IOJPE
International Online Journal of Primary Education - 2012, volume 1, issue 1

THE EFFECTS OF CONCEPT MAPS ON THE ACADEMIC SUCCESS AND ATTITUDES OF 11th GRADERS WHILE TEACHING URINARY SYSTEM

Sümeyye Özbey Akay
Yeniceoba Town, Yeniceoba High School,
Biology Teacher, Konya/Turkey
sum.ozbey@hotmail.com

Baştürk Kaya
Selçuk University, A.K. Faculty of Education,
Biology Education Department,
Konya/Turkey
basturk@selcuk.edu.tr

Selda Kılıç
Selçuk University, A.K. Faculty of Education,
Biology Education Department,
Konya/Turkey
seldakilic@selcuk.edu.tr

ABSTRACT
The aim of the present study is to support, enrich, and broaden the process of education using concept maps and to determine the effects of concept maps in biology classes on school success, attitude and retention of the knowledge taught. The present study was conducted as an experimental study with pre-test and post-test control groups. The participants of the study were impartially chosen 11th grade high school students from an Anatolian High School and a Teacher Training Anatolian High School. 45 students, 21 in the control and 24 in the experimental group, participated in the study. In the present study, 'urinary system' unit was taught. Whereas the control group was taught traditionally, the experimental group was taught using concept map based teaching technique. Data was collected using concept map attitude scale and biology achievement test, a 45 item scale with a reliability coefficient of (α = .78). In order to identify the differences among the groups, biology achievement test was used as pre and post test. Data obtained to determine the achievement of both groups were analyzed using t-test analysis model of the SPSS 11.0 package program. At the end of the study, a statistically significant difference ($p<.05$) between emerged traditional teaching method and using concept map while teaching. The data also indicated that the cognitive support of the concept maps had a positive impact on students' achievement and retention of knowledge. The data furthermore indicated that students have a positive attitude for concept maps.
Keywords: concept map, traditional teaching method, academic achievement, urinary system.

INTRODUCTION

Throughout their lives, people acquire information, skills, attitudes and values as a result of the interaction with their environment. These experiences are the fundamentals of learning. In general, learning can be described as bringing about changes for individual (Ertürk 1993). The main aim of science education and teaching is to teach the essence of science with concepts as its fundamental stones. At the same time, in our heavily teacher centered traditional educational system, the passiveness of students while acquiring information, heavy load of the curriculum to be covered in a short time, and providing only verbal definitions of concepts creates a learning environment which based on rote learning. Science education literature has countless studies showing that students have conceptual errors even after a formal education (Wandersee et al, 1994). Cognitive and behavioral theories tried to explain the phenomenon of learning. Behavioral learning theories sustained their impact until the end of 1960s; however as they focused only on observable behavior, lost their supremacy and gave in to cognitive theories of learning from 1970'ies of as they remained insufficient in identifying important and complicated scientific processes such as perception, problem solving, attention, personality, and

memory. According to cognitive scientist, learning is a cognitive procedure and occurs only if a learner makes sense of the information cognized. This cognition changes in line with learner experiences, culture, the nature of the interaction, and the role of the student in this process (Nakiboğlu 1999). Concept maps, since visual and two dimensional, present different concepts and their interactions within a subject, increase retention and learning as they address to individual differences and learning differences, easy to use and learn from, enable active student participation, and facilitate thus the process of the learning (Demirel, 2004; Kaptan, 1998). Concept mapping method was developed for learner to show what they already know and become aware of the cognitive structure (Novak ve Gowin, 1984). Concept maps help students understand propositions and concepts more clearly, make connection between old and new knowledge, and develop a cognitive structure in their minds (Arnaudin et al, 1984).

MATERIAL and METHOD

The aim of the present study is to examine the effects of concept maps on students' achievement and attitudes while teaching the 'urinary system', considered as difficult to learn, in the curriculum of the 11th grade. Hence the lessons were conducted both using traditional methods and employing concept maps in biology classes.

