ORIGAMI TECHNIQUE IN THE TEACHING OF NUCLEIC ACIDS

NÜKLEİK ASİTLERİN ÖĞRETİLMESİNDE ORİGAMİ TEKNİĞİ

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ABSTRACT: In this study, the effect of the origami technique in the teaching of nucleic acids with which students have trouble understanding, has been investigated. While the topic was explained to the control group of 40 students with a traditional teacher-centered teaching method according to a previously prepared lesson plan created in terms of the curriculum, it was explained to the 40 students in the experimental group in an identical manner and then followed by creating models of the nucleic acids using the origami technique. In this study, in order to determine the knowledge levels of the teacher, candidates success test was applied to both groups as a pre-test and post-test. The data were analysed using SPSS 15.00 packet program. In the analysis of the data, Mann Whitney U and the Wilcoxon significance rank order tests were carried out. Another aim of this study was to determine the topic misconceptions held by the students by asking for 4 drawings and 5 classical explanation questions to the two groups both before and after the explanation of the topic. According to results, due to the use of the models with origami, the students in the experimental group had a higher increase in their levels of success, answered the classical explanation questions better and produce better drawings and also decreased their topic misconceptions to a level lower than that of the control group.
Key words: Nucleic acid (DNA, RNA), origami, model creation, teaching.

ÖZET: Bu çalışmada öğrencilerin anlamakta zorlandıkları nükleik asitlerin öğretilmesinde origami tekniğinin etkisi araştırılmıştır. Konu kontrol grubunu oluşturan 40 öğretmen adayına öğretmen merkezli geleneksel öğretim yöntemi ile anlatılırken, deney grubunu oluşturan 40 öğretmen adayına ise yine aynı şekilde anlatıldıktan sonra origami tekniği kullanılarak nükleik asitlerle ilgili modeller yaptırılmıştır. Çalışmada öğretmen adaylarının bilgi düzeylerini belirlemek için geliştirilen bilgi başarı testi kullanılmıştır. Başarı testi bütün gruplara ön-test ve son-test olarak uygulanmıştır. Elde edilen veriler SPSS 15,00 paket programı ile analiz edilmiştir. Analizlerde Mann Whitney U ve Wilcoxon Anlamlı Sıralar Testleri yapılmıştır. Ayrıca konuyla ilgili olarak 4 adet çizim 5 adet klasik açıklama sorusu her iki gruba hem konu işlenmeden önce hem de konu işlendikten sonra sorularak kavram yanılgıları belirlenmeye çalışılmıştır. Sonuçlara göre origami ile yapılan modeller sayesinde deney grubu öğretmen adaylarının kontrol grubu öğretmen adaylarına göre başarı düzeylerinin daha çok arttığı,çizim ve klasik açıklama sorularını daha iyi cevapladıkları ve kavram yanılgılarının belirgin düzeyde azaldığı tespit edilmiştir.
Anahtar kelimeler: Nükleik asit, (DNA, RNA), origami, model oluşturma, öğretim.

1.INTRODUCTION

One of the most important processes which creates a teaching-learning environment is the use of suitable topic-related techniques and teaching methods by the teacher. Although it is known that for meaningful learning that the use of relevant material along with various teaching methods and techniques is needed, teachers generally prefer to use a standard explanation method which is teacher-centered, course book dependant and far away from practical exercises. However, it is possible to create different teaching-learning processes using different methods and techniques along with suitable materials in order to realise significant learning and to allow many abstract and unobservable concepts, events and organisms which ocur in biology to be better understood.

In the latest studies carried out in the field of cognitive, it has been determined that students who undergo explorative education and direct learning through a research oriented mind, could learn beter then classical lesson (Harris et al., 2001). In order to realise the aims of the teaching-learning process, exercises carried out within a class carry great importance. In studies carried out in this area, it has been stated that in order for learning to occur at the required level, it is necessary to make use of comtemporary approaches, methods and techniques (Birbir, 1999; Harris et al., 2001). On investigating the contents of biology teaching curriculums, it can be seen that this lesson has a

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structure suitable for the use of various methods and techniques. However, it has been determined that in our country the majority of biology lessons are carried out with traditional teaching methods (Ekici, 1996; Ekici, 2001).

The use of materials which benefits the teaching-learning process makes learning and understanding easier, increases interest and brings a liveleness to the class. In education, it takes up less time, increases knowledge levels and the retention of this knowledge. It also allows student participation and improves the desire for reading and research. It allows events and orgasnisms which are impossible to bring into the classroom or the students taken to, to be brought into the classroom (Aslan and Doğdu, 1993). One of the materials which can create a difference in the teaching-learning environment is the development of a topic-relevant teaching model. Modelling in scientific literature is a whole of precedures by using present (available) information for explaining of an unknown situation and making it understandable taht is know as modelling and the outcome product is called a model (Harrison, 2001; Treagust, 2002). According to Justi and Gilbert (2002), one of the most important functions of models is to simplfy complex events. Models are of great importance in scientific research in order to create hypotheses or to define a scientific event (Gilbert 1995). Models and modelling hold an important place in the definition of scientific literature (Gilbert and Boulter, 1998). As scientific modelling plays an important role in education, it has been the subject of a great number of science education studies (Bent, 1984; Cherif, Adams and Cannon, 1997; Erduran, 2001; Harrison and Treagust, 1996 and 1998).

