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THE EFFECT OF JIGSAW-I COOPERATIVE LEARNING TECHNIQUE ON STUDENTS' UNDERSTANDING ABOUT BASIC ORGANIC CHEMISTRY CONCEPTS

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Abstract

The purpose of this study was to investigate effect of Jigsaw-1 Cooperative Learning technique on students' understanding and alternative conceptions concerning basic organic chemistry concepts. The study was conducted with a total of 52 9th grade students in a high school in Trabzon. The study used quasi-experimental design (an experimental group and a control group). While experimental group students performed activities based on Jigsaw 1 technique, control group students were taught with traditional approach. The treatment lasted for three lesson hours in both groups. An Organic Chemistry Achievement Test involving 5 open-ended questions was used to collect data. The data obtained from pre- and post-tests of both groups was compared with the independent t-test. The post-test results showed that there was a significant difference between groups in favor of the experimental group. In other words, the experimental group students taught with Jigsaw I technique performed better in the post-test than the control group.

Introduction

One of main objectives of chemistry education is to help students use school knowledge to explain chemical phenomena that occur in everyday life. Being familiar with chemical representations such as formulas, symbols, equations, and structures is essential for understanding especially basic organic chemistry concepts (Kozma et al., 2000) and transferring to everyday life. However, many researchers have reported students' alternative conceptions about basic chemistry concepts such as acids and bases (Ross and Munby,1991), mole concept (Staver and Lumpe, 1995), solutions (Ebenezer and Ericson,1996; Çalık, Ayas and Roll, 2007) the structure of matter (Haidar and Abraham, 1991), chemical equilibrium (Demircioğlu et al., 2000).

On the other hand, researchers in science education have focused on developing alternative methods for improving students' understanding and remedying their alternative conceptions (Pfundt & Duit, 1991). One of the developed methods is cooperative learning based on social constructivism. The cooperative learning is described as a method where students work together in small mixed groups and help each other for a common academic aim, develop communication abilities, increase problem solving and critical thinking abilities and take an active part in their own learning process (Bowen, 2000; Prince, 2004). This model involves five

essential components: 1) positive interdependence, 2) face to face promotive interaction among students, 3) individual and group accountability, 4) interpersonal and small groups skills and 5) group processing skills (Johnson, Johnson and Smith, 1998). As can be understood from these components, cooperative learning environments make students more active and put their ideas more free when compared to traditional learning. Also, research based on small group activities have shown that cooperative learning leads to positive outcomes such as higher achievement, more positive attitudes toward the subject, higher self-esteem, greater acceptance of differences among peers, greater persistence and retention (Cohen, 1998; Johnson & Johnson, 1999). Aydın (2011) investigated the effects of cooperative learning based on laboratory work on students' chemistry success and their skills and found that experimental group students working in cooperative groups in laboratory performed better compared to the traditional laboratory method. Şahin (2010) compared the effects of Jigsaw II cooperative learning technique and instructional teacher-centered teaching method on university students' attitudes to written expression course, their academic achievement, retention, and their views and found that Jigsaw II group performed better in terms of their attitudes, academic achievement, and retention than control group and had positive views on the use of Jigsaw II technique. Doymuş (2008) investigated the effect of jigsaw technique on first year university students' understanding of chemical equilibrium and found that the jigsaw group was more successful than the non-jigsaw group. In another study, Doymuş, Karaçöp and Şimşek (2012) investigated the effect of jigsaw cooperative learning and animation on first-year university students' understanding of electrochemistry and found that the jigsaw and animation groups performed better results than the control group. As can be seen from the mentioned literature above, cooperative learning is an important alternative to traditional education strategies used in high schools.

1.1 The purpose of the study

The main purpose of this study was to investigate and compare the effectiveness of jigsaw-I cooperative learning technique and traditional teaching on students' understanding of basic organic chemistry courses.

The specific research questions in this study were:

1. Are there statistically significant differences between students in the control group and students in experimental groups in terms of their understanding of organic chemistry concepts before and after the treatment?

