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Full Length Research Paper

Examination of the structural effectiveness of the jigsaw method on students

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ABSTRACT

This study aims to examine the effectiveness of different methods by comparing the academic achievement levels of jigsaw groups in the subjects they are experts in and in those they are not experts in. The sample of the study, which was carried out with a pretest posttest experimental design without a control group, consisted of 24 middle school students, 15 boys and 9 girls. A 20-question "science, technology and society achievement test" was used as the data collection tool. The test included 5 questions about each of the 4 topics of expertise assigned to the groups. The achievement that had a reliability coefficient of 0.85 was applied in the jigsaw groups as the pretest and the posttest. Since the data did not show a normal distribution, Wilcoxon Signed-Rank Test and Kruskal-Wallis test were used for the analyses. In the analysis, the Mann-Whitney U test with Bonferroni correction was used to determine which groups had significant differences. The results showed that using the jigsaw II method increased the academic achievement of the students in all dimensions of the test. However, a significant difference was found between the success levels of the jigsaw groups in the dimensions of the test. This result showed that students are more successful in their assigned subjects than other subjects.

Keywords: Cooperative learning, jigsaw II, social studies, expert groups.

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INTRODUCTION

The cooperative learning model, founded by Kurt Koffka, Kurt Lewin and Morton Deutsch in the early 1900s, is based on the theories of Piaget (1965) in cognitive terms and Dewey (1938) and Vygotsky (1962) in social terms. The features, rules and principles of the cooperative learning model were later developed by David and Johnson (1999), Slavin (1978) and Kagan (1994). Cooperative learning is a model based on students learning the content by helping each other in small mixed groups. In this model, small heterogeneous groups of students work to achieve a common goal (Johnson and Johnson, 2018). Cooperative learning methods with certain principles and criteria have been developed since the 1970s, unlike traditional cluster studies (Ekinci, 2011). These methods are based on the principle of giving the responsibility of learning to the student and developing certain social relationships among the members of heterogeneous groups (Gök et al., 2009). Differences between cooperative learning methods originate from the arrangements made to increase the effect of the critical aspects of these methods, as well as issues such as the organization of the classroom (Sucuoğlu, 2003). The success of cooperative learning methods depends on some principles. These are the positive dependency, individual evaluability, supportive (or face-to-face) interaction, social skills, assessment of group process (Johnson and Johnson, 1998; Sharan and Sharan, 1994), equal opportunity for success, and group reward/common product (Açıkgöz, 2007) conditions. Although the conditions specified in the cooperative learning model are common, these methods differ from each other in terms of tasks, study, group competition and reward features. Slavin (1983) aimed to increase cooperation within a group by stating that the jigsaw method developed by

Aronson (1978) does not have a group goal and individual accountability. For this purpose, he added the features of expert groups taking a proficiency exam before returning to their original groups, forming a team score by combining the grades that students have received individually (Mattingly and VanSickle, 1991; Bayrakçeken et al., 2013; Scager er al., 2016) and rewarding the successful students at the end of the application (Slavin, 1991; Scager et al., 2016).

LITERATURE REVIEW

In the literature, the benefits of cooperative learning in terms of academic, social and psychological aspects, and measurement and evaluation in education have been reported. Cooperative learning increases students' academic success and improves their problem-solving, reasoning, and higher-level thinking skills. It increases the permanence of knowledge and ensures its transfer (Açıkgöz, 1992; Dori et al., 1995; Matthews et al., 1995; Johnson and Johnson, 1998; Doymuş et al., 2005; Özbuğutu, 2011; Crone and Portillo, 2013; Seyhan, 2017; Algani and Alhaija, 2021). Cooperative learning develops students' social skills such as responsibility, leadership, communication, group work, and solidarity. It increases students' interest and motivation towards the lesson and the school. It changes their negative attitudes towards learning (Webb, 1982; Lehr, 1984; Johnson and Johnson, 1989; Açıkgöz, 1992; Gömleksiz, 1993; Doymuş et al., 2005; Bayrakçeken et al., 2013; Alhebaishi, 2019; Veldman et al., 2020). It increases the morale and motivation of students and improves their self-esteem and self-confidence (Webb 1982; Şimşek et al., 2006; Kagan and Kagan, 2009; Bayrakçeken et al., 2013).

