The Application of Group Investigation Technique: The Views of the Teacher and Students

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Abstract

This study aims to determine the views of the teacher and students views on a practice carried out by using group investigation technique of cooperative learning method. The study was conducted with 20 students at 8th grade at a public elementary school in Trabzon during the spring term of 2008-2009 school year. Case study research method was used in this study. Data were collected via informal interviews and observation forms. The data gathered from the interviews were analyzed and presented in tables and networks whereas observation data were given in tables. In the light of the data collected from this study; during the group study, the students enjoyed working in groups, found the group investigation technique useful, undertook several roles and moved from an individual to a cooperative stance in the group. Based on these results, group investigation technique is recommended to be used in secondary and higher education mathematics courses.

Key Words: Coperative learning, group investigation, teacher and student views

1. Introduction

Recently a new approach has been adopted which requires teaching the students how to access knowledge, how to approach a problem and how to find solutions rather than simply loading the students heaps of information. In order to convey this view numerous learning

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models and methods were developed (Tarım & Akdeniz, 2003). One of the most influential of those methods is cooperative learning (Doymuş, Şimşek & Bayrakçeken, 2004).

Cooperative learning is a process in which students congregate in small groups for solving a problem or accomplishing of an assignment or for a common goal to learn a subject matter (Artz & Newman, 1990). As implied in the definition, students work in groups in cooperative learning environment to reach a pre-determined common goal. The attainment of a group member automatically affects the other members to attain the goal or not (Doymuş, Şimşek & Bayrakçeken, 2004). For this reason, the performance of the students in cooperative learning environments should be assessed not individually but as the performance of the group (Yılmaz, 2001). The aim in cooperative learning is not to provide the students to complete the pieces of a task individually but rather to challenge all the members in the group and generate a common product (Çepni, Ayas, Ekiz & Akyıldız, 2008). Due to these characteristics, the activities performed in cooperative learning settings are far more different than the traditional cluster studies in which the students merely work together with peers, help each other and share learning materials.

Cooperative learning provides many advantages to students. Many of these advantages arise from the intrinsic motivational strengths of cooperative learning (Panitz, 1999). A review of the literature on cooperative learning shows that students benefit academically, socially, and psychologically from cooperative learning (Gillies, 2002). *Psychological benefits* include performing higher levels of performance (Bligh, 1998), and reducing test anxiety (Johnson & Johnson, 1989) and classroom anxiety (Kessler, Price & Wortman, 1985). *Academic benefits* include enhancing conceptual understanding, increasing achievement in mathematics (Aksoy, 2006; Artut & Tarım, 2007; Bowen, 2000; Johnson & Johnson, 1989; Johnson & Johnson, 1991; Leikin & Zaslavsky, 1997; Sharan, 1980; Slavin, 1990; Slavin, Madden & Leavey, 1984; Ross, 1995; Tarım, 2003; Tok, 2008; Webb, 1982) and acquiring higher level thinking skills (Webb, 1982). *Social benefits* include helping interactions with group members (Burron, James & Ambrosio, 1993; Gillies & Ashman, 1998), making more friends (Carlan, Rubin & Morgan, 2004), sustaining higher self-esteem (Johnson & Johnson, 1989), increasing involvement in classroom activities, improving positive attitudes toward learning (Lazarowitz, Baird & Bowlden, 1996; Lazarowitz, Hertzlazarowitz & Baird, 1994) and developing students' social interaction skills (Johnson, Johnson & Holubec, 1994) and oral communication skills (Yager, Johnson & Johnson, 1985).

Cooperative learning is important for every student. Different groups may be formed based on students' different skills, needs and learning styles and students may keep learning in these groups. Every student in a group should be allowed to interact with other students and share his / her tools, knowledge and skills. Furthermore, each group member is responsible for a part of the subject and they contribute to the group in all works related to the subject. When students are fulfilling the requirements of their roles, they try to accomplish their tasks with a sense of responsibility and expertise (Doymuş, Şimşek & Bayrakçeken, 2004). In cooperative learning activities, students undertake responsibilities

such as summarizing, supervising, investigating, providing source, recording, supporting, observing and leading (Johnson & Johnson, 1991). A teacher should undertake a role as organizing the environment, helping and supporting when needed. Moreover, the teacher is not only a source of knowledge and an absolute authority; but rather a coach, a guide or a counselor. These coaches should teach the students basic knowledge and skills, provide them with various exercises, and carefully observe the way and timing of how students constructed their learning (Şimşek, 2001).

Cooperative learning method includes many techniques. Some of these are Student Teams Achievement Divisions (STAD), **Group Investigation**, Jigsaw, Learning Together and Constructive Controversy (Özsoy & Yıldız, 2004). In the context of the aim of this study, detailed information was given only about the group investigation technique. According to Baki (2008), group investigation was defined as a learning process involving four fundamental stages. This technique consists of the stages of *determination of instructional goals, establishment of groups, implementation of the group investigation and evaluation of the group investigation*. These stages will be explained in detail in the data collection process section of this paper.