2. Would the jigsaw I technique or traditional introduction be more effective in dispelling students' alternative conceptions?

2. Methodology

A quasi-experimental research design which is a form of true experimental design was used in this study (Robson, 1998). This is an experimental research design that does not provide full control of potential variables. In most instances, full control is not achieved because participants could not be assigned to groups (Johnson & Christensen, 2004). One control and one experimental group were used in this study. The groups were taught by the same teacher with 20 years-experience of teaching chemistry. The cooperative learning sessions for experimental group was conducted for 4 lessons (45 minutes per lesson). The time devoted to

traditional teaching sessions was 5 lesson hours.

While students in control group were taught with traditional approach, experimental group was taught with Jigsaw I technique of cooperative learning. In the experimental group, students were randomly divided into 5 groups and each group with six members was trained by the teacher about how to apply the jigsaw cooperative learning technique in classroom. In this training, the teacher gave information about learning objectives, rules of working in a cooperative group, roles and instruction process.

2.1 Sample

The sample of this study consisted of 52 ninth grade students from two classes in a high school, in Trabzon. One of these classes was randomly assigned as the control group (n=27) that was taught by a teacher-centered approach, and the other was randomly assigned as experimental group (n=25) that was taught through cooperative learning with Jigsaw-1 technique.

2.2 Data collection tools

A test consisting of 5 open-ended questions was developed by the authors and was used as pre- and post-test. Two experienced chemistry teachers and two academicians on chemistry education examined the test for its content validity. The test was used to determine what students knew about basic organic chemistry concepts before the treatment and to evaluate how their ideas changed as a result of the treatment. The maximum score for each item in the test was 10 points and the maximum score for whole test was 50 points. Item 1 was given below as an example.

Which of the following items contains organic compounds, and which does not contain organic compounds? Explain reason of your answer.

Bread:……
An Apple.……
Rusty iron.……
wooden spoon ……
A glass of jar.……

Students' responses to the test questions were divided into five categories and scored: 1) Correct Answer (CA) (2 points), 2) Partially Correct Answer (PCA) (1 point), 3) Wrong Answer (WA) (0 point), 4) Alternative Conception (AC) (0 point), 5) No answer (NA) (0 point). Mean scores were compared by using t test.

3. Findings And Discussion

Before the treatment, the test was given to both control group and the experimental group in order to determine initial performance of students. The results from the pre-test were given in Table 1. As can be seen from Table 1, there was a significant difference in chemistry achievement between the experimental group (M= 8.80, SD= 4.90) and the control group (M= 13.24, SD= 7.51) in favor of the control group (t=2.54, df=45.04, p=.015).

Table 1. The results of independent samples t-test on mean scores in the pre-test.

Groups	N	SD	Mean	df	t	P
Experimental group	25	4.90	8.80	45.04	2,54	.015
Control group	27	7.51	13.24			

After the treatment, the post-test was applied to the experimental group and control group. The results of the post test were given the Table 2. The first research question asked whether there is a statistically significant differences between students in the control group and students in experimental groups in terms of their understanding of organic chemistry concepts. The data in Table 2 showed that there was a significant difference between the experimental group (M=28.58, Sd=9.85) and the control group (M=20.51, Sd= 5.23) with regard to organic chemistry achievement (t=3.61, df=35.92, p<.001).

Tablo 2. The results of independent samples t-test on mean scores in the post-test.

Groups	N	Sd	Mean	df	t	P
Experimental	25	9.85	28.58	35.92	3,61	.001
Control	27	5.23	20.51			

From this, it can be said that the experimental group students who were taught with the jigsaw I technique were more successful than the control group students. The result is not surprising because the experimental group students were more active in both mental and physical aspects during the treatment and attend to group studies and find the possibility to relate their conceptions to the everyday life. The results of the present study support the results of previous studies in the literature (Doymuş, Karaçöp and Şimşek, 2012; Doymuş, 2008; Graith, 2003; Mattigly et al,1991). Similarly, research in the literature suggested that cooperative learning has a positive effect on academic achievement (Slavin, 1980) , and skills of problem solving (Heller et al., 1992), and enhanced motivation (Sharan, 2002).