The use of correct materials in lessons allows the students to remember 50% more of what is taught and lesson participation allows 70% more of what is learnt to be remembered (Silberman, 1996). It is necessary for lessons in biology to direct students to think, research and be active in lessons and to be carried out with practicals. Especially imaginary site of biology makes important creating a model and using it that could be taken as a individual studying method.

In the teaching of biology, sometimes abstract concepts can be difficult for students to grasp and understand. It is a very difficult for students to understand correct perceptional process of abstractive concepts. In this course (process) students especially need more than abstractive concepts, description and depiction for unseen (unobservable) events. For this reason, like many topics, it is necessary to use various teaching methods and techniques with supporting and constructive teaching materials in the process of teaching to allow the teaching of abstract and unobservable concepts, events and organisms in biology in a correct and meaningful manner. Origami technique could be taken within modelling that is seen as an assistant teaching used effectively in Biology and can be considersed as one of individual studying methods.

The word origami, which is a part of Japanese culture, is a compound of two words; oru (fold) and gami (paper). Origami, known as the art of paper-folding, actually has its roots in Chinese culture and after passing from China to Japan began to be developed and later spread throughout all the world (Engel,1989; Fuse, 1992).

As a result of studies carried out, it has been determined that in biology programs students have difficulties with basic concepts such as nucleic acids (DNA and RNA or biochemical molecules), genes, chromosomes, chromatids, homologous chromosomes and the relationships between them and also the processes of mitotic and mieotic division (Brown, 1990; Smith, 1991; Kindfield,1994; Sanders and Moletsane, 1997; Bahar, Johnstone and Hansell,1999; Lewis, Leach and Wood-Robinson, 2000; Tekkaya, Özkan and Sungur, 2001; Atılboz, 2004; Güneş and Güneş, 2005). Also it has been stated that biology teachers experience difficulty when teaching these topics (Cho, Kahle and Nordland, 1985; Kindfield, 1994; Yip, 1998; Öztap, Özay and Öztap, 2003).

It can not be expected that students who have misconceptions about basic topics such as nucleic acids, genes, chromatids and chromosomes will be able to understand the processes of mitosis and mieosis. Students in this situation, instead of learning how and why the events in cell division occur, will instead only be able to learn by heart the names and events of the stages and this creates a barrier to significant learning. For this reason, when teaching basic concepts such as nucleic acids, genes, chromatids and chromosomes, the formation of misconceptions should be prevented and any previously formed misconceptions should be removed and only when it is obvious that the students have fully understood should the details of cell division be given.

There is a rapid increase in the number of studies about reducing misconceptions to a minimum on this topic. To meet this aim, it is thought that new teaching methods such as diagrams and modelling, video and film shows will be effective (Öztap, Özay and Öztap, 2003). There is an insufficient number of studies in our country with regard to the teaching of nucleic acids which are basic concepts in Biology and no studies on the use of the origami technique in the process of teaching this topic. With origami, which can be used within teaching by creating a model as a supportive and useful teaching material within an individual teaching method, we can take an abstract concept, an unobservable event or organism and make it concrete. On evaluating studies carried out until the present time, this study was carried out with the aim of determining how useful the origami technique is in the increase of student learning success and the decrease of misconceptions in the teaching of abstract and difficult to understand concept of nucleic acids. It is thought that the obtained results will be useful in the teaching of biology.

2.METHOD

The research group of this study was composed from the students of Science Teaching, Faculty of Education, 19 Mayis University and the sample group was composed of a total of 80 students from year 2 Science Teaching. This study was carried out with two groups; one control and one experimental group. While the 40 teacher candidates in the control group had the topic explained to them with a teacher-centered raditional teaching method given according to a pre-prepared lesson plan, the 40 teacher candidates in the experimental group had the topic explained to them in the same manner and then they created models of nucleic acids using the origami technnique.

Before moving on to the practical element, information about origami, supported by a handout, was given to the teacher candidates. Following this, the teacher demonstrated how molecules could be created with origami with examples and the students were then allowed to create models with the origami technique using ripping, cutting, sticking and free working. Before the practical, the students were shown how origami is practiced with free-shapes using various coloured handicraft paper, scissors and glue. They were then allowed to develop their own models of DNA and RNA with origami. The students were then asked to show the events of replication with their DNA models. Also, the students were made to create models of a nucleotide forming organic base, sugar and phosphate molecules and a nucleotide which are the building blocks of DNA and RNA. The created models were evaluted by creating an environment for face-to-face debate within the classroom and so the deficiences of the models were discussed and mistakes corrected. Some groups were made to re-form their models.