Study Group

Equivalent classes, one from each school, were chosen from Anatolian High School and Teacher Training High School in Isparta/Şakirkaraağaç. Biology Achievement Test (BAT) was applied to these classes and the results of the tests were evaluated statistically. The outcomes of the analysis (t-test) verified the results of these two classes to be close with each and hence they were enrolled into the study. Two tests were employed in the study. These were Biology Achievement Test and concept map attitude scale (CMAS). The features of the measurement tools used for data collection are indicated in the table below (Table1).

Table1: Research Design of the Study

Groups	Pre-test	Application	Pro-test
Experimental group-EG	T1,T2	CMT	T1,T2
Control group- CG	T1	TBT	T1

EG: Shows the group in which the concept maps are applied for teaching
CG: Shows the group in which the traditional method is applied for teaching
T1: Biology achievement test (BAT: pre-test, pro-test)
T2: Shows the concept map attitude scale

Data Collection Tool

In the study, Biology Achievement Test and Concept Map Attitude Scale were used. The features of the measuring tools used for collecting data are as following.

Biology Achievement Test (BAT)

The test was developed by the researcher. Biology achievement test consists of 45 multiple-choice questions. While preparing the questions the, university entrance exam preparation books, 11th grade biology course books, and Communiqués Journal of the Turkish Ministry of Education were taken into account. The biology achievement test was firstly applied to the 150 students. The questions which were not reliable were changed or removed from the test. So, the

reliability of the biology achievement test was tested and alpha reliability coefficient was found as .78. This test was applied to the control and experiment groups as pre-test before the study was implementation and as post-test after.

Concept Map Attitude Scale (CMAS)

The origin of the concept map attitude scale was developed by Arnaudin and Mintzes (1985) and used for measuring the attitudes of the students about concept maps. It was translated to Turkish by Uzuntiryaki and Geban (1999). It consists of ten questions and is a Likert type scale. Its reliability was found as .92.

Implementation

This study continued for two weeks in the second term of the 2008-2008 academic year. Before the implementation of the study, concept map technique was explained to the participants and some examples were given. The classes consisting of two 40 minutes periods were conducted regularly. For the implementation, two classes consisting each of 21 and 24 students with close achievement levels, were chosen. One of the classes, chosen as the control group, was taught using traditional biology teaching (TBT) method. The other group, experimental group, was taught using concept maps. Besides BAT as pre and post test, this group also answered CMAS. Before the unit of urinary systems, in the previous class hours, concept maps were introduced to the students by giving examples. The researcher joined the classes personally. Throughout the unit concept maps were drawn together with the students and at the end of the previous unit, in order to structure the concept maps more efficiently in their minds, students had to write some concepts into the blank spots of some concept maps. Students were to fill out these gaps and have also to draw new maps to provide feedback.

When the time came for 'urinary system' unit, concept maps were used for teaching the experimental group. Some tasks about concept maps were assigned to the students as homework. Inappropriate concept maps were edited in the classroom after the student had handed in their homework. Furthermore, throughout the course, students were asked to fill in the blanks of concept maps. After the implementation BAT was applied to both groups but CMAS only to the experimental group.

Data Analysis

In the analysis of the pre-tests and post-tests of the groups "matched t-test and for the analysis of pre-tests and post-tests between groups "independent t-test" has been used. SPSS 11.0 package program was employed for the statistical analysis. Biology achievement test (BAT), used for data collection, was prepared as a test multiple-choice consisting of 50 items. After the application of BAT to 150 students and statistical analysis, 45 questions with an item correlation result higher than .30 were incorporated into the test and the remaining 5 questions were removed. Hence the items on BAT were limited to 45 questions. In order to calculate the reliability of the test, Kuder- Richardson (KR-21) Cronbach Alpha formula was used. The reliability co-efficiency was determined as .78.

FINDINGS

45 students were involved in the present study about the effectiveness of using concept maps while teaching the urinary system in biology classes. Out of these 45 students, 21 were in the control group (taught using traditional method) and 24 in the experimental group (concept maps based teaching).