Paired-samples t-test was used to determine whether the improvement in both groups from pretest to posttest is statistically significant. The results of t-test were given Table 3 and 4.

Tablo 3. The results of paired-samples t-test of the experimental group

	N	Mean	Mean difference	r	df	t	P
Pre-test	25	8.80	19.78	0.41*	24	11.0	.001
Post-test		28.58					

* significant at 0.05 level

Table 4. The results of paired-samples t-test of the control group

	N	Mean	Mean difference	r	df	t	P
Pre-test	27	13.24	7.33	0.55*	26	6.03	.001
Post-test		20.57					

* significant at 0.05 level

As seen in Table 3 and 4, each group showed a statistically significant progress from pretest to posttest. However, mean difference of experimental group (19.78) was higher than that of control group (7.33). This difference clearly showed effect of jigsaw I technique.

The findings obtained from analysis of first and second items in the test were presented in Table 5 and 6.

Table 5. The analysis of control group students' responses to first and second item in the test on the pre- and post-tests

		CA				**WA**				**PCA**				**AC**				**NA**			
		Pre		**Post**		**Pre**		**Post**		**Pre**		**Post**		**Pre**		**Post**		**Pre**		**Post**	
		f	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**
Item 1	Bread	1	4	0	0	1	4	5	18	12	44	11	41	0	0	3	11	13	48	8	30
	An Apple	1	4	0	0	3	11	7	26	12	44	13	48	1	4	1	4	10	37	6	22
	Rusty iron	0	0	0	0	4	15	6	22	9	33	10	37	1	4	3	11	13	48	8	30
	Wooden spoon	1	4	0	0	6	22	4	15	0	0	5	18	4	15	7	26	16	59	11	41
	A glass of Jar	0	0	0	0	3	11	5	18	9	33	13	48	3	11	1	4	12	44	8	30
Item 2	CO_2	3	11	1	4	0	0	1	4	3	11	17	63	3	11	4	15	18	67	4	15
	CH_3COOH	5	19	3	11	1	4	5	19	5	19	13	48	2	7	0	0	9	33	6	22
	KCN	1	4	0	0	3	11	2	7	5	19	21	78	5	19	1	4	9	33	3	11
	CCl_4	0	0	0	0	4	15	2	7	4	10	18	66	0	0	0	0	12	44	7	26
	HCOOH	5	19	3	11	0	0	4	15	8	30	14	52	0	0	0	0	10	37	6	22

In the "correct answer" category, while the percentages of control group students' responses for item 1 in pre-test ranged from 0% to 4%, none answered correctly to item 1 in the post test (Table 5). Similarly, while the percentages of students' responses for item 2 in pre-test ranged from 0% to 19%, it ranged from 0% to 11% in the post-test (Table 5). The percentages of correct answers for item 1 and 2 decreased from pre-test to post-test. In the "wrong answer" category, while the percentages of students' responses for item 1 in pre-test ranged from 4% to 22%, it ranged from 15% to 26% in the post-test (Table 5). Similarly, while the percentages of students' responses for item 2 in pre-test ranged from 0% to 15%, it ranged from 4% to 19% in the post-test (Table 5). In the "alternative conception" category, while the percentages of students' responses for item 1 in pre-test ranged from 0% to 15 %, it ranged from "4% to 26%" in the post-test. Similarly, while the percentages of students' responses for item 2 in pre-test ranged from 0% to 19%, it ranged from 0% to 15% in the post-test (Table 5).