In order to determine the knowledge levels of the teaching candidates of the students in the study, a developed information success test was used. A pilot study of the information success test, which consisted of true-false and gap-filling type questions, was carried out on 72 students. On removing questions with low question reliability, the final success test consisted of 12 true/false and 13 gap-filling questions and was found to have a KR-20 reliability co-efficient of 0,75. After the success test was applied as a pre-test to both groups, the topic was explained in the traditional way to them and then the experimental group made models with the origami technique in a laboratory. A while later, the same success test was applied to both groups as a post-test. The obtained data were analysed using the SPSS 15.00 packet program. The Mann Whitney U and Wilcoxon Significance Rank tests were carried out with the aim of determining whether there was a significant difference in terms of academic success between the control and experimental groups. The results are given in tables in the results section.

This study also aimed to determined the misconceptions of the students on this topic by asking for 4 drawings and 5 classic explanation questions to both groups both before and after the topic was given. The answers to the drawings and the classical explanation questions were analysed by the teacher using the analysis method used by Westbrook and Marek (1991).

In order to obtain the opinions of the teacher candidates on the exercise, two questions were directed at the students, ‘ Would you like this exercise to continue?’ and ‘Would you like this type of exercise to be carried out in other lessons?’ and after written answers to these questions were recieved from the students and qualitatively evaluated. Also, ‘What would you like to comment on as regards this exercise?’ was applied as an open-ended question and some of the answers given to the questions were taken wtihout any change.

3.FINDINGS AND COMMENTS

Table 1. Results Of Mann Whitney U Test of Pre-Test Points Of Experimental And Control Groups.

Pre-Test	No. of Sutudent N	Aritmetic Average X	Rank Total	U value	Z value	p value
Experimental	40	40,94	1637,50	782,500	-,169	,865
Control	40	40,06	1602,50			

According to the results shown in the table, the results of the Mann Whitney U test showed no significant statistical difference between the pre-test points of the experimental group and the control group [Z= -,169, p>0,05]. The fact that the pre-test averages of both groups were similar to each other and that there was no statistically significant difference between the groups showed that the students of both groups had very similar knowledge levels before the start of this study.

Table 2. Results Of Wilcoxon Significance Rank Test Of Pre-Test- Post-Test Points Of Experimental And Control Groups.

Control		No.of Students (N)	Aritmetic Average (X)	Rank Total	Z value	p value
Pre-test	Negative value	1	4,50	4,50	5,112	,000
Post-test	Positive value	34	18,40	625,50		
	Equality	5				
Experimental						
Pre-test	Negative value	1	5,50	5,50	5,443	,000
Post-test	Positive value	39	20,88	814,50		
	Equality	0				

As can be seen from Table 2, the differences between the pre-test points and post-test points for both the control group [Z=5,112, p<0,05] and for the experimental group [Z=5,443, p<0,05] were found to be statistically significant according to the Wilcoxon Significance Ranking test. This difference is in favour of the post-test points. It is to be expected that an increase in success levels would occur after the explanation of the chosen topic to both groups and would create higher rates of academic success. On examining the pre and post-test averages of the experimental and control groups, it can be seen that, after the explanation of the topic, although both groups increased their academic success averages, the experimental group showed a greater increase according to the control group.

Table 3. Results Of Mann Whitney U Test of Post-Test Points Of Experimental And Control Groups.

Post Tests	No. of Sutudent N	Aritmetic Average X	Rank Total	U value	Z value	p value
Experimental	40	25,10	1004,00	184,000	-5,963	,000
Control	40	55,90	2236,00			

As can be seen from Table 3, according to the Mann Whitney U test of the post-test points of the teaching candidates of both groups, a significant difference [Z=-5,963, p<0,05] was found in favour of the experiemental group. On examining this difference in terms of increased academic success by the teaching candidates, this difference showed a significant increase in academic success in students in the experimental group, who had carried out modelling with the origami technique, in contrast to the students in the control group. This increase could be due to the fact that the use of the origami technique in modelling made the learning process into a more active process.