Many students are anxious in mathematics classes. In the traditional mathematics instruction, many students fear making mistakes. Competition leads the academically unsuccessful students to perceive themselves as defeated and insulted and also make them feel despised by their peers (Tarım & Akdeniz, 2003). Group investigation technique provides an environment that encourages safe-risk taking and that reduces mathematics anxiety and fear of making mistakes (Johnson & Johnson, 1989). Moreover, group work plays an important role in evaluation and development in secondary and higher education (Baki, 2008; Salend, Gordon & Lopez, 2002).

First of all, a large number of studies were conducted on cooperative learning at elementary, secondary and higher education levels both in Turkey and abroad. These studies investigated the effects of cooperative learning on academic success and attitude. It was reported in these studies that students were more successful in cooperative learning environments than they had been in traditional settings and they developed positive attitudes towards the subject. Recent studies on cooperative learning shifted focus from the effectiveness of cooperative learning to investigating cooperation mechanisms or the methods of increasing the effects of cooperative learning (Açıkgöz, 1990). The foreign studies (Carlan, Rubin & Morgan, 2004) were encountered in the literature. This study was found which collected students' views on cooperative learning. Although a number of tips were obtained related to some views regarding cooperative learning, the number of studies on this issue seems insufficient. Thus, more detailed studies are needed on cooperative learning in mathematics. In this respect, use of cooperative learning method in mathematics classes and revealing teachers' and students' views on this method are very important. For these reasons, the aim of this study is to determine teacher and students' views on a practice carried out by using group investigation technique of cooperative learning method. The subproblems are as follows:

1. What are the participants thinking about whether the group investigation technique is useful?
2. What kind of ideas do the participants have about individual and group studies?
3. What are the participants thinking about whether the group members are working cooperatively?
4. What kind of roles are the participants undertaking during the practice?
5. What are the overlapping and not overlapping aspects of the data gathered from observation forms and interview questions?

2. Method

Case study research method was used in this study. This research method seek to examine and explicate a single case related with a certain phenomenon in depth. This special case may be a person, an event, a group or an institution. Although case studies are commonly used in both qualitative and quantitative methods of research, in the qualitative studies, case study method deals with a single case, by investigating a limited number of subjects in a limited space and time (Çepni, 2007). In this process, the setting, individuals or processes are examined with a holistic approach and the roles and associations in this process are on the focus. Moreover, since case studies benefit from more than a single data collection tool, a rich and inter-supportive variety of data are provided (Yıldırım & Şimşek, 2005).

2.1. Participants

The participants of this study were 20 pupils at 8^{th} grade attending a elementary school in Trabzon and the mathematics teacher of this school. The mathematics teacher had five years of experience. Most pupils came from middle-class families. Approximately 50% of the pupils was girls (12 boys, 8 girls, average age 13 years).

2.2. Data Collection Tools

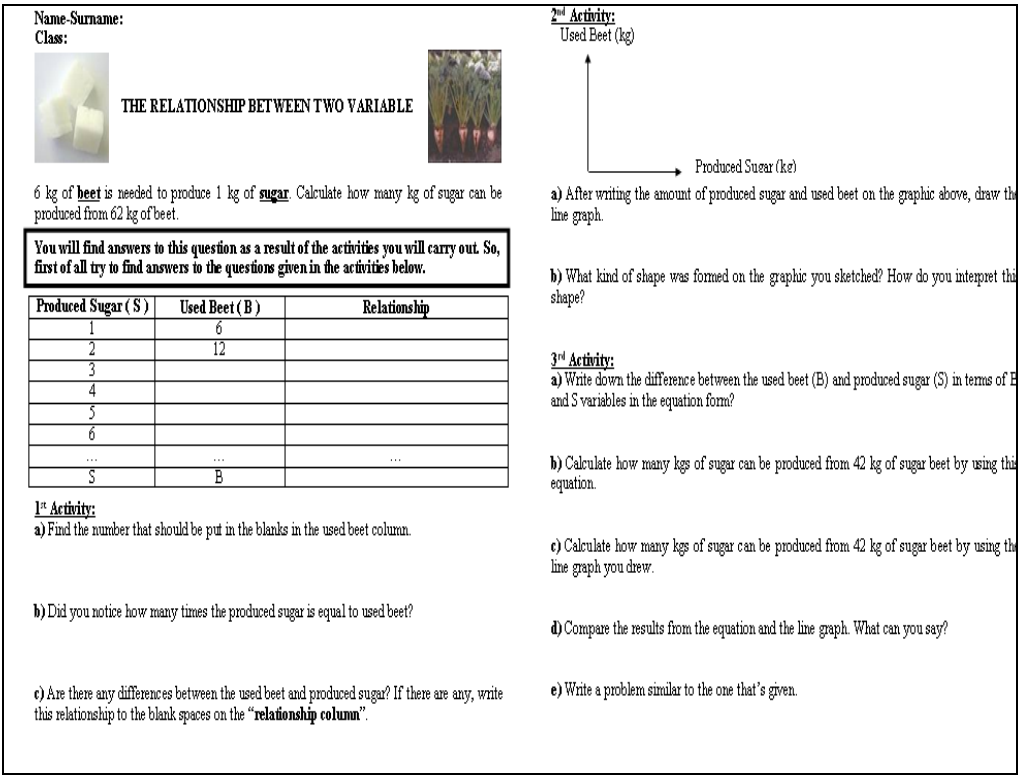
More than one data collection tool were resorted to in this study to elucidate data with different nature. According to the aim of this study, a document was developed to enable the students to comprehend the importance of the study and three worksheets were developed to allow the students to work together. Furthermore, informal interviews were conducted, and teacher and student observation forms were prepared for the views of the teacher and students.