In the "correct answer" category, while the percentages of experimental group students' responses for item 1 in pre-test ranged from 0% to 8%, it ranged from 24% to 44% in the post-test (Table 6). While none of students answered correctly to item 2 in pre-test, percentages of correct responses ranged from 13% to 64% in the post-test (Table 6). The percentages of correct answers for item 1 and 2 increased from pre-test to post-test. In the "wrong answer" category, while the percentages of students' responses for item 1 in pre-test ranged from 12% to 24%, it ranged from 0% to 16% in the post-test (Table 6). Similarly, while the percentages of students' responses for item 2 in pre-test ranged from 0% to 4%, it ranged from 6% to 20% in the post-test (Table 6). In the "alternative conception" category, while the percentages of students' responses for item 1 in pre-test ranged from 0% to 15 %, it ranged from "4% to 26%" in the post-test. Similarly, while the percentages of students' responses for item 2 in pre-test ranged from 0% to 28%, it ranged from 0% to 8% in the post-test (Table 5).

Table 6. The analysis of experimental group students' responses to first and second item in the test on the pre- and post-tests

		CA				**WA**				**PCA**				**AC**				**NA**			
		Pre		**Post**		**Pre**		**Post**		**Pre**		**Post**		**Pre**		**Post**		**Pre**		**Post**	
		f	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**
Item 1	Bread	1	4	11	44	3	12	1	4	6	24	11	44	3	12	1	4	12	48	1	4
	An Apple	2	8	9	36	6	24	4	16	5	20	11	44	2	8	0	0	10	40	1	4
	Rusty iron	0	0	9	36	5	20	0	0	7	28	9	36	2	8	1	4	11	44	6	24
	Wooden spoon	0	0	10	40	5	20	3	12	1	4	8	32	5	20	0	0	14	56	3	12
	A glass of Jar	0	0	6	24	4	16	4	11	4	16	11	44	1	4	1	4	16	64	5	20
Item 2	CO_2	0	0	13	52	0	0	3	6	2	8	4	16	4	16	2	8	19	76	5	20
	CH_3COOH	0	0	16	64	0	0	2	8	2	8	1	4	0	0	1	4	19	76	5	20
	KCN	0	0	14	56	1	4	5	20	1	4	2	8	7	28	0	0	16	64	3	12
	CCl_4	0	0	52	13	1	4	4	16	2	8	3	12	2	8	2	8	20	80	5	20
	HCOOH	0	0	15	60	0	0	4	16	2	8	2	8	3	12	1	4	20	80	3	12

The alternative conceptions obtained from analysis of all items in the test are listed in table 7. As seen in Table 7, the students in both groups held almost the same alternative conceptions on the pre-tests. After the treatment, only one student in the experimental group and two students still hold their alternative conceptions.

Table 7. The misconceptions determined in the pre-tests and post-tests

Students' misconceptions	Experimental Group				Control Group			
	Pre Test		Post test		Pre test		Post test	
	f	%	f	%	f	%	f	%
Foods which contain sweeteners are organic	5	20	-	-	5	18	1	4
Handmade and artificial matters contain inorganic molecules	6	24	-	-	-	-	-	-
Matters that change chemically are organics, while ones that do not change chemically are inorganic	2	8	-	-	2	7	1	4
Matters containing –COOH are organics.	2	8	1	4	-	-	1	4
C in formula is an indicator of organic molecules	7	28	-	-	3	11	1	4
Living things are organic.	2	8	-	-	1	4	-	-
Rusty iron is not organic because it is rusty	1	4	-	-	2	7	-	-
HCOOH is not organic because it contains CO_2	2	8	1	4	2	7	1	4

4. Conclusions And Suggestions

Before the treatment, it was found that there was a significant difference between mean scores of groups with respect to the students' initial understandings of the concepts of organic chemistry ($t(45.04)=2.54$; $p=0.015$) in favor of the control group. Since the difference is in favor of the control group, the statistical results of the present study would not be affected adversely. After the treatment, t test was run to compare the effect of treatment on students' understanding of organic chemistry concepts in post-test. The results of t- test indicated that the experimental group students taught with the cooperative learning jigsaw I technique performed much better in the post-test than the control group students taught with traditional instruction. The results from the pre-test showed that some students in both groups held same alternative conceptions before

receiving formal instruction on the organic chemistry. After the treatment, students in both groups showed progress in eliminating their alternative conceptions, but the experimental groups were better overall. However, it is not correct to say that jigsaw I technique was more effective in eliminating alternative conceptions than traditional approach because only one student in experimental group and two students in control group continued to hold their alternative conceptions.