No statistically significant difference was found in the BAT pre-test and CMAS results of the students taught traditionally or concept maps based related to the 'urinary system' unit. Whereas the arithmetic average, resulting from statistical analyses, of the control group was 19,6842, the arithmetic mean of experimental group was 18,5500. T value calculated between the achievement scores of the two groups was - .950 (Table 2).

According to these outcomes, in the pre-tests of the control and experimental group, no statistically meaningful difference was found between the achievement scores considering p>.05. Hence, it can be assumed that both groups are equal in terms of their pre-test results.

Table 2: BAT-Pre-test Score Comparison of the Control and Experimental Group

Groups	N	$\bar{x}$	SS	SD	t	p
Control group	21	19.6842	3.49687	39	-0.950	,348
Experimental group	24	18.5500	3.95335			

p>.05

Regarding the 'urinary system' unit in the biology curriculum, as a result of statistical analyses the arithmetic mean of the control group was 34,0435 and of the experimental group 37.9500 calculated when the post tests of the two groups lectured traditionally and concept maps based were compared. T values calculated between the two groups' achievement scores is 3,083 (Table 3).

According to this outcome, considering p<0.05, there was a statistically meaningful difference between the achievement scores obtained in the post-tests of the control and experimental group showing that concept maps based teaching is more effective than traditional teaching methods. This is also an indicator for the positive effect of using concept maps on students' performances during teaching.

Table 3: BAT-Post-test Score Comparison of the Control and Experimental Group

Groups	N	$\bar{x}$	SS	SD	t	p
Control group	21	34.0435	4.59722	39	3.083	,004*
Experimental group	24	37.9500	3.70597			

*p<.05

Whereas the experimental groups' arithmetic mean of the pre test is 18,5500, it is for the post-test 37,9500, as a result of the statistical analysis conducted regarding the 'urinary system' unit in the 11th grade biology curriculum. T value, calculated between experimental group's pre and post tests achievement scores, is - 14,756 (Table 4).

According to this result, considering p<0.01, a statistically meaningful difference was found between the experimental group's pre and post test, achievement scores. Hence, this shows that using concept maps throughout the courses increases learners' achievement levels.

Table 4: BAT-Pre and Post-test Comparisons of the Experimental Group

Groups	N	$\bar{x}$	SS	SD	t	p
Control group	21	18.5500	3.95335	21	-14,756	,000**
Experimental group	21	37.9500	3.70597			

**p<.01

Considering the 'urinary system' unit in the 11th grade biology curriculum, statistical analysis of the pre and post test achievement scores of the traditional biology teaching (TBT) group, the control group, revealed that the pre test arithmetic mean value was 19,6842 and of the post test 34,0435.

T value calculated for the pre and post test scores of the control group is - 9,8921. This is an indication that TBT also increases the success levels of the students since the topic was taught during the traditional teaching of biology. However, this success level of is less than the success level of the concept maps based biology teaching group (CMT). These shows there are still missing parts of urinary system unit in the TBT group (Table 5).

According to this result, considering p<.01, there is a significant difference between the control group's pre- test and post- test scores. However, the average mean is less than the difference of the (CMT).

Table 5: BAT- Pre and Post-test Comparisons of the Control Group

Groups	N	$\bar{x}$	SS	SD	t	p
Control group	24	19.6842	3.49687	24	-9,891	,000**
Experimental group	24	34.0435	4.59722			

**p<.01

Considering the 'urinary system' unit in the 11th grade biology curriculum, statistical analysis of the pre and post test achievement scores of the CMT group, the experimental group, revealed that the pre test arithmetic mean value was 18,6500 and after the implementation of the CMT program 23,4500.

A statistically significant difference, considering p <0.01, was found between CMT group's pre and post-test achievement scores. This results show a positive development in the attitude of the CMT students towards concept maps (Table 6).

Table 6: Comparison of the Experimental Groups Pre and Post Test Data

Groups	N	$\bar{x}$	SS	SD	t	p
Total pre-test	21	18,6500	2,79614	21	-5,173	,000**
Total post-test	21	23,4500	2,25890			

**p<.01

RESULTS AND DISCUSSION

One of the most important goals of biology education is enabling the learners to acquire concepts of biology in a meaningful way and using them.