Receiving the support of administrators, school personnel and family during collaborative work ensures the creation of a positive learning environment. This positive environment helps students solve their economic, emotional and family problems (Kagan, 1994; Stevens and Slavin, 1995; Goodwin, 1999; Doymuş et al., 2004; Bayrakçeken et al., 2013). In the cooperative learning model, the use of individual, group, process and self-assessment in measurement and evaluation offers the opportunity to measure and evaluate success in multiple ways. Cooperative learning provides immediate feedback to the learner about their learning process and performance (Johnson and Johnson, 1987). It facilitates classroom management by allowing teachers to manage students as a group rather than individually (Slavin, 1992).

It is stated that in cooperative learning, the structuring of knowledge by the student, assigning the responsibility of learning to the student and the obligation of group members to develop products by taking joint responsibility is effective in the success of the student (Webb, 1980; Slavin, 1992; Açıkgöz, 2007). It is argued that increasing students' cognitive, psychological and social performance, minimizing their individual differences, establishing positive dependence and interaction among group members and creating a learning-oriented structure instead of racing logic are also effective in success (Webb, 1980; Slavin, 1992; Açıkgöz, 2007; Doymuş, 2008; Doymus et al., 2010). It is asserted that the fact that students have to comply with certain behaviors during cooperative group work is effective in the development of students' personal and social skills. During collaborative work, group members should accept different views. When there are conflicts between group members, it is expected that all members will positively resolve their conflicts of opinion with a common view. In this model, all students have to manage time, take appropriate action and encourage other members of the group to study and learn (Johnson et al., 1993; Kagan, 1994; Cohen, 1994; Stevens and Slavin, 1995; Johnson and Johnson, 1997; Goodwin, 1999; Doymuş et al., 2004).

When cooperative learning conditions are not adequately structured, some limitations arising from the teacher and the student emerge and cause the learning process to be inefficient (Buchs et al., 2017). From the teacher's point of view, teachers have problems in organizing collaborative activities such as creating groups, designing tasks suitable for group members, and managing and evaluating time (Gillies and Boyle, 2010). Some teachers do not pay enough attention to organizing collaborative activities such as setting group norms and facilitating group work (Ruys et al., 2011). Some teachers initiate group work without preparing students for productive collaboration (Blatchford et al., 2003). Teachers have difficulty in evaluating students' success and performance at the same time (Strijbos, 2011). The absence of assessment tools to measure the collaborative performance of each group member weakens learning (Strom and Strom, 2011). When the problems experienced by students are examined, while the group members are heterogeneous, some students may not participate as much as others in the group (Baker and Clark, 2010). The fact that some students do not manage time effectively or make the necessary preparations may reduce the effectiveness of the method that is being used (Gillies and Boyle, 2010). Giving the same grade to all group members may disturb some students (Alhebaishi, 2019). Students who do not believe in the benefits of cooperative learning may not participate actively in group work (Loh and Ang, 2020). The fact that teachers do not assign a specific role to each group member or that some students become dominant in group work may cause other students to see the process as a break from the lesson (Alhebaishi, 2019). For cooperative learning to be successful, it is important for teachers to control the classroom and to trust and believe that students will work together. Teachers should play the role of facilitators well in cooperative learning activities. The responsibility for learning should be left to the student, and student-centered environments should be created (Buchs et al., 2017).

For effective learning, students should be prepared for active cooperation (Janssen and Wubbels, 2018). It is important for teachers to provide effective group work and build group interaction on a strong level for the success of cooperative learning methods (Blatchford et al., 2003). When the cooperative learning process is not structured well, some group members share the success of the group without performing their own tasks (preparation effect). In this case, these students reduce the efforts of the other members (exploitative effect), successful students' self-development in social and cognitive aspects, gaining more benefit from the work done by taking roles such as leadership (the rich get richer), and the students who are good in the group manage the group according to their own wishes by ignoring the suggestions and explanations of the low-achieving passive students (mixing responsibility) (Açıkgöz, 1992).

Students with individual differences in cooperative learning have to work in collaboration in line with their abilities and skills for the determined academic and social goals. This is because each group member is responsible not only for their own learning but also for the learning of the other members of the group (Johnson and Johnson, 1991; Johnson et al., 2000). The aim of education is for students to achieve all targeted outcomes. For this reason, if there is a structure that prevents students from learning all subjects equally in the jigsaw II method, learning objectives may not be achieved no matter how effective cooperation is provided.