Table 4. The Distribution Of Percentages To The Pre-Test Drawing Questions Of Experimental And Control Groups

Control Pre-test (n=40)					Experimental Pre-test (n=42)				
Answers	**Questions (%)**				**Answers**	**Questions (%)**			
	1	**2**	**3**	**4**		**1**	**2**	**3**	**4**
a	00.0	00.0	00.0	00.0	**a**	00.0	00.0	00.0	00.0
b	00.0	00.0	00.0	00.0	**b**	00.0	00.0	00.0	00.0
c	27.5	15.0	15.0	00.0	**c**	25.0	12.5	10.0	00.0
d	12.5	7.5	17.5	5.0	**d**	7.5	10.0	12.5	2.5
e	5.0	10.0	15.0	2.5	**e**	2.5	7.5	15.0	2.5
f	70.0	67.5	52.5	92.5	**f**	65.0	70.0	62.5	95.0

a = Completely Known, b = Known Well, c = Partially known,
d = Partially known + Topic Misconception, e = Topic Misconception, f = Not Known

The distribution of the percentages of the answers given by the teacher candidates to the drawing questions asked in the pre-test before the explanation of the topic can be seen in Table 4. According to these results, it can be stated that most of the students did not know the topic and a section of them had misconceptions. Also, when a drawing of a nucleotide, DNA and RNA model with the processes of replication were requested, most of the students couldn't produce a drawing and in the drawings which were done, there was either missing information or some topic misconceptions were detected.

Table 5. The Distribution Of Percentages To The Post-Test Drawing Questions Of Experimental And Control Groups

Control Post-test (n=40)					Experimental Post- test (n=42)				
Answers	**Questions (%)**				**Answers**	**Questions (%)**			
	1	**2**	**3**	**4**		**1**	**2**	**3**	**4**
a	2.5	00.0	00.0	00.0	**a**	37.5	35.0	40.0	15.0
b	10.0	00.0	00.0	00.0	**b**	35.0	30.0	25.0	27.5
c	35.0	37.5	35.0	15.0	**c**	20.0	27.5	27.5	40.0
d	12.5	22.5	25.0	27.5	**d**	2.5	2.5	2.5	10.0
e	7.5	10.0	10.0	20.0	**e**	00.0	00.0	00.0	7.5
f	32.5	30.0	30.0	37.5	**f**	5.0	5.0	5.0	10.0

Table 5 shows the results of the distribution of percentages of the students' answers to the drawing questions given in the post-test in both the control and the experimental groups after the explanation of the topic. On comparison of the pre- and post-test results of the control group, it can be stated that a certain ratio of the teacher candidates had learnt the topic, however, in terms of topic misconceptions, it was observed that old misconceptions had not been removed and even that new misconceptions had been created. The comparison of the post-test results of the control and experimental groups within themselves showed that the results greatly favoured the experimental group. On comparison of the pre-test results and post-test results of the experimental group with each other, it was noticed that the teacher candidates had both learned the topic and had also decreased their level of misconception. Also, it was determined that, on examination of the drawing results of the post-test, that the experimental group had produced good drawings. According to these results, while there was a noticeable decrease in the number of topic misconceptions, the knowledge levels of the teacher candidates significantiy increased due to the models carried out with the origami technique.

Table 6. The Distribution Of Percentages To The Pre-Test Explanation Questions Of Experimental And Control Groups

Control	Pre-test (n=40)					Experimental	Pre- test (n=42)				
Answers	Questions (%)					Answers	Questions (%)				
	1	2	3	4	5		1	2	3	4	5
a	00.0	00.0	00.0	00.0	00.0	a	00.0	00.0	00.0	00.0	00.0
b	00.0	00.0	00.0	00.0	00.0	b	00.0	00.0	00.0	00.0	00.0
c	10.0	7.5	5.0	15.0	2.5	c	5.0	7.5	5.0	10.0	2.5
d	15.0	12.5	17.5	10.0	10.0	d	10.0	15.0	12.5	15.0	10.0
e	25.0	27.5	22.5	20.0	15.0	e	22.5	27.5	25.0	22.5	20.0
f	50.0	52.5	55.0	55.0	72.5	f	62.5	50.0	57.5	52.5	67.5

The percentage distribution of the answers given to the classic explanation questions asked in the pre-test before the explanation of the topic can be seen in Table 6. According to these results, it can be stated that the majority had low knowledge levels of the topic and a portion had topic misconceptions, as also seen in the answers given to the drawing questions. From the answers given by the teacher candidates, it was determined that they had both knowledge gaps and topic misconceptions about concepts such as chromatin chromosomes, chromotides, DNA and genes.

