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Effect of Cooperative and Individual Learning Activities on Students' Understanding of Diffusion and Osmosis

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Abstract

Problem Statement: Students find diffusion and osmosis difficult to understand.

Purpose of Study: This research has two aims. The first aim is to determine the effects of learning activities in 9th grade students' understanding of diffusion and osmosis using the conceptual change approach in individual and cooperative learning environment, and compare these two conceptual change based aproaches with each other and traditional teaching. The second aim is to investigate the effect of these three approaches on students' attitudes towards biology.

Methods: This is a quasi-experimental study and designed as a Non-Equivalent Groups pre-test, post-test, control, and comparison group model. The subjects were ninety 9th graders from Anatolian high school in Erzurum. For this research, a control (C) and two experimental groups (E_1 and E_2) were selected. The control group was taught through traditional teaching based on whole-class lecturing. The E_1 group was taught using cooperative learning supported by conceptual change, while the E_2 group was taught through individual learning supported by conceptual change over four weeks. The data was collected through the Diffusion and Osmosis Concept Test (DOCT), Biology Attitude Scale (BAS), Science Process Skill Test (SPST) and

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Cooperative Learning Self Report Survey (CLSRS). The data were analyzed by t-test and ANOVA, and presented together with descriptive statistics.

Findings and Results: According to the results, there were significant improvements in academic achievement both in experimental and control groups. The E_1 group resulted in higher improvement in academic achievement compared to the E_2 and C groups. Students' attitudes towards biology were developed in a positive direction in the experimental groups, whereas in the control group, no significant change was noticed.

Conclusions and Recommendations: The results suggest that cooperative Predict-Observe-Explain (POE) tasks provided a more complete framework for understanding than POE tasks, which were administered in individual groups. The results regarding improving students' attitudes toward biology suggest that cooperative learning activities are much better than individual learning activities, and students' perceptions of personal and academic peer support and team cohesiveness in their particular groups correlated with academic achievement.

Keywords: Biology teaching, osmosis and diffusion, cooperative learning, POE tasks, misconceptions.

Students' pre-instructional ideas generally differ from accepted scientific views and are resistant to change (Liew & Treagust, 1998; Odom, 1995; Savinainen, Scott, & Viiri, 2005). According to the constructivist view of learning, when students are learning about science, they interpret any new information in the light of their existing ideas, understandings and beliefs, which may then become modified or revised (Leach & Scott, 2003; Rebich & Gautier, 2005). Learning then proceeds as the students' ideas become progressively reconstructed (Palmer, 2003). Theories of conceptual change, which were based on constructivism, attempt to describe possible learning pathways from students' pre-instructional conceptions to the scientific conceptions to be learned (Palmer, 2003; Savinainen et al., 2005).

The most well-known conceptual change theory was proposed by Posner, Strike, Hewson, and Gertzog (1982), which argued that conceptual change entails fundamental changes in the cognitive structure, based on Piaget's (1985) notion of accommodation. Posner et al.'s (1982) conceptual change model (CCM) consisted of two major components (Russel, 2002). The first was a set of four conditions for accommodation to occur: *First*, there must be dissatisfaction with existing conceptions. *Second*, a new conception must be intelligible. Intelligible means that the new conception must be clear enough to make sense to the learner. *Third*, a new conception must appear initially plausible. Plausible means the new conception must be seen as plausibly true. *Finally*, a new concept should suggest the possibility of a fruitful research program. Fruitful means the new conception must appear potentially productive to the learner for solving current problems. Posner et al.'s (1982) perspective assumes that these cognitive conditions should be met during the learning process for a successful conceptual change (Liu, 2004; Özdemir & Clark, 2007). The second component of CCM was conceptual ecology (Russel, 2002). According to Posner et al., a learner's conceptual ecology consists of their conceptions and ideas rooted in their epistemological beliefs. This conceptual ecology includes learners' epistemological commitments, anomalies, metaphors, analogies, metaphysical beliefs, knowledge of competing conceptions, and knowledge from outside the field, all of which impact the restructuring of conceptions and highly influence a learner's interactions with new ideas and problems. In other words, prior conceptions are highly resistant to change, because concepts are not independent from the cognitive artifacts within a learners' conceptual ecology. Some concepts are attached to others, and they generate thoughts and perceptions. Because of this web-based relationship between concepts, a revision to a concept requires revisions to others (Özdemir & Clark, 2007; Southerland, Johnston, & Sowell, 2006).