Although there are studies on the limitations of cooperative learning in the literature, studies on the functionality of cooperative learning conditions and the extent to which group members learn each other's subjects are considered insufficient. In the jigsaw II method, examining the level of learning of each other's subjects by the members who are experts in different subjects in the group can provide an idea about not only the success of the method but also the operability or adequacy of the cooperative learning conditions. Determining whether the students have learned all subjects adequately or not may offer ideas for developing some precautions to be taken. As a matter of fact, in some studies, it is stated that collaborative work is a waste of time and prevents individual success. It is suggested that a student who thinks that those who do not make enough effort in the group are rewarded as much as other working students have a negative attitude towards collaborative work and does not participate in group work. Nevertheless, when the distribution of tasks to students with different interests and academic achievements is made, the debate continues whether all these students participate in group work at the determined time and on the same level and whether the success of the group is due to the efforts of the hardworking students (Berliner and Glass, 2014). Such situations may prevent the achievement of the targeted outcomes and success with the application of the method. For this reason, the extent to which students participate in collaborative work and how well they learn subjects other than those within their own learning and teaching responsibility may also be an indicator of the success of the method.

Objective

This study will be effective in determining the extent to which each student learns the subjects of the other members of the group they are in for practices of the jigsaw II method and predicting the level of their participation in group work. This way, the study will shed light on the studies about increasing the success and effectiveness of the method. This study aims to evaluate the effectiveness of the jigsaw II method by comparing the academic achievements of students in the method between the subjects they are experts in and those they are not experts in. For the objective of this study, answers to the following questions were sought:

- Is there a significant difference between the pretest and posttest scores of jigsaw groups on specialization subjects?
- Is there a significant difference between the mean success levels of jigsaw groups on the subjects they are experts in and those they are not experts in?

METHOD

Design

In the study, the pretest posttest experimental design without a control group, which is a quantitative research method, was used. In this design, an independent variable is determined for a randomly selected group (Karasar, 2012). In this model, which does not have a control group, a pretest is given to the sample before the experimental process starts, and their success before the experimental process is determined. After the experimental process is finished, the same test is given to the same groups as a posttest. The effect of the experimental procedure is evaluated according to the difference between the results of these two tests. It is a more convenient, useful and effective design than the posttest-only design without a control group, in which a pretest is not used. A quasi-experimental design without

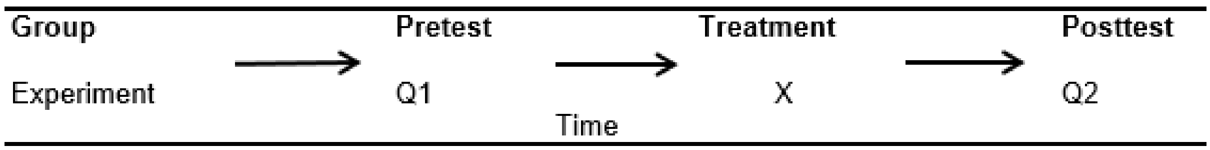

Figure 1. One-group pretest-posttest design. Q1: Pretest for the experimental group; Q2: Posttest for the experimental group; X: Jigsaw Method.

a control group was used in the study since the study included a class on the 7th-grade level during the application period. The experimental design of the research model is shown in Figure 1.

Participants

The sample of the study consisted of a total of 24 students, 15 boys and 9 girls, studying at a middle school in the Rize province of Turkey in the second semester of the academic year of 2019-2020. The simple random sampling method was used in the selection of the sample. In simple random sampling, the researcher selects the participants who will be the representatives of the population for the sample (Creswell, 2012). In the process of assigning the students to cooperative learning groups, heterogeneous groups were formed by considering the academic achievement and gender characteristics of the students in the sample due to the nature of cooperative learning. In the formation of heterogeneous groups, the exam grades of the students in the social studies course and their genders were taken into account. After the students forming the jigsaw groups were determined by impartial assignment, a Science, Technology and Society Academic Achievement Test was applied in all groups, and it was seen that there were no significant differences between the scores of the jigsaw groups that were formed before the experimental implementation.