Table 7. The Distribution Of Percentages To The Post-Test Explanation Questions Of Experimental And Control Groups

Control	Post-test (n=40)					Experimental	Post- test (n=42)				
Answers	Questions (%)					Answers	Questions (%)				
	1	2	3	4	5		1	2	3	4	5
a	00.0	00.0	00.0	00.0	00.0	a	15.0	15.0	17.5	20.0	15.0
b	2.5	5.0	2.5	7.5	00.0	b	25.0	30.0	22.5	30.0	20.0
c	17.5	12.5	15.0	25.0	7.5	c	30.0	32.5	32.5	37.5	27.5
d	22.5	15.0	17.5	12.5	20.0	d	7.5	2.5	5.0	2.5	7.5
e	22.5	27.5	25.0	17.5	27.5	e	5.0	5.0	7.5	2.5	7.5
f	35.0	40.0	40.0	25.0	45.0	f	17.5	15.0	15.0	7.5	22.5

The percentage distribution of the answers given by the students to the classic explanation questions asked in the post-test of both the experimental and control groups after the explanation of the topic are given in Table 7. Similar to the data obtained from the drawing questions, on comparison of the results of the pre- and post-test of the control group, it can be stated that the students had mainly learnt the topic. However, in terms of misconceptions, it was noticed that they continued to keep their previously formed misconceptions and had even created new ones. On the comparison of the post-test results of the control and experimental groups within themselves it was noticed that the results were noticebly in favour of the experimental group. On comparison of the pre-test results and post-test results of the experimental group with each other, it was noticed that the teacher candidates had both better learned the topic and had also decreased their level of misconception. According to these results, while the knowledge levels of the teacher candidates significantiy increased, there was a noticeable decrease in the number of topic misconceptions due to the models carried out with the origami technique.

Table 8. Answers Given To Open-Ended Questions By Teacher Candidates

	Yes	No	Undecided	Total
Question 1) *'Would you like this exercise to continue?'*	72	2	6	80
Question 2) *'Would you like this type of exercise to be carried out in other lessons?'*	67	2	11	80

It can be seen from the above results that the majority of the students wanted the exercise to continue and also to be used in other lessons.

Table 9. Answers Given To Open-Ended Questions By Teacher Candidates

Question 3) *'What would you like to comment on as regards this exercise?'*	*'' ....I managed to make something by myself. I learnt the topic while doing this model because if I didn't know this topic, I couldn't have made the model....''* *''......I like making things. I have made something and while doing this I have learnt the topic.....''* *''....I was having troble understanding this topic but while I was doing the origami model, I had fun and I could visualise the topic inside my head,......''* *''.....This type of exercise can sometimes be boring but I am certain that they help us to understand the topic and to see our mistakes.....''* *''....Due to our education system we are used to solving test questions and taking pre-prepared knowledge and learning it by heart.However significant learning is not like this, If we participate in the process, if we make some effort, then we think more deeply and visualise it more....''* *''....We already have models of abstract topics and we are shown them. I wondered why we should do these types of models. And it seemed like a waste of time, however, I have understood that while doing this kind of model, it needs the use of knowledge and if we don't have that, it needs reading, thought and practice and I was more successful ....''* *''...... I entered into communication with my friends most when I was doing this exercise. While we were discussing this, I realsied that I understood some things better and that some things I knew were wrong .....''* *''........I saw what I knew wrong while doing the origami model and could correct my mistakes ....''* *''.....It was really different to model with origami. This type of exercises are both fun and educational according to the topic. The same exercises should be carried out for all topics. It's good to have different exercises that are interesting and fun. ....''* *''......There are many abstract concepts in biology. Different exercises like origami should be used in the teaching of these abstract concepts ....''*

Table 9 gives some chosen quotes given by the students to the third question. It can be seen that the majority were of a positive opinion and this supports the results given to the second question, shown in Table 8. It is noticeable that most of the students wanted this exercise to continue and to be carried out in other lessons.

4.RESULTS AND DISCUSSION

In order to help students create an image of miscroscopic events in their minds teaching with the support of concrete teaching helps to prevent the creation of topic misconceptions by allowing abstract concepts to be shaped into concrete forms (Atılboz, 2004). Studies carried out in recent years in the field of biology have shown that students have problems with understanding and have some misconceptions on various topics in biology (Amir and Tamir, 1994; Odom, 1995; Mann and Treagust, 1998; Alparslan, Tekkaya and Geban, 2003). It is difficult to change topic misconceptions as they are resistant to change especially with traditional methods (Bahar, 2003; Sinan, 2007). Other works have obtained similar results to this study. It is noticeable in the answers given to the classical explanation questions and the drawings questions in the post-test exercises after the explanation of the topic with traditional methods that there is no decrease in pre-formed topic misconceptions and even that new misconceptions were formed (Tables 4, 5, 6, and 7).