Abd-El-Khalick and Akerson (2004) use conceptual ecology as a means of "stretching" the CCM. They ultimately argue that conceptual ecology is "largely restricted to the cognitive domain." Their suggestion is to look beyond conceptual ecology and propose an additional construct, "learning ecology" that they describe as "expanded [in relation to conceptual ecology] to include cognitive, affective, motivational, contextual, social and cultural domains" (p. 786). Similarly, Pintrich, Marx, and Boyle, adopting a social and affective perspective, argued that CCM should not just refer to changes in "cold and isolated cognition;" it should also recognize the important moderating roles of motivational beliefs (including goals, values, self-efficacy, and control beliefs) and classroom contexts. They rightfully argued that individual cognition views of conceptual change ignore the mediating roles that affective, social, cultural, and environmental factors play in human cognition. Consequently, teachers who ignore the social and affective contexts of learning may limit conceptual change (1993; (p. 167), as cited in Liu, 2004; Rebich & Gautier, 2005).

Cooperative Learning

The use of cooperative learning strategies to improve verbal interactions between students in the process of constructing scientific concepts has been shown to be successful (Lonning, 1993). In a cooperative group, students are able to demonstrate what they know about a subject while listening, observing and learning from others, resulting in the modification of their own understanding (Brown, 2003). The work of Vygotsky is based on the premise that knowledge is social, constructed from cooperative efforts to learn and understand. Furthermore, Piaget's theories argue that when children's interactions with the world result in experiences that do not fit their current conceptions, their mental balance is disturbed, and socio-cognitive conflict occurs that creates cognitive disequilibrium. A modification of children's conceptions or a replacement of old conceptions with new ones can restore the balance (as cited in Johnson, Johnson, & Holubec, 1998). Consequently students often solve difficult tasks more effectively in small groups that provide opportunities to share information and engage in constructive cognitive conflict, than working alone (King, 1989).

The POE technique developed by White and Gunstone (1992) has been widely used with student teams (Tao & Gunstone, 1999). In this technique, students need to do three tasks. First, students must predict the outcome of some events, and prediction must be justified; then, they must describe what they see happening; and finally, students must reconcile any conflict between prediction and observation (Bahar, 2003). By fostering awareness of inconsistencies and contradictions through the making of predictions of experiment outcomes, learners will be more willing to change their thinking (Watson & Konicek, 1990). Numerous studies indicated that POE tasks can be used by teachers to design learning activities and strategies. Studies also suggest that POE is effective in facilitating the teacher and students in documenting student achievement and profiling student progress (Liew & Treagust, 1998).

Learning Diffusion and Osmosis

There have been several studies that have explored the difficulties students have with learning diffusion and osmosis. The early studies concentrated on misconceptions on diffusion and osmosis concepts that were held by students (Friedler, Amir, & Tamir, 1987; Odom & Barrow, 1995; Odom, 1995; Tarakçı, Hatipoğlu, Tekkaya, & Özden, 1999; Westbrook & Marek, 1991; Zuckerman, 1994). Some of the most prevalent misconceptions identified so far are given in Table 1.

Later studies began to explore how to help students move from their misconceptions to more scientifically accepted conceptions (Christianson & Fisher, 1999; Meir, Perry, Stal, Maruca, & Klopfer, 2005; Odom & Kelly, 2001; Sanger, Brecheisen, & Hynek, 2001). For example Odom and Kelly (2001) found that the concept mapping/learning cycle and concept mapping treatment groups significantly outperformed the expository treatment in conceptual understanding of diffusion and osmosis. Meir et al. (2005) designed a new program for teaching diffusion and osmosis through simulated experiments that are observable at the molecular level. Here they showed that these simulated laboratories do indeed teach diffusion and osmosis and help overcome some student misconceptions.

Purpose

Having the concepts of diffusion and osmosis is key to understanding many important life processes. They are also closely related to key concepts in physics and chemistry such as permeability, solutions, and the particulate nature of matter (Friedler, Amir, & Tamir, 1987). However, students find these concepts difficult to understand. Learning these concepts requires a form of strong restructuring or reconceptualization. In this study, two instructional sequences were designed and staged to improve the understanding and elicit the misconceptions on diffusion and osmosis. Designing and staging of the activities was informed by the cooperative and individual perspective on the conceptual change. The purpose of this research was twofold. The first aim was to determine and compare the effects of cooperative and individual learning activities based on the conceptual change approach with