Data collection tool

The "Science, Technology and Society Achievement Test" that was used in the study consisted of a total of 20 questions, 5 for each specialization, by paying attention to the subject distribution of the learning field. While preparing for the test, dissertations, academic articles and high school transition, exam preparation books and textbooks were utilized. Since each student in each main group was assumed to be an expert in a different subject, an equal number of questions was prepared from all dimensions of the achievement test. The subjects of the learning field of science, technology and society are divided into four topics. These topics are as follows:

1. From clay tablets to smart tablets
2. Pioneers of science
3. Every innovation is a contribution to our future
4. Contribution of free thinking to science

In order to develop the achievement test, a pool of 50 questions with 4 response options each was created first. Afterward, these questions were presented for the opinions of a group of experts consisting of 3 faculty members in the field of social studies education and 1 faculty member in the field of educational sciences to be examined in terms of content, language and objectives. In line with the opinions of the experts, the number of questions was reduced to 32. Then, the test was applied to 50 8th-grade students at the school where the study was conducted. The reliability coefficient of this test was found to be 0.73. Twelve items with a discrimination coefficient smaller than 0.20 were removed from the test, for which item analyses were performed. The item discrimination index and item difficulty levels of the remaining 20 questions of the test were calculated. The reliability coefficient (Cronbach's Alpha) of the test was found to be 0.85. This test was applied to the sample as a pretest before the experimental procedure and as a posttest after the procedure.

Instruments and procedure

The following process was followed in the implementation of the study:

First of all, the subjects to be covered by the teaching implementations that would last for 6 weeks were determined. The working rules to be followed in cooperative learning, the roles of the main group and expert group members, the work to be done and the evaluation processes were explained to the sample. The Science, Technology and Society Achievement Test was applied to the sample as a pretest. The 24 students in the sample were divided into 6 heterogeneous main groups of 4, taking into account their academic achievement levels and genders. The main groups were given the codes A, B, C, D, E and F, and each group member was numbered. In this study, since the achievement levels of students who were considered experts in different subjects were compared, as opposed to the case in other jigsaw studies, the main groups were given codes and numbers, and the expert groups were given both codes and names. The names of the expert groups were chosen from words that would remind them of the subject they would be experts in.

The experts in charge of the “clay tablets to smart tablet” subject were denoted as the “Tablet Group”, those in charge of the “Pioneers of Science” subject were named the “Science Group”, those in charge of “Every innovation is a contribution to our future” were called the “Innovation Group”, and those in charge of “Contribution of free thinking to science” were called the “Freedom Group”. Considering the integrity of the subject and achievement, the "science, technology and society" learning area was divided into 4 topics and distributed to the group members by the group leaders for research, learning and teaching to other group members. The members with the same codes in different groups dealt with the same topics. After the main group members researched and studied their own subjects for a week, in the second week, 4 expert (Jigsaw) groups with 6 students were formed by bringing together the students from the other main groups who were assigned the same subject in the class. The experts created a topic report for a week by working in-depth and discussing various sources related to the topic. Before returning to their original groups, the expert groups took a proficiency exam on their expertise. The experts, who returned to their main groups in the 3rd week, explained their subjects to the other members of the main groups in order of subject and instructed them to discuss the subjects like a teacher. In the main groups, a different chairperson was determined each week. The learning of all topics in the main groups continued for 4 weeks. In the last week, the participants presented the lesson report they prepared in the main groups to the whole class in 15 minutes. At the end of the 6th week, the Science, Technology and Society Achievement Test, was applied again to the students as a posttest. At the end of the process, the scores of the groups were announced to the class. Ten points were added as progress points to the groups with students who had improved their previous performance. The name of the group with the highest score was hung on the classroom board, and the students in the group were rewarded. The schemes of the main groups and expert groups are given in Figure 2.