2.2.1. Worksheets

In this study, three worksheets were developed. The first worksheet named **"The Relationship between Two Variables"** consists of the question "*6 kg of **beet** is needed to produce 1 kg of **sugar**. Calculate how many kg of sugar can be produced from 62 kg of beet."* and 10 other questions related to this question. The second worksheet named **"The Distance between Two Points"** consists of the question *"A moving object is starting its*

course at point A with a velocity of 120 km/per hour and another object is starting its course from point B at the ***same time, in the same direction*** *and they meet at point C. If the moving object starting from point A meets with the other moving object at point C, 5 hours after the start, then how far is point A from point B?"* and 10 questions related to this question. The third worksheet is named "**Mathematics without X**" and consists of 10 questions related to the question *"Two towers with heights 40 and 30 steps respectively are 50 steps far away from each other. How far should the food be located from the first tower, for two birds, one on each tower, to start flying at the same time and reach to a light source on the ground at the same time? (take the speeds of the birds as equal)"*

The worksheets were prepared considering the student attainments in the 8th grade, the pre-existing knowledge of the students about these concepts and the views of the teacher. Developed worksheets were then examined by two mathematics educators and two mathematics teachers. Teachers and academicians confirmed that the worksheets may appropriately serve the aim of the study. The worksheet named "**The Relationship Between Two Variable**" is given below.



Name-Surname:
Class:

THE RELATIONSHIP BETWEEN TWO VARIABLE

6 kg of **beet** is needed to produce 1 kg of **sugar**. Calculate how many kg of sugar can be produced from 62 kg of beet.

You will find answers to this question as a result of the activities you will carry out. So, first of all try to find answers to the questions given in the activities below.

Produced Sugar (S)	Used Beet (B)	Relationship
1	6	
2	12	
3		
4		
5		
6		
…	…	…
S	B	

1st Activity:

a) Find the number that should be put in the blanks in the used beet column.

b) Did you notice how many times the produced sugar is equal to used beet?

c) Are there any differences between the used beet and produced sugar? If there are any, write this relationship to the blank spaces on the "**relationship column**".

2nd Activity:

Used Beet (kg)

Produced Sugar (kg)

a) After writing the amount of produced sugar and used beet on the graphic above, draw the line graph.

b) What kind of shape was formed on the graphic you sketched? How do you interpret this shape?

3rd Activity:

a) Write down the difference between the used beet (B) and produced sugar (S) in terms of B and S variables in the equation form?

b) Calculate how many kgs of sugar can be produced from 42 kg of sugar beet by using this equation.

c) Calculate how many kgs of sugar can be produced from 42 kg of sugar beet by using the line graph you drew.

d) Compare the results from the equation and the line graph. What can you say?

e) Write a problem simular to the one that's given.

Figure 1. The worksheet named **The Relationship Between Two Variable**

2.2.2. Let's Learn Together Document

Considering the studies of Johnson and Johnson (1991) and Şimşek (2001), and the views of field experts, the document named "**Let's Learn Together"** about the importance of field work and how to work together was developed. There are total 11 items such as *"When you can not understand a question or an explanation, demand new explanations from your friends.", "If you really do not want, do not be compelled to change your ideas to conform with the majority of the group. Share your ideas clearly and do not attempt to persuade your friends.", "Do not criticize people, but criticize their ideas during group discussions. For example, rather than statements such as You know nothing, You speak stupid, use more positive expressions such as I could not understand, Can you explain please?."* and two pictures in this document describing the importance of cooperative learning. The document named "**Let's Learn Together"** is given in Figure 2.

- I am here to help you.
- When you are faced with a difficulty, please call for help.
- Success and failure apply for all of us.

Read the sentences below and when you're working in a group with friends, do not forget how important these sentences are.

1) When you can not understand a question or an explanation, demand new explanations from your friends. **2)** Check the accuracy of your own answers and the answers of others with the materials or texts in your hand. **3)** Agree or disagree what you hear, do not interrupt one's speech and wait until his/her speech finishes. **4)** If you really do not want, do not be compelled to change your ideas to conform with the majority of the group. Share your ideas clearly and do not attempt to persuade your friends. **5)** When you do not agree with an opinion of your friend, state this without hurting him/her. Do not be always inharmonious for the sake of defiance. **6)** Do not criticize people, but criticize their ideas during group discussions. For example, rather than statements such as "**You know nothing**", "**You speak stupid**", use more positive expressions such as "**I could not understand**", "**Can you explain please**?".	**7)** You can object to a shared idea but instead of using expressions such as "**Absolutely wrong**", "**How can you say that**?", "**I've never heard such a stupid thing**", prefer using expressions such as "**Yes, it can be valid for different cases, but let's take it that way once …", "and what about…?"** **8)** Do not forget that you can share all your ideas with your friends. Explain your ideas by using expressions such as "**How do you find this idea**?", "**Do you agree with this idea?"** **9)** Remember that in case of success, the amount of benefit will affect both the group and the individual and if your friends in the group fail, it will affect the group at the same time. **10)** Do not forget that one can be a football player worth millions of dollar but if the team drops on his/her own the value of a player will not be important. **11)** During the group studies, do not forget the questions such as "**How did we succeed?", "What are the characteristics that make us successful?", "What were the problems that made us unsuccessful?"**.