Table 1
The identified misconceptions about diffusion and osmosis

Misconceptions Identified	Students' Age	Revealed By
Water moves from high to low concentration. When a drop of dye is placed in a container of clear water, the dye molecules continue to move around, because if dye molecules stopped, they would settle to the bottom of the container. Particles general1y move from high to low concentration, because particles tend to move until the two areas are isotonic, and then the particles stop moving. Diffusion and osmosis would stop if a cell were killed.	University & High School	Odom & Barrow (1995), Odom (1995), Odom & Kelly (2001), Tarakçı et al. (1999).
Different amounts of water across the membrane, rather than different concentrations, drive osmosis. Water molecules cease moving across the membrane at osmotic equilibrium, and the amounts of water across the membrane must be equal at osmotic equilibrium.	High School	Zuckerman (1994)
Equilibrium is static, and diffusion happens at the same speed regardless of the concentration difference. There are equal numbers of water molecules on each side, instead of equal concentrations of water. Students was asked to predict the amount of water in the tomato at equilibrium, many students chose amounts based on the numbers of water or salt molecules in the outside and inside solutions, rather than equalizing the concentrations of solute in both solutions.	University	Meir et al. (2005)

traditional teaching for 9th grade students' understanding of diffusion and osmosis. The second aim was to investigate the effect of these three approaches on students' attitudes towards biology. It was believed that this study would fill the gap in designing and developing effective teaching activities for the concepts of diffusion and osmosis.

Method

Research Design

In order to achieve the above aim, this quasi-experimental study was designed as Non-Equivalent Groups pre-test, post-test control and comparison group model. This model is very prevalent and useful in education, since the researcher is able to use intact, already established groups of subjects (McMillan & Schumacher, 2006, p. 273).

Participants

The participants of the study consisted of 90 ninth grade students from three different classes from the Erzurum Anatolian High School. Anatolian High Schools accept students who performed at a high level of achievement in centralized exams in grades six to eight as described below. Therefore, students were quite homogeneous in terms of academic achievement. In addition, no statistically significant difference was observed between the groups in their first-semester biology course score means ($F_{(2,87)}$= 1.851, $p>.05$; $\bar{x}_{E1}$=61.22, SD=14.18; $\bar{x}_{E2}$=60.00, SD=7.70; $\bar{x}_{C}$=65.13, SD=9.46). Each of the three classes had 13 girls and 17 boys between the ages of 14 and 15. Two of the classes were selected as the experimental groups (E_1 and E_2), and one of the classes was the control group (C). Classes were randomly assigned to either the control or experimental groups, as ANOVA results (see table 2) on pre-tests' mean scores showed no statistically significant differences between the groups.

Table 2

Control and Experimental Groups' PreTests ANOVA Results

Test		Sum of Squares	df	Mean Square	F	p
DOCT	Between Groups	21.622	2	10.811	1.571	>.05
	Within Groups	598.867	87	6.884		
	Total	620.489	89			
BAS	Between Groups	0.436	2	0.218	0.753	>.05
	Within Groups	25.208	87	0.290		
	Total	25.645	89			
SPST	Between Groups	12.987	2	6.494	0.583	>.05
	Within Groups	957.215	86	11.130		
	Total	970.202	88			

Study Instruments

The data was collected through four different tools entitled DOCT, BAS, SPST and CLSRS. The DOCT was administered to control and experimental groups as pre and post–test. Students were given the SPST as a pre-test to determine their science process skills. Since the study did not aimed to determine the effect of intervention on students' science process skills SPST was not used as a post-test. The BAS was administered as a pre- and post-test to measure students' attitudes toward biology. The CLSRS was administered only to the E_1 group as a post-test.

The DOCT consisted of 15 items. The first six questions of the DOCT were multiple-choice, and the latter nine questions were two-tier items. The first tier consisted of content questions with two, three, or four choices; whereas, the second tier consisted of possible reasons for the first part: one, two or three alternative reasons and one desired reason. The alternative reasons were based on misconceptions previously detected during a multiple-choice test and reported in the literature.

Some questions on the DOCT were constructed by the researcher, and the other part of the questions was modified from the literature (Kılıç, 1999; Lab Quiz 2007; Meir et al. 2005; Odom & Barrow, 1995; Quiz Engine 2007; Yıldırım, Nakiboğlu, & Sinan, 2004). The main aim of the DOCT was to identify students' misconceptions about diffusion and osmosis and to measure students' achievement related to diffusion and osmosis concepts before and after the treatment. Each question on the DOCT was given one point, and the total possible maximum score could be 15. The whole test could be found at Cinici (2010).

The areas covered by the test are presented in Table 3. In order to calculate the reliability of the DOCT, item difficulty indexes ($\bar{x}$= 0.615) and discrimination powers ($\bar{x}$= 0.41) were calculated for each item. Using the data from item analysis, the KR-20 reliability was calculated as 0.625. The content validity of the test was achieved by taking four experts views.