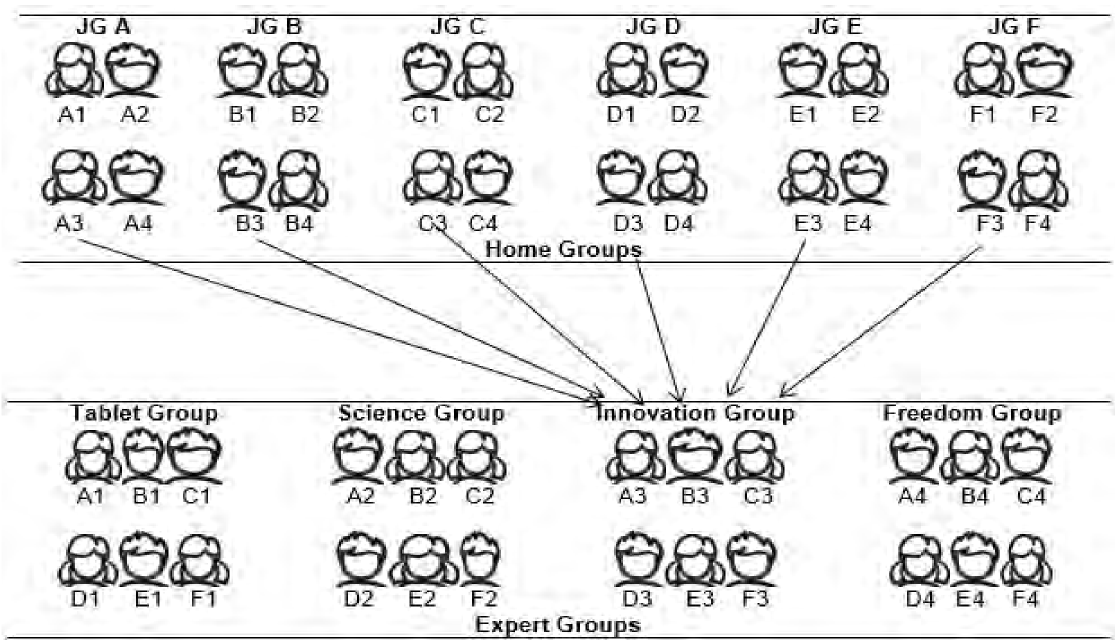

Figure 2. Jigsaw method learning groups.

Data analysis

Examining the assumptions and providing the assumptions before the data are analyzed is also proof of the validity of the analysis results. It is stated that in case of the violation of one or more assumptions, the reliability and validity of the analysis results decrease significantly, and in cases where the distribution deviates from normal, statistical inferences are erroneous. Non-parametric tests can be used in cases where parametric test assumptions such as normality, independence, homogeneity, sphericity, linearity and multicollinearity are not required or provided (Field, 2009; Stevens, 2009). Whether the data are normally distributed or not is determined by Kolmogorov-Smirnov and Shapiro Wilk tests. In cases where the number of people in a sample is greater than 50, the Kolmogorov-Smirnov test is used to check the normality of the distribution of the data, whereas the Shapiro-Wilk test is used for cases where this number is smaller than 50 (Saruhan and Özdemirci, 2011; Büyüköztürk, 2012; Demir et al., 2016). In the analysis of the data obtained within the scope of this study, first of all, the normality of the distribution of the data over the dimensions of the test was examined with "Shapiro-Wilk test", and the homogeneity of the variances was examined with "Levene's Test of Homogeneity of Variances". The results of the normality analyses of all dimensions of the test are given in Table 1.

Table 1 shows that the pretest and posttest data of the sample were not normally distributed ($p < 0.05$). As a result of the Levene's Test performed to test the homogeneity of group variances, the variances in the "from clay tablets to smart tablets" dimension for the pretest ($L = 0.219$; $p = 0.882$) and posttest ($L = 0.74$; $p = 0.973$), the "pioneers of science" dimension for the pretest ($L=0.625$; $p = 0.607$) and posttest ($L = 1.447$; $p = 0.259$), the "every innovation is a contribution to our future" dimension for the pretest ($L = 2.571$; $p = 0.083$) and posttest ($L = 2.227$; $p = 0.117$) and the "contribution of free thinking to science" dimension for the pretest ($L = 0.822$; $p = 0.497$) and posttest ($L = 1.567$; $p = 0.229$) were homogeneous ($p > 0.05$).

As a result of the analysis, it was determined that the scores obtained by the participants in the test provided homogeneity in all dimensions of the test, but they did not fulfill the normality assumption. Since the parametric test assumptions could not be met, the significance of the difference between the pretest and posttest scores of the groups was examined with Wilcoxon Signed-Rank Test, which compares two means belonging to the same sample. Kruskal-Wallis H Test was used to test the significance of the difference between the mean values of three or more groups in unrelated measurements (Kalaycı, 2010). Mann-Whitney U test was used to determine between which groups the significant difference was found as a result of the Kruskal-Wallis H test (Miller, 1981). This test is a test of differences between two independent groups for data that are measured continuously (Kalaycı, 2010). In all cases, a significance level of 0.05 was assumed. The Statistical Package for the Social Sciences (SPSS 22.0) was used for all statistical analyses.

Table 1. Normality test results of the pretest and posttest scores of the sample.