The results of the present study have shown that the use of concept maps while teaching the urinary system has positive influence on the students' achievements. It is common fact that the changes in the behavior of the individuals resulting form personal practices are far more effective than changes resulting from observation and hearing (Yalın, 2003). Hence, concept maps which have been drawn during the lesson by the students gain further importance.

A 45 item biology achievement test (BAT) has been applied to both study groups (CMT and TBT) as a pre-test. In relation to BAT, pre-test statistical analysis of the CMT group revealed an outcome in 18, 55 average scores and of the TBT an average of 19,68, and p = .348 between groups without a statistically significant difference (Table 1). In terms of the objectivity of the study, it is important that both research groups have equal achievement levels. It can be seen that after implementation, the CMT group has an average score of 37, 95 and the TBT group of 34,03. In terms of post-test scores, CMT group has more average scores than the TBT group; however this difference is not statistically significant ($p<.05$). At the same time, the post-test scores of both groups are higher than their pre-test scores and of statistical significance $p <0.01$.

These results are in line with the findings of he below mentioned studies: Okebukola and Jegede (1988), Pankratius (1990), Franklin (1991), Willerman and Mac Harg (1991), Esiolu and Soyibo (1995), Jegede et al. (1990).

The study also investigated the effect of using concept maps in biology class on the attitudes of students. Therefore, as stated in earlier sections, CMAS was applied to only to the CMT group, the experimental group, during the pre and post-tests. There is a statistically significant difference in the pre-and post-tests scores of the attitude scale. At the end of the implementation, a positive attitude towards the concept maps has been detected in the participants. It can be stated that the implementation had a positive impact on the students' attitudes towards the use of concept maps in biology education. Furthermore, the change in the students' attitudes after the implementation of the study might be attributed to their active concept maps drawings.

In the study of Şan (2008) conducted with second grade high school students, on the effects of using concept maps while teaching the "transportation system in plants," in his biology classes with an experimental group of 70 students (CMT), the pre-test average scores of the experimental group was 12,88; whereas of the control group (TBT) it was 14,34. Although there wasn't significant difference in the preliminary tests, in the final test the experimental group's average raised to 27,05 while the control group's average remained at 22,14.

No statistically significant difference was found between the pre-tests average scores of the CMT group, 8,97, and of the TBT group, 7,64, in the study of Kılıç (2005) investigating the effects of conceptual learning of the basic components of living things unit on students success. However, the post-test analyses showed that CMT group's average rose to 20,38 and TBT group's average to 15,20. CMT group's higher post-test scores show that concept maps are more effective that TBT.

In the study of Thompson and Mintzes (2002), the effects of concept maps to students success was studied with 238 participants from the 5^{th}, 8^{th}, 11^{th} grades, freshman and undergraduates. They concluded that concept maps had a positive impact on students' achievements.

Güçlüer (2006), in order to determine the contribution of concept maps as a support to cognition to students' success, retention, and attitude toward science classes in primary school science education formed an experimental and control group consisting each of 48 pupils. Whereas the average pre-test score of the control group is 2,72, of the experimental group it is 2,22. The

average post- test scores of the control group is 11,91 and of the experimental group 22,14. The information obtained from the analysis of the information put forward that teaching with concept maps is more effective than plain narrative teaching method.

In line with the findings of the present study and discussions considering the following proposals for science but particularly biology education is important:

1. Teachers should be given information about new teaching methods and shown examples of how to apply these methods in their classes.
2. Teachers should make use of different techniques and methods in order to facilitate learning and teaching in biology courses and make them love the topics.
3. A more student centered teaching should be adapted in teaching biology and teacher dominated classes are to be avoided as much as possible.
4. Teachers should be able to use concept maps not only teach them but also to follow and assess the students' cognitive development.

REFERENCES

Arnaudin, M. W., & Mintzes, J. J. (1985). Student's alternative conceptions of the human circulatory system; A cross age study. *Science Education*, 69(5),721-733.