Table 3

Titles Covered and Corresponding Questions Tested by the DOCT

Titles	**Questions**
The particulate and random nature of the matter	6, 15
Concentration and tonicity	1, 3, 5
The influence of life forces on diffusion and osmosis	4, 9
The factors affecting diffusion rate and kinetic energy of matter	7, 11
Dynamic equilibrium	13
The process of diffusion	10, 12
The process of osmosis	2, 8, 14

The BAS was used to determine students' attitude towards biology. It was developed by Pekel (2005), and the reliability of the test was reported as 0.92. The BAS has 15 items with a five-point Likert-type scale ranging from *absolutely agree* to *absolutely disagree* respectively for the positive statements and vice versa for the negative statements.

The SPST was originally developed by Burns, Okey, and Wise (1985) and adapted to Turkish by Geban, Aşkar, and Özkan (1991). They reported the cronbach alpha reliability of the SPST as 0.81. This test consisted of 36 four-alternative multiple choice questions, and each question on the SPST was one point with the total possible maximum score being 36. The test measures five subsets (identifying variables, identifying and stating hypotheses, operationally defining, designing investigations, and graphing and interpreting data) from the different aspects of science process skills.

The CLSRS was administered only to the E_1 group as a post-test to assess students' perceptions of personal and academic support and cohesiveness within cooperative learning teams. The CLSRS was developed by Karsch (2001) and adapted to Turkish by the researchers who found the cronbach alpha reliability of the CLSRS to be 0.91. It contains 12 items. Except for one item, all items were measured on a Likert-type scale ranging from four (*strongly agree*) to one (*strongly disagree*). The one negative question required reversing the score. The last one was a multiple choice item provided with three options to identify whether a particular student was happy with the group in which s/he was placed.

Procedure

Teaching was performed by the first author who is the real teacher of these classes. The treatment took over four weeks, and each instruction consisted of two 45-minute sessions per week. For this research, the C group was taught by the whole-class teaching technique, while the E_1 group was taught through the cooperative learning method, supported by the conceptual change approach. The E_2 group was taught using individual learning supported by the conceptual change approach. For the purpose of performing the conceptual change approach, the POE technique is dominantly used in the experimental groups. The C group was taught through lecturing and questioning following the sequence of the biology textbook. Students were mostly passive recipients of knowledge and resorted to rote learning.

The Turkish education system is based on a centralized student selection system almost at all levels. Students have to take these exams the second part of primary education (grades six-eight) to be able to enroll in the secondary schools. In addition, students have to take a competitive university placement exam at the end of grade 12. All these exams are based on students' problem solving skills on multiple choice questions. Therefore, teachers are mostly inclined to use well-constructed lectures and the solving of multiple-choice problems in teaching. For the students taking part in this study, it was the first time they had experienced cooperative or active learning strategies.

In the E_1 group, firstly, students were informed about cooperative learning and POE in the first semester, and a pilot study was implemented for a month period in a different topic. As students were mostly familiar with individual working activities, the pilot study improved students' communication and critical thinking skills, since they were required to work in small groups, teach each other and reduce jealousy, which is essential for cooperative learning environments. The students were divided into six heterogeneous groups with five students in each group. Firstly, each group was given two worksheets that have POE tasks as well as a "Student Individual Prediction Form (SIPF)." The diffusion and osmosis SIPF and all worksheets could be found at Cinici (2010).

Students' preconceptions were activated by the use of worksheets. In the beginning of the POE task, students were informed about the experiment/demonstration that was to be performed and, based on their current understanding, students were asked to predict with explanations what would happen. Students wrote their individual predictions on the SIPF. Later, the experiment/demonstration was performed, and students made observations. Group reporters then wrote the shared group observations on a worksheet. If the predictions and observations were inconsistent with each other, students discussed these inconsistencies in groups and made shared explanations. After POE tasks, students discussed and answered the questions on worksheets in groups. Finally, class discussions were made that were guided by the teacher.

In the E_2 group, individual learning supported by the conceptual change approach was used. Initially, students were informed about the POE process; then they were given a POE tasks worksheet and asked to predict with explanations what would happen at the end of the experiment or demonstration. Each student wrote their individual predictions on the worksheet. Later, the experiment/demonstration was performed, and students made observations and wrote their understanding on the POE worksheet. If the predictions and observations were inconsistent with each other, each student made explanations. Finally, class discussions were made under the guidance of the teacher.

The results were analyzed by means of SPSS, using a paired sample t-test and ANOVA, and were presented together with descriptive statistics.

Findings

Paired sample *t*-tests were used to analyze the differences of means in pre- and post achievement and attitudes between control and experimental groups. One way ANOVA was used to compare the groups was in determining whether there was any statistically significant difference between the groups in terms of attitudes towards biology, scientific process skills and academic achievements. The results are presented below.