Test	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Tablet Group pretest	.321	24	.000	.728	24	.000
Tablet Group posttest	.183	24	.037	.915	24	.046
Science Group pretest	.358	24	.000	.637	24	.000
Science Group posttest	.250	24	.000	.890	24	.013
Innovation Group pretest	.395	24	.000	.735	24	.000
Innovation Group posttest	.271	24	.000	.859	24	.003
Freedom Group pretest	.291	24	.000	.788	24	.000
Freedom Group posttest	.235	24	.001	.879	24	.008

a. Lilliefors Significance Correction.

RESULTS

In this section, the results of the analyses of the data collected in line with the research questions are presented through tables and plots.

Pretest and posttest results of the sample in the dimensions of the test

Whether there was a significant difference between the pretest and posttest results of the students in the sample in the dimensions of the Science, Technology and Society Achievement Test was examined with Wilcoxon Signed-Rank Test, and the results are given in Table 2.

As seen in Table 2, as a result of the Wilcoxon Signed-Rank Test, statistically significant differences were found between the pretest and posttest scores the students obtained in the dimensions of "clay tablets to smart tablets" ($z = -4.304$, $p < 0.05$), "pioneers of science" ($z = -3.992$, $p < 0.05$), "every innovation is a contribution to our future" ($z = -4,044$, $p < 0.05$) and "contribution of free

Table 2. Wilcoxon signed-rank test results of pretest-posttest scores related to the dimensions of the science, technology and society achievement test.

Dimensions of the test	Posttest-Pretest	n	Mean rank	Sum of ranks	z	p
	Negative ranks	0	0.00	0.00		
From clay tablets to smart tablets	Positive ranks	23	12.00	276.00	-4.304	.000*
	Equal	1				
	Negative ranks	0	0.00	0.00		
Pioneers of science	Positive ranks	20	10.50	210.00	-3.992	0.000
	Equal	4				
	Negative ranks	1	9.00	9.00		
Every innovation is a contribution to our future.	Positive ranks	21	11.62	244.00	-4.044	0.000
	Equal	2				
	Negative ranks	0	0.00	0.00		
Contribution of free thinking to science	Positive ranks	23	12.00	276.00	-4.311	0.000
	Equal	1				

* $p < 0.05$.

thinking to science" ($z = -4.311$, $p < 0.05$). Regarding the mean ranks and sums of the differences, it was seen that these observed differences were in favor of the positive ranks, that is, those in the posttest results. This result showed that the test scores of the sample increased significantly after the application of the experimental procedure.

In the analysis of the data collected in regard to the second research question, the Kruskal-Wallis H test, which is a non-parametric test, was used because the means of the groups did not show a normal distribution. Mann-Whitney U test with Bonferroni correction was applied in the pairwise comparisons to determine between which groups the significant differences determined as a result of the analysis were. The Kruskal-Wallis H test results for the "from clay tablets to smart tablets" dimension of the Science, Technology and Society Achievement Test results of the expert groups are given in Table 3.

As shown in Table 3, there was no significant difference between the pretest scores of the expert groups in the "from clay tablets to smart tablets" dimension of the Science, Technology and Society Achievement Test [χ^2 (3) = 0.483; p = 0.923; p > 0.05], whereas a significant difference was found between their posttest scores [χ^2 (3) = 8.858; p = 0.031; p < 0.05]. To identify the source of this difference among the groups, Bonferroni-corrected Mann-Whitney U tests were performed on the pairwise combinations of the groups. As a result of these tests, it was seen that there was a significant difference between the Tablet Group and the Innovation Group in favor of the Tablet Group. Additionally, no significant difference was observed between the other groups. According to the mean ranks of the groups, it was determined that the Tablet Group was more successful than the other groups in the "from clay tablets to smart tablets" dimension of the achievement test.

The results of the Kruskal-Wallis H test for the "pioneers of science" dimension of the Science, Technology and Society Achievement Test scores of the expert groups are given in Table 4.

As seen in Table 4, there was no significant difference between the pretest scores of the expert groups in the "pioneers of science" dimension of the test [χ^2 (3) = 1.835; p = 0.607; p > 0.05], while a significant difference was found between the posttest scores [χ^2 (3) = 10.699; p = 0.013; p < 0.05]. Bonferroni-corrected Mann-Whitney U tests were performed on the paired combinations of the groups to determine which groups the observed difference was in favor of. As a result of these tests, it was determined that there was a significant difference between the Science Group and the Tablet, Innovation and Freedom groups in favor of the Science Group. According to the mean ranks of the groups, the Science Group was more successful than the other groups in the "pioneers of science" dimension of the test.