Figure 2. The document named **Let's Learn Together**

2.2.3. Informal Interviews

In order to determine the views of the teacher and the students about cooperative learning, informal interviews were conducted after the application. To use in these interviews for exploring the teacher and students views about cooperative learning, four questions were prepared by the help of experts. The interviews were conducted in the library of the school with the teacher individually, and with the students in groups of four. Group interviews were conducted with students because group interviews create a discussion environment which may foster diverse ideas, provide students with opportunities to test and improve their ideas through the ideas of their friends and gather individuals from different backgrounds (Çoştu, 2002). The group interviews were conducted in the school library at different times. The interviews were made in one week. Each interview took about 30-40 minutes.

2.2.4. Observation Forms

In order to observe the reflections in the established cooperative learning environment, observation forms developed by Baki (2008) and Şimşek (2001) were used. Additionally, evaluation forms of cooperative skills comprising 15 items each were developed consulting two field experts. There are similar items in these two forms. There are some items in the observation forms prepared for teachers and students related to volunteering for the study, expressing opinions clearly, giving recommendations, actively participating in discussions, fulfilling responsibilities, demonstrating a good performance, acting together, helping group members, respecting others' views, being unbiased, doing constructive evaluation, warning positively, outlining what's discussed, celebrating others, respecting individual differences and working in cooperation". Observation form prepared for students is given in Figure 3.

Dear Students

The aim of the evaluation form below is to determine the contribution of each member and of you to the study. When evaluating yourself and your friends, try to be **objective, fair, consistent and realistic**. Please read the sentences below and mark an X in the boxes next to the sentences you think most appropriate about you and your friends. If you think your friend does not do the action expressed, leave the relevant box blank.

	Names of Group Members			
Observation Form Items				**You**
1. Showed eagerness to group work.				
2. Engaged in group discussions actively.				
3. Worked in cooperation with teammates.				
4. Restated and summarized what was said.				
5. Behaved positively while warning others.				
6. Moved in harmony with group members.				
7. Shared views with other group members clearly.				
8. Demonstrated a good performance in group work.				
9. Showed respect to the views of other group members.				
10. Showed respect to cultural and individual differences.				
11. Provided individual assistance to group members in need.				
12. Accomplished individual responsibilities during group work.				
13. Made recommendations in group study and expressed useful ideas.				
14. Celebrated other group members when they made big contributions.				
15. Assessed the contributions of other group members positively and without prejudice.				

Figure 3. Cooperative skills evaluation form for students

2.3. Data Collection Process

While the worksheets were used as instructional material, the four steps of group investigation technique developed by Baki (2008) were applied. Some properties of the steps followed during the implementation of the study of the developed instructional materials and the actions meanwhile may be summarized as follows:

2.3.1. Determination of Instructional Goals

Firstly, academic and social skills falling under the scope of this study were determined by the researchers by reviewing the literature. Students' both academic **(a)** Examines the linear relationship between two variables by using table and graphics, explains how a variable changes in terms of the other, **b)** Uses the equation in solving the problem.) and social skills (**a)** Reflects thoughts and ideas, **b)** Provides individual assistance to group members in need, **c)** Works in cooperation with teammates, **d)** Shows eagerness to group work, **e)** Shows respect to the views of other group members.) are fostered in group work. Therefore, social skills should not be neglected while emphasizing academic skills. Social aims such as acquiring personal communication skills and group skills are as important as the academic aims such as developing positive attitude towards mathematics and problem solving. Only social skills were addressed within the scope of this study.

2.3.2. Establishment of Groups

The classrooms in Turkey are in traditional style. Since this case did not enable cooperative working, teacher moved the desks from rows to groups and began implementing cooperative learning. Before cooperative learning method was applied to all the class, it had been thought that the group size would consist of four students because previous studies indicate that threesome or foursome groups operate better (Davidson, 1990). Additionally, various studies suggest that establishing heterogeneous groups would be more useful in helping students gain academic and social skills (Gillies, 2002; Leonard, 2001). For this reason, the groups were attempted to be heterogeneous. These heterojen groups were formed by considering the first exam scores of the students in spring term, their social abilities and sexes. After separating the students to groups, they were told that they would learn maths lessons in their own groups and their work did not matter without their groups. Lastly, groups were told to find a group name.