Comparisons of Groups DOCT Mean Scores

An overview of the mean grades and standard deviation pre- and post-test (DOCT) scores for the groups are displayed in Table 4.

Table 4

DOCT Descriptive Statistics and Dependent Sample t-test Results (Pre-test and Post-test).

Groups		N	Pre-test		Post-test		t- test		
			Mean	SD	Mean	SD	df	t	p
E1	Female	13	8.38	2.81	12.06	1.49	**29**	**-7.11**	**< .05**
	Male	17	7.88	2.28	11.63	2.89			
	Total	**30**	**8.08**	**2.49**	**11.84**	**2.36**			
E2	Female	13	7.70	3.06	10.46	2.84	**29**	**-4.10**	**< .05**
	Male	17	6.30	3.09	9.68	2.75			
	Total	**30**	**7.00**	**3.11**	**10.07**	**2.77**			
C	Female	13	7.76	2.48	9.00	2.16	**29**	**-2.90**	**< .05**
	Male	17	7.35	1.96	8.88	2.71			
	Total	**30**	**7.55**	**2.17**	**8.94**	**2.64**			

The E_1 group post-test total mean scores ($\overline{X}$=11.84, SD=2.36) were higher than that of the E_2 ($\overline{X}$=10.07, SD=2.77) and C groups (X=8.94, SD=2.64). Their pre-test total mean scores were $\overline{X}$=8.08 (SD=2.49) $\overline{X}$=7.00 (SD=3.11) and $\overline{X}$=7.55 (SD=2.17) respectively. The comparison between the pre- and post-test mean scores showed that all three groups made progress in terms of academic achievement. The pre- and post-test t-test comparisons (see Table 4) showed a statistically significant difference between the experimental groups ($E_{1(pre-post\ test)}$, $t_{(29)}$ =-7.11; p<.05; $E_{2(pre-post\ test)}$, $t_{(28)}$ =-4.10; p<.05) and the control group ($C_{(pre-post\ test)}$, $t_{(29)}$ =-2.90; p<.05). However the comparison among the post-test mean scores showed that students in the first experimental group gained higher scores than the other two groups ($F_{(2,86)}$=10.030; p<.05). The least successful group was the control group in which the traditional teaching approach was applied.

Comparison of Students' Attitudes Towards Biology

An overview of the mean scores and standard deviation for pre-test SPST scores and pre- and post-test BAS scores and the t-test results of each group for pre–post BAS scores are displayed in Table 5.

Table 5

BAS and SPST Descriptive Statistics and BAS t-test Results (Pre-Test and Post-Test).

Groups		N		Pre-test SPST		Pre-test BAS		Post-test BAS		t- test BAS		
		BAS	SPCT	Mean	SD	Mean	SD	Mean	SD	df	t	p
	Female	13	13	20.31	3.66	3.32	0.46	3.84	0.51			
E1	Male	17	16	21.81	3.27	3.33	0.38	3.95	0.50	**29**	**-4.79**	**<.05**
	Total	**30**	**29**	**21.14**	**3.47**	**3.32**	**0.41**	**3.91**	**0.50**			
	Female	13	13	19.85	4.07	3.43	0.89	3.89	0.48			
E2	Male	17	17	20.47	2.85	3.37	0.56	3.78	0.58	**29**	**-2.55**	**<.05**
	Total	**30**	**30**	**20.20**	**3.38**	**3.40**	**0.71**	**3.83**	**0.53**			
	Female	13	13	19.23	3.21	3.40	0.40	3.61	0.32			
C	Male	17	17	21.71	2.7	3.56	0.46	3.68	0.37	**29**	**-1.70**	**>.05**
	Total	**30**	**30**	**20.63**	**3.14**	**3.48**	**0.43**	**3.64**	**0.37**			

The comparison between the pre- ad post-test mean scores showed that all three groups made progress in terms of students' attitudes towards biology. The pre- and post-test t-test comparisons for each group (see Table 5) showed a statistically significant difference on the experimental groups ($E_{1(pre-post\ test)}$, $t_{(29)}$ = -4.79; p<.05; $E_{2(pre-post\ test)}$, $t_{(29)}$ = -2.55; p<.05), while there was no statistically significant difference in the control group ($C_{(pre-post\ test)}$, $t_{(29)}$ = -1.70; p>.05). There was no statistically significant differences among both experimental and control groups in the post-test mean scores for attitudes ($F_{(2,87)}$ =2.231; p>.05).