The Kruskal-Wallis H test results for the scores of the expert groups in the "every innovation is a contribution to our future" dimension of the Science, Technology and Society Achievement Test are given in Table 5.

As seen in Table 5, there was no significant difference between the pretest scores of the expert groups in the "every innovation is a contribution to our future"

Table 3. Kruskal-Wallis H test results on the “from clay tablets to smart tablets” dimension of the test for the pretest-posttest scores of the expert groups.

Achievement test	Groups	N	Mean rank	df	χ^2	p	Significant Difference
Pretest	Tablet	6	12.00	3	0.483	0.923	
	Science	6	12.00				
	Innovation	6	14.00				
	Freedom	6	12.00				
Posttest	Tablet	6	18.50				TG-IG
	Science	6	12.33	3	8.858	0.031*	
	Innovation	6	6.83				
	Freedom	6	12.33				

*p<0.05 TG = Tablet Group, IG = Innovation Group.

Table 4. Kruskal-Wallis H test results on the “pioneers of science” dimension of the test for the pretest-posttest scores of the expert groups.

Achievement test	Groups	N	Mean rank	df	χ^2	p	Significant Difference
Pretest	Tablet	6	12.25	3	1.835	0.607	
	Science	6	12.25				
	Innovation	6	10.33				
	Freedom	6	15.17				
Posttest	Tablet	6	7.17	3	10.699	0.013*	TG-SG
	Science	6	19.33				SG-IG
	Innovation	6	13.17				SG-FG
	Freedom	6	10.33				

*p < 0.05, TG = Tablet Group, SG = Science Group, IG = Innovation Group, FG= Freedom Group.

Table 5. Kruskal-Wallis H test results on the “every innovation is a contribution to our future” dimension of the test for the pretest-posttest scores of the expert groups.

Achievement test	Groups	N	Mean rank	df	χ^2	p	Significant Difference
Pretest	Tablet	6	10.50	3	2.673	0.445	
	Science	6	12.25				
	Innovation	6	15.58				
	Freedom	6	11.67				
Posttest	Tablet	6	10.50				TG-IG
	Science	6	12.00	3	9.306	0.025*	SG-IG
	Innovation	6	19.17				IG-FG
	Freedom	6	8.33				

*p < 0.05, TG = Tablet Group, SG = Science Group, IG = Innovation Group, FG = Freedom Group.

dimension of the Science, Technology and Society Achievement Test [χ^2 (3) = 2.673; p = 0.445; p > 0.05], while a significant difference was found between the posttest scores [χ^2 (3) = 9.306; p = 0.025; p < 0.05]. Bonferroni-corrected Mann-Whitney U tests were performed on the pairwise combinations of the groups to determine which groups were favored in the observed difference. As a result of these tests, it was seen that there was a significant difference between the Innovation Group and the Tablet, Science and Freedom groups in favor of the Innovation Group. The mean ranks of the groups showed that the Innovation Group was more successful than the other groups in the "every innovation is a contribution to our future" dimension of the test.

The Kruskal-Wallis H test results for the scores of the expert groups in the "contribution of free thinking to science" dimension of the Science, Technology and Society Achievement Test are shown in Table 6.

As seen in Table 6, there was no significant difference between the pretest scores of the expert groups in the "Contribution of Free Thinking to Science" dimension of the Science, Technology and Society Achievement Test [χ^2 (3) = 2.342; p = 0.505; p > 0.05], while a significant difference was found between the posttest scores [χ^2 (3) = 7.855; p = 0.049; p < 0.05]. Bonferroni-corrected Mann-Whitney U test was performed on the paired combinations of the groups to determine which groups the observed difference was in favor of.

Accordingly, it was determined that there was a significant difference between the Freedom Group and the Tablet, Science and Innovation groups in favor of the Freedom Group. According to the mean ranks of the groups, the Freedom Group was more successful than the other groups in the "contribution of free thinking to science" dimension.

Table 6. Kruskal-Wallis H test results on the “contribution of free thinking to science” dimension of the test for the pretest-posttest scores of the expert groups.

Achievement test	Groups	N	Mean rank	df	χ^2	p	Significant Difference
Pretest	Tablet	6	9.58	3	2.342	0.505	
	Science	6	10.67				
	Innovation	6	10.67				
	Freedom	6	19.08				
Posttest	Tablet	6	9.58				TG-FG
	Science	6	10.67	3	7.855	0.049*	SG-FG
	Innovation	6	10.67				IG-FG
	Freedom	6	19.08				

*p < 0.05, TG = Tablet Group, BG = Science Group, IG = Innovation Group, FG= Freedom Group.