Teacher should be aware of students' prior knowledge and alternative conceptions on organic chemistry topics, because they are strong predictors of student achievement. In the process, we have thought that present study would be an important source for the chemistry teachers. Student teachers and chemistry teachers should be introduced about cooperative learning models and its applications such as Jigsaw techniques.

Reference

Aydın, S. (2011). Effect of cooperative learning and traditional methods on students' achievements and identifications of laboratory equipments in science-technology laboratory course, Educational Research and Reviews, 6(9), 636-644.

Bowen, C. W. (2000). A quantitative literature review of cooperative learning effects on high school and college chemistry achievement. Journal of Chemical Education, 77(2), 116–119.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ:awrence Earlbaum Associates

Çalık, M., Ayas, A. & Coll, R.K. (2007). Enhancing pre-service primaryteachers' conceptual understanding of solution chemistry with conceptual change text. International Journal of Science Mathematics Education, 5(1), 1-28.

Demircioğlu, G.. Özmen, H. and Ayas,A.(2004).Eğitim Bilimleri / Educational Sciences: Theory & Practice . 73-80

Doymuş, K., (2008). Teaching Chemical Equilibrium with the Jigsaw Technique. Research in Science Education, 38: 249-260

Doymuş, K., Karaçöp, A., and Şimşek, Ü.(2010).Effects of jigsaw and animation techniques on students'understanding of concepts and subjects in electrochemistry, Educational Technology Research and Development, 58, 671-691

Ebenezer, J.V. & Erickson, L.G. (1996). Chemistry students' conception of solubility: A phenomenograpy. Science Education, 80(2), 181-201.

Ghaith,G. And A.R. Bouzeineddine(2003).Relationship between reading attitudes, achievement and learners' perceptions of their Jigsaw II Cooperative learning experiences,Reading Psychool,24(1):105-12

Haidar, A.H., & Abraham, M.R. (1991). A comparison of applied and theoretical knowledge of concepts based on the particulate nature of matter. Journal of Research in Science Teaching, 28, 919–938

Haller, R.C ., Gallagher, V.J ., Weldon,T.L., Felder, R.M., 2000. Dynamics of peer interactions in cooperative learning. Journal Engineering Education, 89(3), 285-293

Johnson.,B.&Christensen,L.(2004) Educational Research,Quantitative,Qualitative and mixed Approaches, second edition,Pearson,U.S.A

Johnson, David W., Johnson, Roger T., and Smith, Karl A. (1991). Active learning: Cooperation in the college classroom. Edina, MN: Interaction Book Company.

Kozma, R.B., Chin, E., Russell, J., & Marx, N. (2000). The roles of representations and tools in the chemistry laboratory and their implications for chemistry instruction. Journal of the Learning Sciences, 9(2), 105 ± 143.

Mattingly,R.M and R.L,Van Sickle (1991).Cooperative Learning and achievement in social studies:Jigsaw II.Social Psychol.,128(1):345-352

Pfundt, H., & Duit, R. (1991). Students' alternative frameworks and science education ,Bibliography. Kiel, Germany : Institute for Science Education

Prince, M. (2004). Does active learning work? A review of the research. Journal of Engineering c Education, 93(3), 223–231.

Robson, C.(1998) Real Word Research, Blackwell Publishers Ltd. Oxford, UK

Sharan, S. (2002). Differentiating methods of cooperative learning in research and practice. Asia Pacific Journal of Education, 22(1), 106 – 116.

Slavin, R. E. (1980). Cooperative learning. Review of Educational Research, 50(2), 315-342.

Staver, J.R. & Lumpe, A.T. (1995). Two investigations of students understanding of the mole concept and its use in problem solving. Journal of Research in Science Teaching, 32(2),177-193.

Şahin, A. (2010). Effects of jigsaw II technique on academic achievement and attitudes to written expression course, Educational Research and Reviews, 5(12), 777-787