Linear relationship between sense organs and learning is very important to form teaching supplies and their effective use, during education an learning process. Learning by students occurs through 83% sight, 11% hearing, 3.5% smell, 1.5% touch and 1% through taste. Also people remember 10% of what they have read, 20% of what is heard, 30% of what is seen, 50% of what is both seen and heard, 70% of what they say and 90% of what they say and do (Ergin, 1995; Kılıç, 1997). As modelling uses both the hands and eyes, it allows more than one part of the brain to be stimulated and increases learning (Haury, 1989; Lavoie, 1993). In this study, which supports this data, it was determined from the answers given to the explanation questions and the drawings obtained from the students from the post-test result of the experimental group, the topic had been in the main learnt and there was a significant decrease in topic misconceptions. On investigating the results of the post-test drawings of the experimental group, it was seen that the teacher candidates drew very good drawings. Also according to the Mann Whitney U test scores of the post-test results of the experimental and control groups, a significant difference was found in favour of the experimental group [$Z=-5,963$, $p<0,05$]. The use of the origami technique by the students to create their own models allowed the students to learn by sight and experiencing and so using more than one sense organ.

Atılboz (2004) deterrmined that the majority of students did not sufficently understand basic concepts such as DNA, chromosomes, chromatids, relationship of chromosomes-DNA, homologous chromosomes and haploid-diploid cells and the relationships between them and also the basic events in the processes of mitotic and mieotic division related to this structure and chromosomal behaviour. Brown (1995) stated that students were learning the stage names of cell division by heart and couldn't visualise the events in 3-D and also couldn't understand the dynamic structure of the division process. For this reason, the use of supportive material such as photographs, film, video and chromosome models is recommended in the teaching of the situation, shapes and movements of chromosomes in these stages. In a similar manner, Atılboz (2001) reported that students who are educated on the topic of cell division with activities such as slide shows, modelling and examination of slides along with traditional methods were more successful than students who were only educated with traditional methods. The results of Brown (1995) and Atılboz (2001-2004) showed similar results to the present study. This is due to the fact that the making of models by the teacher candidates with the origami technique, in a way similar to exercises such as slide shows, modelling and the examination of slides, increased the success of the students more than traditional techniques (Tables 2 and 3). By leaving the traditional system with the increase of similar studies, it is possible to find suitable methods and techniques or exercises for every topic in biology.

Pashley (1994) showed that topic misconceptions of genes and alleles could be removed with a chromosome model developed in a 1994 study and that if teachers were aware of topic misconceptions before the teaching of the topic this could increase the success of the students. As stressed by Pashley, the knowledge success test applied as the pre-test in this study with the Readiness of the students and by having an idea of thier topic misconceptions was directed to origami with modelling process. One of the biggest gaps observed in the Turkish education system is the application of various exercises before any information on the students pre-knowledge of the unit and their topic misconceptions is collected and this could be a limiting factor in the success of even the best exercises.

In a study carried out by Lewis, Leach and Wood-Robinson (2000) they obtained comments on the concepts of chromosomes, DNA and genes which are the basic concepts of cell divison such as,'Chromosomes make DNA', 'Chromosomes are in DNA', 'Chromosomes are in your genes' and 'Chromosomes make genes' and therefore it was determined that students had learned alternative concepts. In this study, in a similar manner, topic misconceptions such as 'Chromosomes are in DNA', 'DNA = genes', Chromosomes and Chromatins are different structures', Chromatin forms during cell division', 'Every chain of DNA is called a chromatid', 'Chromosome = gene', 'Chromosomes are always found in a cell, Chromatin only occurs in cell division' were determined.

In conclusion:

●Models can be made of difficult to learn topics such as nucleic acids by students without them becoming bored due to the use of origami which is seen as a game by the students.

●The use of origami to turn abstract ideas into more concrete ideas can positively affect the development of a student's learning potential and help bring out their imagination potential.

●Activities repeated with origami are an example of schematic perception. Also there is an aesthetic side to this. The students make their own models by listening to the given directions and by concentrating on making them successful. In this way, learning can occur at the required level and an increase in the students' success can occur.

●For students, management molecules are management molecules and they generally don't think about their structure and where they are formed. However, while doing a nucleotide, DNA or RNA model with origami, they are required to think about what DNA and RNA structure consists of and even to think more, comment after thinking and carry out and witness this through living it. While they are doing thier own models, they transform abstract idea as a concrete idea. In this way, the formation of new topic misconceptions can be prevented and previously formed misconceptions can be corrected.

●While students are making their own models with the origami technique, they find the opportuunity to express themselves, they answer questions directed at them, they mentally evaluated the knowledge to be used into an order. At this time, if there are misunderstandings and knowledge gaps these can be noticed by both the teacher and the student and thus corrected.

●Students can become emotionally satisfied on creating their own 'work of art' and on being complimented by their friends and teacher and this could increase the interest of the student in the lesson and can bring them to want to learn more about the topic.

On taking all of this into consideration, it is important that teacher candidates can understand science and can look at it from a scientific point of view. On understanding the topic and by using the learnt information in their daily lives, this will help them to understand various scientific concepts. This will help show itself to be successful in the future generations of students that these teacher candidates will teach.