DISCUSSION

The findings that were obtained in this study showed that the jigsaw II method increased the academic achievement levels of the students in all four examined subjects of science, technology and society. It is stated in the literature that the jigsaw method increases the academic achievement of students and changes their attitudes towards the course positively (Johnson et al., 2000; De Baz, 2001; Doymuş, 2008; Karaçöp and Doymuş, 2013; Kılıç, 2008; Seyhan, 2017; Ilgaz and Çelen, 2017; Costouros, 2020). Nonetheless, the findings showed that the students with different specializations answered the questions related to their own subject in the Science, Technology and Society Achievement Test more accurately than the questions related to the other subjects. This result suggested that students study and learn better in the subjects of their expertise for which they are responsible to teach their groupmates. This result may be interpreted as that expert students cannot learn all subjects on the same level in the jigsaw II method, and there is a difference between students' learning levels in different subjects.

Additionally, it may be stated that some group members do not feel responsible enough to learn about subjects other than their own. However, in education, it is considered essential that students learn all subjects. Research has shown that when students with different interests, abilities, personalities, genders, learning styles and work ethics are forced to work together in a group, some difficulties may always arise (Aronson and Patnoe, 1997; Johnson and Johnson, 2008). It is explained that while some students are against working together at the beginning of a process, some may have a negative attitude towards working together after doubting the effectiveness of the process (Felder and Brent, 2007). It is stated that cooperative group work is rendered dysfunctional this way, thus limiting or eliminating the productivity to be achieved in working. Researchers have offered some recommendations to prevent or overcome the problems that may adversely affect the functionality of group work that arise during implementation of a teaching method. Such recommendations have included increasing the dependency on goals, resources, tools, roles and rewards in groups (Johnson et al., 1990; Smith, 1996; Johnson and Johnson, 2009; Burke, 2011; Chang and Brickman, 2018), determining the effect of each member's qualitative and quantitative achievements on group success together with their own success (Bayrakçeken et al., 2013), reducing the number of people in a group, having active students talk to passive students in the group and encouraging them, putting students who work well and students who do not work well in the same group (Cohen, 1994; Jacobs and Hall, 2002; Bayrakçeken et al., 2013), ensuring equal participation in learning processes (Cohen, 1994; Doymuş et al., 2004), distributing group members homogeneously in terms of language, race and gender (Jacobs and Hall, 2002; Gillies, 2016; Scager et al., 2016), and not sharing the available topics equally, teaching all targeted topics. For students who show avoidance, the teacher needs to be aware of the working strategies of the groups and guide the students when necessary (Slavin, 1983; Felder and Brent, 2007). It was also stated that students need to learn cooperation skills to work effectively with the other members of a group (Johnson and Johnson, 2009; Scager et al., 2016). In some studies, it was recommended to integrate cooperative learning into teaching systems with technology (Resta and Laferriere, 2007; Domalewska, 2014). It was emphasized that all these measures cannot guarantee the success of students, since it is difficult for teachers to provide positive dependency and individual accountability (Brush, 1998; Johnson and Johnson, 2009; Gilles, 2016).

These measures (rules) determined at the point of the effectiveness of cooperative learning can be effective in the success of the group and the individual, but they do not provide information on which targeted outcomes the group member has learned better or is lagging behind in. Teachers can observe group members who do not fully fulfill their duties during group work. They can oblige these students to participate in group work by giving individual grades in measurement and evaluation because the scores of these students affect the success of the other members of the group besides their own success. However, in the jigsaw II method, such students may not have the will and determination to learn subjects other than those assigned based on their own learning and teaching responsibilities. Therefore, revealing the level on which students learn subjects other than those of their own expertise will be effective in determining students' learning problems. In this context, there will be a need to find new solutions in the jigsaw II method to encourage students to learn subjects other than their field of expertise on a sufficient level. As a matter of fact, based on the findings in this study, it was understood that the jigsaw II expert groups partially learned subjects other than their specialization and neglected to learn some subjects. In light of these findings, it may be asserted that a systematic and objective basis should be determined for measures that should be taken to make the necessary and adequate effort for jigsaw II main group members to learn all subjects that are being taught. In the jigsaw II method, it is recommended that different studies be carried out to increase the success of expert groups in different subjects and increase the ability of the main group members to learn all subjects on the same level.

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