Arnaudin, M. W., Mintzes, J. J., Dunn, C. S., & Shafer, T. H. (1984). Concept mapping in college science teaching. *Journal of College Science Teaching*., 14, 117-121.

Demirel, Ö. (2004). *Öğretimde planlama ve değerlendirme öğretme sanatı*. Ankara: Pegem A Yayıncılık.

Ertürk, S. (1993). *Eğitimde program geliştirme.* Ankara: Meteksan Matbaacılık.

Esiolu, G. O., & Soyibo, K. (1995). Effects of concept and vee mapping under three learning modes on students' cognitive achievement in ecology and genetics. *Journal of Research in Science Teaching*, 32(9), 971-995.

Franklin, C. E. (1991). An experiment testing the effects of concept mapping on science anxiety and acquisition of scientific knowledge among eighth-grade students low in integrative complexity. Dissertation Abstracts International. 52, 1689A.

Güçlüer, E. (2006). *İlköğretim fen bilgisi eğitiminde kavram haritaları ile verilen bilişsel desteğin başarıya hatırda tutmaya ve fen bilgisi dersine ilişkin tutuma etkisi.* Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi Eğitim Bilimleri Enstitüsü, İzmir.

Jegede, O., Alaiyemola, F., & Okebukola, P. A. (1990). The effect of concept mapping on students' anxiety and achievement in biology. *Journal of Research in Science Teaching*, 27(10), 951-960.

Kaptan, F. (1998). Fen öğretiminde kavram haritası yönteminin kullanılması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 14, 95-99.

Kılıç, S. (2005). *Lise I öğrencilerinin canlıların temel bileşenleri ünitesini kavramsal öğrenmelerinin başarıya etkisi.* Yayımlanmamış Doktora Tezi, Selçuk Üniversitesi Fen Bilimleri Enstitüsü, Konya.

Nakipoğlu, C. (1999). Kimya öğretmeni eğitiminde bütünleştirici (constructivist) öğrenme modelinin öğrenci başarısına etkisi. *DEÜ Buca Eğitim Fakültesi Dergisi,* Özel Sayı, 11, 271-280.

Novak, J. D., & Gowin, B. D. (1984). *Learning how to learn.* New York: Cambridge University Press.

Okebukola, P. A., & Jegede, O. (1988). Cognitive preference and learning mode as determinants of meaningful learning through concept mapping. *Science Education*, 72(4), 489-500.

Prankratius, W. J. (1990). Building an organized knowledge base: Concept mapping and achievement in secondary school physics. *Journal of Research in Science Teaching*, 27(4), 315-333.

Şan, İ. (2008). *Lise2. sınıf biyoloji derslerinde okutulan bitkilerde taşıma sistemi konusunun kavram haritaları ile öğretilmesinin başarıya etkisi.* Yayımlanmamış Yüksek Lisans Tezi, Selçuk Üniversitesi Fen Bilimleri Enstitüsü, Konya.

Thompson, T. L., & Mintzes, J. J. (2002). Cognitive structure and the affective domain: On knowing and feeling in biology. *International Journal of Science Education*, 24(6), 645-60.
Uzuntiryaki, E., & Geban, O. (1999), *İlköğretim 8. sınıf çözelti konusunun öğretiminde kavramsal değişim metinleri ve kavram harirtalarının kullanımı.* III. Ulusal Fen Bilimleri Eğitimi Sempozyumu Bildiri kitabı, s:142-152.

Wandersee, J. H., Mintzes, J. J., & Novak, J. D. (1994). Research on alternative conceptions in science (Ed.D.L.Gabel). *Handbook of Research on Science Teaching and Learning*, New York: McMillan, 177-210.

Willerman, M., & MacHarg, R. A. (1991). The concept map as an advance organizer. Journal *of Research in Science Teaching*, 28(8), 705-711.

Yalın, H. İ. (2003). *Öğretim teknolojileri ve materyal geliştirme.* Ankara: Nobel Yayınları.