruction may help preventing these kinds of errors which are seen in traditional instruction method (Sezgin & Köymen, 2002; Atılboz, 2004). Our study results demonstrated that CAI group was more successful than control group. These findings were consistent with those found in literature. In a previously conducted study, Baki (2002) stated that the use of computers plays an important role in motivation and learning process.

Meaningful learning requires mental modelling (mental configuration). In teaching abstract concept at microscopic level, models are being used for mental modelling. The term of modelling refers all the process used for illustrating a new subject and the term of model refers to the product of these processes (Harrison, 2001; Treagust, 2002).

In our study, it is determined that using models such as plasticine, yarns, wire, buttons and beads help students to achieve better conceptual understanding and students to learn what happens in each phase by living and experiences within a group.

As a conclusion, the study revealed that supportive educational devices improve success level of students and the use of such supportive tools was more effective than computers in teaching such abstract concepts. Our study results demonstrated that the use of modelling in science courses can increase students' motivation and success level. In the light of these data it is concluded that the subjects who are taught using visual aids (models) are more permanent than the subjects taught using computer assisted instruction materials. Computer assisted instruction help students to visualize abstract concept but making models help students' individual learning processes according to their perception skills. Science teacher should consider this fact in their courses.

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