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Genişletilmiş Özet

Bu çalışmada biyolojinin soyut fakat temel konularından biri olan ve öğrencilerin anlamakta zorlandıkları nükleik asitlerin (DNA,RNA) öğretilmesinde origami tekniğinin etkisi araştırılmıştır.

Bir çok soyut ve gözlenemeyen kavram, olay ve varlıkların bulunduğu biyoloji konularının daha iyi anlaşılabilmesi ve anlamlı öğrenmenin gerçekleşebilmesi için farklı yöntem ve teknikler ile birlikte uygun materyaller kullanılarak farklı eğitim-öğretim süreçleri oluşturulabilmelidir. Bilişsel alanda yapılan son araştırmalarda, düz anlatım yöntemi ile (geleneksel) yapılan öğretim ve öğrenmeden, keşfedici öğretim ve öğrenmeye doğru gidildikçe öğrencilerin zihinlerinin araştırmaya aktif olarak yönlendirilmesi sonucu daha iyi öğrendikleri saptanmıştır (Harris et al., 2001). Eğitim-öğretim sürecinde yararlanılacak olan materyal kullanımı, algılama ve öğrenmeyi kolaylaştırır, ilgi uyandırır, sınıfa canlılık getirir. Öğrenmede, zamanı kısaltır, bilgiyi pekiştirir ve kalıcılığa yardım eder. Öğrencilerin konuya katılımlarını sağlar, okuma ve araştırma arzusu uyandırır. Yanına gidilmesi veya sınıfa getirilmesi mümkün olmayan olay, olgu ve varlıkları, sınıfa taşır (Aslan ve Doğdu, 1993). Eğitim-öğretim ortamını farklılaştırabilecek materyallerden biri de konuya uygun bir öğretim modeli oluşturmaktır. Fen bilimleri literatüründe modelleme; mevcut bilgilerden yola çıkarak bilinmeyen bir durumu açıklamak ve anlaşılır hale getirmek için yapılan işlemler bütünü olup modelleme sonucunda ortaya çıkan ürün ise model olarak nitelendirilmektedir (Harrison, 2001; Treagust, 2002).). Justi ve Gilbert'e (2002) göre, modellerin en önemli işlevlerinden birisi, karmaşık olguları basitleştirmeleridir.

Derste doğru materyallerin kullanımı öğrettiklerimizin %50 daha fazla hatırlanmasını, öğrencilerin derse katılımları ise öğrendiklerinin %70'ini hatırlamalarını sağlamaktadır (Silberman, 1996). Öğrencilerin, biyoloji derslerinde düşünmeye, araştırmaya, aktif olmaya ve bu dersi uygulamalı yapmaya yönlendirilmesi gereklidir. Biyolojinin özellikle soyut tabiatı, bireysel çalışma yöntemi kapsamında ele alabileceğimiz model oluşturma ve kullanımını önemli kılmaktadır.

Biyoloji öğretiminde, bazen soyut kavramların öğrenciler için ulaşılabilir ve anlaşılabilir yapılması oldukça güç olabilmektedir. Soyut kavramların açık ve anlaşılır bir şekilde doğru olarak algılanma süreci öğrenciler için oldukça zordur. Bu süreçte öğrencilerin özellikle soyut kavramlar, gözlenemeyen olay veya varlıklar için tanımlamalardan ve tasvirlerden fazlasına ihtiyaçları vardır. Bu sebeple, bir çok konuda olduğu gibi, biyoloji ile ilgili soyut ve gözlenemeyen kavram, olay ve canlıların öğrencilere doğru, anlamlı ve birbirleriyle ilişkilendirilerek öğretilebilmesi sürecinde çeşitli öğretim yöntemleri ve teknikleri ile destekleyici ve yardımcı öğretim materyallerinin kullanılması gerekmektedir. Biyolojide kullanılabilen etkili, somutlaştırıcı ve destekleyici bir öğretim yardımcısı olarak da görülen model oluşturup kullanma yani modelleme içerisinde origami tekniğini ele alabiliriz ve öğretim yöntemlerinden biri olan bireysel çalışma yöntemi içinde düşünebiliriz.