2.3.3. Implementation of the Group Investigation

At this step, firstly the document named **"Let's Learn Together"** was distributed to the students. Each student read this document individually and a small class discussion was brought about on the content of this document. The students were first given the worksheet named **"The Relationship between Two Variables"**, then the second worksheet named **"The Distance between Two Points"** and lastly, the third worksheet named "**Mathematics without X**". Worksheets were answered by the students in groups of four. Solving the worksheets in groups lasted four class hours. The teacher was presenting the knowledge

directly and students were passively listening to him / her prior to establishing a cooperative learning environment. During the group investigation, the teacher walked among the groups and gave timely feedbacks. In order to provide full attendance, a number of warnings was made by the teacher when necessary.

2.3.4. Evaluation of the Group Investigation

In the fourth class hour, first a group discussion and then a whole class discussion were held. In the group discussions, several questions were directed at the students such as: "**What did you learn today?", "What is your contribution to the study?", "Why did you fail/succeed?" and "Which activities were useful and which were not?"**. Besides, every group presented their solutions to the class. At the end of the lesson, "**Evaluation Form of the Cooperative Skills of Students**" was distributed for the students to evaluate their group peers. In the meantime, the teacher filled in the "**Cooperative Skills Evaluation Form for Teacher**". Finally, the students were asked to write their feelings and opinions about the activities carried out in the context of cooperative learning.

2.4. Data Analysis

Content analysis method was used in this study to analyze data of the interview. A proper coding scheme was developed because an operational order is recommended during content analysis (Kishore, Agrawal & Rao, 2005). Then the codes were generated by the researchers. In order to maintain the reliability of the coding process, the two researchers coded the teacher interview transcript independently. The reliability was calculated with the formula Reliability = Consensus / (Consensus + Dissidence) and reliability was found a high value as 0.89 (Miles & Huberman, 1994). The codings on which a disagreement aroused were discussed again. With this discussion, a compromise was provided on many codes. As a result of the comparisons, by making use of the themes created by common codings, the results were presented in tables and networks. The codings on which a disagreement aroused were discussed again. With this discussion, a compromise was provided on many codes. As a result of the comparisons, the results were presented in tables and networks, by making use of the themes created by common codings. Moreover, only a small portion of the answers of the students and the teacher to the questions that was found to be unique was directly presented.

In the analysis of the observation forms, the items checked by the teacher regarding the students and the items checked by the students regarding themselves and their friends were collected in one observation form. By using this observation form, The total number of items checked by the teacher regarding the students and the items checked by the students regarding themselves and their friends were calculated.

3. Findings

At this section, the data gathered from the interviews were presented in tables and networks, whereas observation data were given in tables.

3.1. Findings Regarding Whether the Group Research Method was Useful or not

The teacher and the students were asked whether they found the group study useful and findings obtained were given in Table 1.

Table 1. The benefits of group study according to the teacher and the students

		Teacher and Groups						
		T	G 1	G 2	G 3	G 4	G 5	f
Finding Group Study Useful or not	Finding useful	1	4	4	4	4	4	21
Pattern Codes	Codes	T	G 1	G 2	G 3	G 4	G 5	f
The Academic, Social and Psychological Reasons for the Finding Group Study Useful	Making the knowledge more meaningful	1	1	3	3	3	1	12
	Enjoying the study more	1	2	1	2	1	4	11
	Learning new information	1	3	2	1	1	2	10
	Knowledge exchange	1	3	1	1	1	1	8
	Noticing and fixing the mistakes	1	1	1	2	2	1	8
	Being sure of the accuracy of the results	1	1	1	2	1	1	7
	Increasing success	1	1	1	1	1	1	6
	Feeling better	1			2	1	1	5
	Learning working together	1	1	1			1	4
	Refreshing / revising knowledge	1			1	1		3
	Solving the questions easier	1				1	1	3
	Sharing different opinions	1		1				2
	Knowing the friends better	1						1
	Gaining listening skills	1						1
	Learning to respect others	1						1

When we examine Table 1, it can be seen that teacher and all students found group research useful and the views of the participants regarding the usefulness of group research were found to fall under academic, social and psychological benefits. According to the results in Table 2, 50-60% of the students stated the codes of "*Making the knowledge more meaningful*", "*Enjoying the study more*" and "*Learning new information*". This shows that these three codes regarding the benefits of group work stand out. As a consequence, Table 1 shows that group work was found useful.

3.2. Findings Regarding Individual and Group Work

Teacher and students were asked about their views on individual and group work and the obtained findings were presented in Table 2.