Analysis of the Cooperative Learning Self Report Survey Results

In order to ascertain the effects of students' attitudes towards their particular groups on academic achievement, Table 6 was organized. The DOCT post-test mean scores and sub–scales of CLSRS mean scores showed that "group biologists," which had lowest academic achievement, had the lowest mean scores for personal support, academic support and cohesiveness items on CLSRS. As a response to the twelfth item, three students in this group selected, "*Please do not put me in this group again next marking period,*" and the others selected, "*I liked working with this group, but I'd like to try working with a new group next marking period.*" All members of "group proofs," which had the highest academic achievement, selected the item, "*I would like to continue working in this cooperative learning group next marking period*."

Table 6

CLSRS Descriptive Statistics

Teams	DOCT		Sub – Scales of CLSRS		
	Pre-test mean	Post-test mean	Personal support items mean	Academic support items mean	Cohesiveness items mean
Ionic	8.80	11.80	3.55	3.40	3.13
Profs	9.40	13.40	3.30	3.35	3.33
Biologists	8.60	10.40	2.30	2.15	2.26
Geniuses	6.60	11.80	2.80	2.85	2.66
Philosophers	7.40	11.60	3.90	3.50	3.86
Metal storm	7.80	12.00	3.35	3.35	3.40

Results and Implications for Teaching

In this study, POE tasks implemented in cooperative and individual groups are found more effective than when implemented in a traditional teaching group. However POE tasks implemented in cooperative groups are found more effective than those implemented in individual groups. In this respect, this study suggests that science teachers may carry out experimental lab activities with small groups to help students construct their knowledge and enhance their understanding of science concepts. Particularly, by providing opportunities for students to predict the outcome of an experiment, operating the experiment, observing the result of the experiment, then negotiating and discussing the results within cooperative groups, teachers can promote scientifically acceptable understandings. Niaz, Aguilera, Maza, and Liendo (2002) have also concluded that if students are given the opportunity to argue and discuss their ideas, their "understanding can go beyond the simple regurgitation of experimental detail" (p. 523). This study also shows that POE tasks, which were administered in cooperative groups, provided a more complete framework for understanding than POE tasks that were administered in individual groups. This result is consistent with Pintrich et al.'s (1993) "social and affective perspective" and Abd-El-Khalick and Akerson's (2004) "learning ecology" construct.

Teachers should be aware of students' prior knowledge and misconceptions, because they are strong predictors of student achievement in science, and the teacher should examine why these misconceptions occur. This study indicated that high school students have difficulty with the concepts of diffusion and osmosis both before and after instructions. Even after intervention, it was observed that some of the misconceptions were still resistant to change. Meir *et al.* (2005) showed that simulated laboratories do indeed help overcome some, but not all, student misconceptions. Also, Westbrook and Marek (1991) noted that none of the secondary and college-level science students in their study had a complete understanding of diffusion. Christianson and Fisher (1999) found that certain aspects of diffusion and osmosis are clearly easier for students to master, but some aspects (correct use of terminology and concepts) are not.

This study also attempted to examine students' attitudinal perceptions of biology in the three-course contexts. The development of positive attitudes and perceptions toward school subjects is an important and desirable educational outcome. The statistical analysis of each group’s pre- and post-BAS mean scores showed that students in cooperative groups made more positive progress on biology attitudes than individual-student groups. In the control group, mean differences before and after the study were not significant. Handelsman, Houser and Kriegel, (2002) stated that cooperative learning has considerable value in affecting students’ attitudes toward the subject matter and themselves. Students’ attitudes appear to be positively influenced when they do better in science subjects, and they are active participants in their learning environments.

In comparing the DOCT post-test mean scores and the CLSRS mean scores’ results for each group, it was revealed that students’ academic achievements were related to their feeling of personal support, academic support and cohesiveness in cooperative groups. In other words, students’ attitudes towards their particular group are a crucial factor on their academic achievement. The students in “group biologists,” which had the lowest academic achievement, did not feel that their team was supportive enough in terms of personal and academic support and cohesion. But the members of “group proofs,” which had the highest academic achievement, did feel that their team was sufficiently supportive and cohesive. Slavin concluded that the effects of cooperative learning on achievement are firstly motivational, whereby working cooperatively to achieve a group goal creates peer support, which enhances student motivation for mutual assistance (1983, cited in Pisani, 1994). As stated by Handelsman et al., (2002), the natural combination of rigor and support leads to a dynamic environment that fosters creativity and active learning. Duffy and Zeidler (1996) indicated that the grouping climate alone had a significant effect on conceptual change. Taken together, these findings provide strong evidence for the importance of social and academic encouragement, cohesiveness and support from team members for the development of science achievement and positive science attitudes.