Özel durum yöntemi kullanılan çalışmanın örneklemini Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Fen Bilgisi Öğretmenliği 2. sınıf öğrencilerinden toplam 80 öğretmen adayı oluşturmuştur. Çalışma biri kontrol diğeri deney grubu olmak üzere iki grup ile yapılmıştır. Konu kontrol grubunu oluşturan 40 öğretmen adayına müfredat doğrultusunda önceden hazırlanan ders planına göre öğretmen merkezli geleneksel öğretim yöntemi ile anlatılırken, deney grubunu oluşturan 40 öğretmen adayına ise yine aynı şekilde anlatıldıktan sonra origami tekniği kullanılarak nükleik asitlerle ilgili modeller yaptırılmıştır. Uygulamaya geçmeden önce öğretmen adaylarına dağıtılan yönerge doğrultusunda origami hakkında bilgi verilmiştir. Daha sonra yönetici molekülleri origami ile nasıl yapacakları örnekler üzerinde gösterilerek anlatılmış ve yırtarak , keserek, yapıştırarak ve serbest şekillendirme tarzında origami tekniği ile modeller yaptırılmıştır. Çalışmada öğretmen adaylarının bilgi düzeylerini belirlemek için geliştirilen bilgi başarı testi kullanılmıştır. 12 doğru yanlış ve 13 boşluk doldurma tarzında toplam 25 sorudan oluşan başarı testinin KR-20 güvenirlik katsayısı 0.75 olarak bulunmuştur. Başarı testi bütün gruplara ön-test olarak uygulandıktan bir süre sonra aynı başarı testi son-test olarak uygulanmıştır. Elde edilen veriler SPSS 15,00 paket programı ile analiz edilmiştir. Analizlerde kontrol grubu ile deney grubu arasında akademik başarı açısından anlamlı bir

farklılık olup olmadığını belirlemek amacıyla Mann Whitney U ve Wilcoxon Anlamlı Sıralar Testleri yapılmıştır.

Ayrıca konuyla ilgili olarak 4 adet çizim 5 adet klasik açıklama sorusu her iki gruba hem konu işlenmeden önce hem de konu işlendikten sonra sorularak kavram yanılgıları belirlenmeye çalışılmıştır. Öğretmen adaylarının çizim ve klasik açıklama sorularına verdikleri cevapları incelenerek Westbrook ve Marek (1991) tarafından kullanılan veri analiz yöntemi ile değerlendirilmiştir.

Uygulamayla ilgili öğretmen adaylarının görüşlerini almak üzere *''Uygulamanın devam etmesini ister misiniz?'', ''Bu tip uygulamaların diğer derslerde de yapılmasını ister misiniz?''* şeklinde 2 soru yöneltilmiş ve cevapları yazılı olarak alındıktan sonra betimleme, analiz ve yorumlama şeklinde değerlendirilmiştir. Ayrıca *''Uygulamayla ilgili neler söylemek istersiniz?''* şeklinde başka bir açık uçlu soru daha yöneltilmiş ve bu soruya verilen cevaplardan bazıları aynen alınmıştır.

Çalışmada deney grubu ile kontrol grubu ön-test puanları arasında istatiksel olarak anlamlı bir fark bulunmamıştır [Z=-,169 p>0,05]. Sonuca göre grupların bilgi düzeyi bakımından bir birine yakın olduğu söylenebilir. Ayrıca çalışmada ön test uygulamasında bir nükleotitin, DNA ile RNA 'nın ve replikasyon olayının çizimle gösterilmesi istendiğinde büyük çoğunluğun çizim yapamadığı, yapılan çizimlerde de ya eksik bilgilerin ya da bazı kavram yanılgılarının olduğu tespit edilmiştir. Aynı şekilde öğretmen adaylarının klasik açıklama sorularına verdikleri cevaplardan da kromatin ipliği, kromozom, kromatit, DNA, gen gibi kavramlarla ilgili olarak hem eksik bilgiye hem de kavram yanılgılarına sahip olduğu görülmüştür. Kontrol grubunun son test uygulamalarından elde edilen çizimlere ve açıklama sorularına verilen cevaplara bakılarak konunun kısmen öğrenildiği ancak kavram yanılgılarında azalma olmadığı hatta yeni kavram yanılgılarının oluştuğu söylenebilir. Oysa deney grubunun son test uygulamalarından elde edilen çizimlere ve açıklama sorularına verilen cevaplara bakıldığında ise konunun büyük oranda öğrenildiği ve kavram yanılgılarında önemli ölçüde azalma olduğu dikkati çekmektedir. Ayrıca deney grubunun son test çizim sonuçlarına göre öğretmen adaylarının oldukça iyi çizimler yapabildiği görülmüştür. Bu sonuçları destekler nitelikte çalışmada deney ve kontrol grubunun son test puanları arasında Mann Whitney U Testine göre istatiksel olarak anlamlı bir fark bulunmuştur. Bu fark deney grubu lehinedir [Z=-5,963, p<0,05]. Bu sonuçlara göre origami ile yapılan modeller sayesinde deney grubu öğretmen adaylarının kontrol grubu öğretmen adaylarına göre başarı düzeylerinin daha çok arttığı,çizim ve klasik açıklama sorularını daha iyi cevapladıkları ve kavram yanılgılarının belirgin düzeyde azaldığı tespit edilmiştir. Ayrıca öğretmen adaylarının büyük bir kısmının uygulamadan memnun olduğu da görülmüştür.

Anahtar kelimeler: Nükleik asit (DNA, RNA), origami, model oluşturma, öğretim.