Table 2. The reasons why the teacher and the students preferred group study

		Teacher and Groups						
		T	G1	G2	G3	G4	G5	f
Individual or Group Study	Preferring working in groups	1	4	4	4	4	4	21
	Preferring working individually	1	1	1				3
Pattern Codes	Codes	T	G1	G2	G3	G4	G5	f
Reasons for Individual or Group Study	Providing time economy			1				1
	Not confusing the knowledge		1					1
Pattern Codes	Codes	T	G1	G2	G3	G4	G5	f
The Academic, Social and Psychological Reasons of Working in a Group	Expressing ideas about questions better	1	4	4	1	4	1	15
	Consulting other group members	1	1	2	2	1	1	8
	Providing more permanent knowledge	1	1	1	1	2	1	7
	Catching different points about a question	1					1	2
	Increasing self-confidence	1		1				2
	Creating a common synergy / power						1	1
	Providing efficient working		1					1
	Realizing skills	1						1
	Developing sense of responsibility	1						1

When Table 2 is examined, it can be seen that the teacher and two of the students preferred both individual and group works, whereas the other students preferred only group work. Moreover, the participants' views on preferring group work were found to fall under academic, social and psychological reasons. It was determined that the reasons why some students preferred individual work were codes such as *"Providing time economy"* and *"Not confusing the knowledge"*, and the reasons why some students preferred group work were codes such as "*Expressing ideas about questions better", "Consulting other group members"* and "*Providing more permanent knowledge"*. Also, the reasons why some of the hardworking students preferred both group study and individual study were determined.

The data regarding the question *"Do you prefer working alone or in a group? Why?"* directed at the teacher and the students are explained with the network shown in Figure 4. The network made regarding the benefits of group investigation according to the teacher and the students is given in Figure 4.

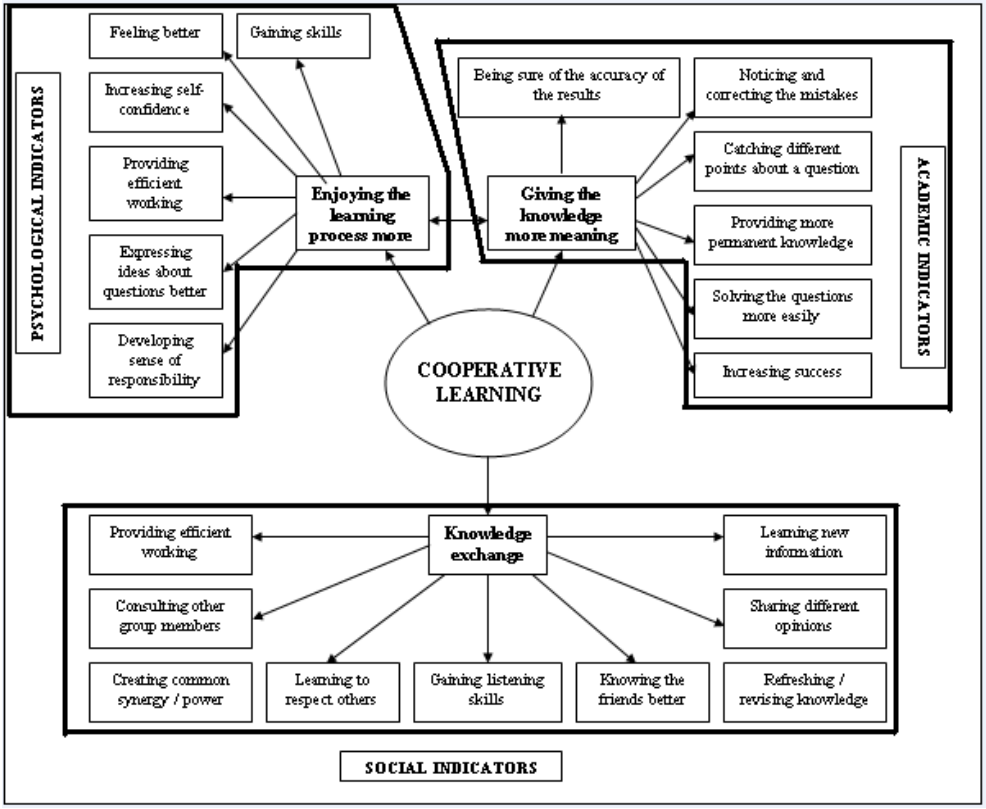


Figure 4. The network regarding the benefits of group investigation according to the participants

As can be seen in Figure 4, the benefits of cooperative learning may be grouped under three themes as academically, psychologically and socially originated. Furthermore, it can be seen that the answers given by the participants gather under 3 different codes as *"Enjoying the learning process", "Giving the knowledge more meaning", "Knowledge exchange"*. As a result, Table 2 and the network show that the teacher and students preferred group work.

3.3. Findings Regarding Working Cooperatively or not

The teacher and the students were asked whether they worked in cooperation and the findings obtained were are in Table 3.

Table 3. The views of the teacher and the students regarding whether the study was completed in cooperation

		Teacher and Groups						
		T	G1	G2	G3	G4	G5	f
Working in Cooperation or not	Believing that the work was done in cooperation	1	4	4	2	4	4	19
	Not believing that the work was done in cooperative				2			2
Pattern Codes	Codes	T	G1	G2	G3	G4	G5	f
The Academic, Social and Psychological Indicators of Cooperative Work	Participating in decision making process actively during problem solving	1	4	4	2	4	4	19
	Helping each other	1	2	3	3	4	4	17
	Considering the views of the others during problem solving	1	1	2	1	2	1	8
	Giving feedback to each other about their actions	1	3			1		5

When we examine Table 3, it can be seen that all students except two and the teacher believed that the work was cooperative. Also, 85-100% of the students worked cooperatively by stating reasons such as "P*articipating in decision making process during problem solving*" and "*Helping each other*". When we examine Table 3, it can be seen that teacher and students views show that the students worked in cooperation.