Consequently, in traditional teaching approaches, students are passive recipients, but in the cooperative learning approaches, students are an active participant in the learning environment. Cooperative learning tasks that require social interaction stimulate learning and enable students to recognize that actions should be taken with reference to others. As suggested by Bilgin and Geban (2006), conceptual change conditions and episodes of cooperative learning promote active participation, evidence gathering, interaction among students, discussion, and critical thinking.

Thus, according to this study, the combination of POE tasks and cooperative learning, together with attitudes through social interactions in cooperative groups, increases the understanding of students in diffusion and osmosis.

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İşbirlikli ve Bireysel Öğrenme Etkinliklerinin Öğrencilerin Difüzyon ve Osmoz Kavramlarını Anlamaları Üzerine Etkisi

(Özet)

Problem durumu: Difüzyon ve osmoz kavramlarının öğrenimi birçok fen kavramının anlaşılmasında anahtar rol oynamaktadır. Difüzyon kavramının tam olarak anlaşılması, sindirim ve gaz alışverişi gibi önemli birçok biyolojik olayın tam olarak anlaşılabilmesi için esastır. Ayrıca difüzyon kavramının; madde, enerji ve biyolojik organizasyon kavramlarını birleştirebilmek için de öğrenilmesi gerekir. Osmoz ise bitkilerde su alınımında, turgor basıncında, sucul ve karasal organizmaların su dengesinde, canlılardaki taşıma sistemlerinde önemli işlevi olan bir mekanizmadır. Ancak yapılan araştırmalar, öğrencilerin bu kavramları anlaşılması zor kavramlar olarak gördüklerini ve ayrıca bu konuda birçok kavram yanılgılarının olduğunu göstermiştir.

Günümüzde fen bilimleri ile ilgi çağdaş öğretimsel yaklaşımların çoğunda, öğrencilerin bilimsel olarak yanlış olan bu kavram yanılgılarını değiştirebilmek için onların ön bilgilerine önem verilmesi gerektiği vurgulanmaktadır. Oluşturmacı öğrenme yaklaşımına göre öğrenciler bilgilerini oluştururken ön bilgilerinden oldukça çok etkilenmektedirler. Öğrenciler dünyayı, dünyadaki olayları anlayabilmek için bu ön bilgilerine ve geçmiş deneyimlerine dayanarak içsel betimlemeler ya da zihinsel modeller oluştururlar. Bu zihinsel modeller, olayları açıklamak veya olaylarla ilgili tahminlerde bulunmak için kullanılır. Dolayısıyla kavram yanılgılarının bilimsel kavramlarla değiştirebilmesi için zihinsel modeli temsil eden bir döngüye (tahmin etme, yansıtma, uyum sağlama ve sonuç çıkarma) ihtiyaç vardır. Öğrenciler hipotez kurmalı, deneyler tasarlamalı, verileri analiz etmeli, sonuçları tahmin etmeli ve bilgiyi yapılandırmak için işbirliği içinde çalışmalıdırlar.

Çalışmanın Amacı: Bu araştırmanın iki amacı vardır. Birincisi, dokuzuncu sınıf öğrencilerinin difüzyon ve osmoz kavramlarını anlamaları üzerine kavramsal değişim yaklaşımına dayalı işbirlikli ve bireysel öğrenme etkinliklerinin etkilerini belirlemek ve geleneksel öğretim yöntemiyle karşılaştırmaktır. İkinci amaç ise, bu üç öğretim yönteminin, öğrencilerin biyolojiye karşı tutumları üzerine etkisini araştırmaktır.

Yöntem: Çalışmada yarı deneysel yöntemin eşit olmayan gruplar öntest-sontest kontrol ve karşılaştırma modeli kullanılmıştır. Araştırmanın örneklemini Erzurum Anadolu Lisesinde 9'uncu sınıfta öğrenim gören toplam doksan öğrenci oluşturmuştur. Araştırmada bir kontrol (K) ve iki deney grubu (D_1 ve D_2) seçilmiştir.

Kontrol grubunda (K) düz anlatıma dayalı geleneksel öğretim yöntemi, birinci deney grubunda (D_1) kavramsal değişim yaklaşımına dayalı işbirlikli öğrenme yöntemi, ikinci deney grubunda (D_2) ise kavramsal değişim yaklaşımına dayalı bireysel öğrenme yöntemi, uygulanmıştır. Her iki deney grubunda da öğrenme etkinlikleri Tahmin-Gözlem-Açıklama (TGA) tekniği üzerinden yürütülmüştür. Yöntem uygulaması dört hafta sürmüştür. Difüzyon ve Osmoz Kavram Testi (DOKT) ve Biyoloji Tutum Ölçeği (BTÖ) deney ve kontrol gruplarına ön test ve son test olarak uygulanmıştır. Bilimsel İşlem Beceri Testi (BİBT) ise öğrencilerin bilimsel işlem becerilerinin belirlenmesi amacıyla ön test olarak uygulanmıştır. Ayrıca İşbirlikli Öğrenme Öz Değerlendirme Anketi (İÖÖDA) sadece birinci deney grubundaki öğrencilerin takımları hakkındaki; sosyal destek, akademik destek ve bağlılık algılarını belirlemek amacıyla son test olarak uygulanmıştır. Sonuçlar t-testi, ANOVA ve betimsel yollarla analiz edilmiştir.

Bulgular ve Sonuçlar: Araştırmadan elde edilen sonuçlara göre hem deney hem de kontrol gruplarında akademik başarı açısından anlamlı gelişme sağlanmıştır. *Kavramsal değişim yaklaşımına dayalı işbirlikli öğrenme* etkinliklerinin yürütüldüğü D_1 grubu akademik başarı bakımından *kavramsal değişim yaklaşımına dayalı bireysel öğrenme* yönteminin uygulandığı D_2 grubuna ve *düz anlatıma dayalı geleneksel öğretim* yönteminin uygulandığı K grubuna göre daha yüksek başarıya erişmiştir. Deney grubundaki öğrencilerin biyolojiye karşı tutumları olumlu yönde gelişme göstermişken, kontrol grubunda anlamlı bir değişim olmamıştır.

Sonuç ve Öneriler: Araştırmanın sonuçları TGA etkinliklerinin işbirlikli gruplarda uygulanmasının, bireysel olarak uygulanmasına göre kavramsal anlama sürecinde daha bütüncül bir yapı oluşturduğunu ortaya koymuştur. Bu sonuç sınıftaki sosyal iklimin öğrenmede temel bir rol oynadığını göstermiştir. Öğrencilerin biyolojiye karşı tutumlarının gelişimiyle ilgili sonuçlar işbirlikli öğrenme aktivitelerinin bireysel öğrenme aktivitelerinden daha iyi olduğunu ve öğrencilerin takımlarından aldıkları bireysel ve akademik akran desteğinin ve takım bağlılığının akademik başarıyla ilişkili olduğunu ortaya koymuştur. Bu araştırmayla ilgili olarak elde edilen sonuçlar dikkate alınarak öğretmen yetiştiren kurumlara, MEB yetkililerine ve farklı öğretim basamaklarında görev yapan Fen bilimleri öğretmenlerine şu önerilerde bulunulmuştur:

1. Gelişmiş bir toplum olabilmemizin gereği olarak; bilgiyi ezberleyen değil anlamlı olarak zihninde yapılandıran, öğrenme sürecinde pasif alıcı değil aktif katılımcı olan, merak eden, sorgulayan, analiz eden ve bunları sağlayabilmek için işbirlikli olarak çalışabilen bireyler yetiştirilmelidir. Bunun sağlanabilmesi için ilk olarak, öğretmen adaylarına öğretim süreci içerisinde, ilk ve orta öğretim kurumlarımızda görev yapan öğretmenlere ise uygulamaya dayalı hizmet içi eğitim programları yoluyla, çağdaş öğretimsel yaklaşımlar ve bunların eğitim-öğretim ortamındaki uygulamaları hakkında bilgi ve beceriler kazandırılmalıdır.

2. Fen bilimleri öğretmenleri, sonuçları somut olarak gözlemlenebilecek deneysel etkinlikler tasarlayarak, öğrencilerin, difüzyon ve osmoz gibi moleküler düzeyde gerçekleşen sub-mikroskobik kavramları ya da mikroskobik kavramları daha kolay anlamalarına yardımcı olmalıdır.

3. Son zamanlarda fen eğitiminin öncelikli amaçlarından birisi, temel fen kavramlarının doğru bir şekilde anlaşılmasını sağlamaktır. Bu amaçla öğrencilerin aktif olarak katılabilecekleri veri toplayabilecekleri, gözlem yapabilecekleri ve bu gözlemleri hakkında fikir yürütüp tartışabilecekleri merak uyandırıcı öğrenme aktivitelerine sokulmaları gerekmektedir. Böylece öğrenciler yeni kavramı anlamlı olarak öğrenme fırsatı yakalayacaklardır.

Anahtar Kelimeler: Biyoloji öğretimi, osmoz ve difüzyon, işbirlikli öğrenme, TGA, kavram yanılgıları.