3.4. Findings Regarding the Roles Undertaken by the Participants During Group Research

The teacher and the students were asked what kind of roles they undertook during the group investigation and the findings obtained are given in Table 4.

Table 4. The roles in group investigation stated by the teacher and the students

Teacher and Groups	Roles	f	Codes
T	Supporter	1	Spending encouraging words
	Supervisor	1	Observing what is going on in a group -Asking question to students about what they've done
	Counselor	1	-Giving feedback to students -Warning the students
G1	Problem solver	2	Knowledge exchange with the teacher about the problem
	Supporter	2	Supporting the ideas of friends
	Supervisor	2	Observing what is going on in a group
	Recorder	1	Keeping records
G2	Supporter	3	Saying encouraging words
	Supervisor	1	Observing what is going on in a group

	Recorder	1	Keeping records
	Researcher	1	Investigating the accuracy of the answer to a question
	Leader	1	Showing the correct solution to a problem
	Problem solver	1	Managing debates
G3	Supporter	3	Supporting the ideas of friends
	Problem solver	2	Explaining the difficult parts to friends
	Recorder	1	Keeping records
G4	Supporter	5	Saying encouraging words
	Supervisor	2	Observing what is going on in a group
	Leader	1	Explaining the difficult parts to friends
	Problem solver	1	Managing debates
	Recorder	1	Keeping records
G5	Supporter	4	Supporting the ideas of friends
	Recorder	2	Keeping records
	Supervisor	1	Observing what is going on in a group
	Teacher	1	Answering questions
	Problem solver	1	Solving the unsolved problems
	Leader	1	Showing the correct solution to a problem

As can be seen from Table 4, some students undertook one role and some students undertook more than one role. Among the roles stated by the students, 17 were supporters, 7 were problem solvers, 6 were recorders, 5 were supervisors, 3 were leaders, 1 was the teacher and researcher. Among the roles stated by the teacher, 1 was the supporter, supervisor and counselor.

The data regarding the question *"Which of the roles among* ***"supervisor, researcher, recorder, supporter, problem solver and leader"*** *did you undertake during solving the problems? Why? Are there any roles you adopted other than those mentioned"* directed at the teacher and the students were explained in the network shown in Figure 5. The network made regarding the roles the teacher and the students undertook in the group study is given in Figure 5.

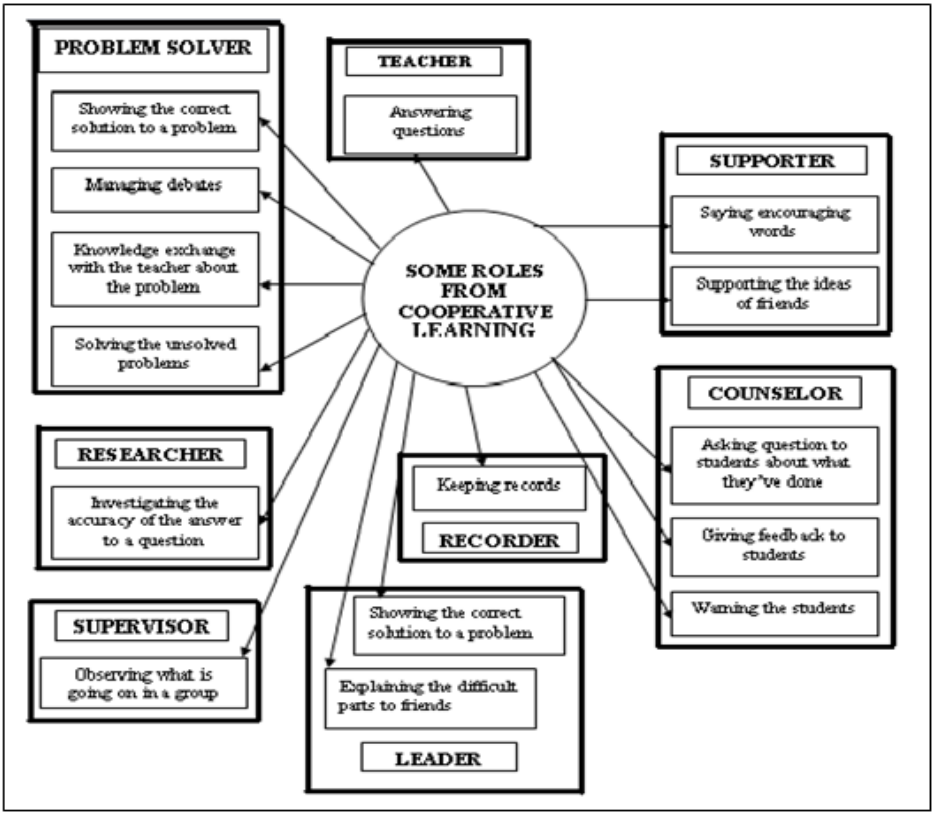


Figure 5. The network regarding the roles the participants undertook in the group study

As can be seen in Figure 5, the roles in cooperative learning may be grouped under eight roles as leader, problem solver, researcher, counselor, supervisor, recorder, supporter and teacher. Moreover, the codes regarding some roles were found to fall under more than one role. As a consequence, Table 4 and the network show that students undertook many roles during group researches and the most frequent roles were found as supporter and problem solver.

3.5. Findings Regarding Whether Data Obtained from Observations and Interviews Overlap or not

By using the observation forms, the total number of items checked by the teacher regarding the students and the items checked by the students regarding themselves and their friends were calculated. The total number of items was found to be close after this calculation. Therefore, it is concluded that interpreting the data obtained by only considering the items

checked by the students about themselves will not be risky. The number of each item on the observations forms checked by the students is presented in Table 5.

Table 5. The number the items on the observation form are checked by the students

The items on the observation form	**f**
1. Showed eagerness to group work.	19
2. Shared views with other group members clearly.	18
3. Made recommendations in group study and expressed useful ideas.	15
4. Engaged in group discussions actively.	15
5. Accomplished individual responsibilities during group work.	18
6. Demonstrated a good performance in group work.	11
7. Acted in harmony with group members.	17
8. Provided individual assistance to group members in need.	17
9. Showed respect to the views of other group members.	15
10. Assessed the contributions of other group members positively and without prejudice.	13
11. Behaved positively while warning others.	16
12. Restated and summarized what was said.	16
13. Celebrated other group members when they made big contributions.	9
14. Showed respect to cultural and individual differences.	15
15. Worked in cooperation with teammates.	18

When Table 5 is examined, it can be seen that all items except the ite*m "Celebrated other group members when they made big contributions."* were found to be marked by most students. This indicates that most students volunteered in the study, shared their views clearly, gave recommendations, fulfilled their responsibilities, demonstrated a good performance, moved together with group friends, provided individual help and support to group friends, showed respect to the views of others, evaluated group friends' contributions without prejudice and in a positive manner, behaved positively when warning friends, paraphrased accurately what was told, showed respect to cultural and individual differences, worked in cooperation and were involved actively in group discussions. The observations made by the teacher and the researchers, and the interviews made with the students support these findings.

4. Discussion

At this chapter, the findings obtained will be discussed and interpreted in the context of subproblems of the study.

In the context of 1st subproblem, all the students were found to view the study as useful. According to the results in Table 1, 50-60% of the students stated the codes of "*Making the knowledge more meaningful*", "*Enjoying the learning process*" and "*Learning new knowledge*". Moreover, as can be seen in Figure 1, the benefits of cooperative learning may be grouped around these three codes. The codes obtained are partially in line with the findings of the Bourner, Hughes and Bourner's study (2001). It's thought that the codes such as "*Expressing the ideas about questions more easily*", "*Consulting group members*"

and "*Making the knowledge more permanent*" were effective in students' finding the group work useful.

In the context of 2nd subproblem, all the students were found to prefer group study. This finding aligns with the results of the works by Burron, James and Ambrosio (1993), Gillies and Ashman (1998), Johnson, Johnson and Holubec (1994) and Yager, Johnson and Johnson (1985). Hard-working students want to reinforce their knowledge and weak students want to learn from their peers and this can be suggested to yield the previous finding. Student interviews seem to support this finding.

In the context of 3rd subproblem, according to the data in Table 3 and Table 5 85-100% of the students worked cooperatively by stating reasons such as "P*articipating in decision making process during problem solving*" and "*Helping each other*". This result aligns with the findings of study by Lejk, Wyvil and Farrow (1996). It can be said that several reasons were effective in the students cooperative study such as, giving the document named "*Let's Learn Together"* to the students, telling the benefits of group study, the students feeling themselves better during group study and enjoying working together.

In the context of 4th subproblem, as can be seen in Figure 2, the students were found to undertake roles in cooperative learning such as leader, problem solver, researcher, counselor, supervisor, recorder, supporter and teacher. This result about roles aligns with studies of Doymuş, Şimşek and Bayrakçeken (2004) and Şimşek (2001), which showed that the students undertake many roles in the group. Among these roles, supporter and problem solver roles are eminent. This may be a result of the students' feeling that they are responsible towards each other (Burron, James & Ambrosio, 1993; Ross, 1995; Whicker, Nunnery & Bol, 1997; Gillies & Ashman, 1998) in cooperative learning and helping friends.

In the context of 5th subproblem, when the data on Table 2 and Table 5 are compared, it can be seen that 15 students stated the code "*Expressing the ideas about questions more easily*" and 18 students checked the item "*Shared his / her beliefs with group members clearly*". When Table 3 is examined, it was determined that 19 students stated the codes "*Believe the existence of cooperative study*" and "P*articipating in decision making process during problem solving*" whereas 17 students used the code "*Helping each other*". When Table 5 is examined, it was determined that 18 students checked the item "*Worked in cooperation with group members*", 15 students checked the item "*Actively participated in group discussions*" and 17 students marked the item "*Provided individual support and help to group members in need*". This shows that the data obtained from the observation forms and interviews are in accordance and support each other. Besides, consulting expert views during the preparation of these two instruments is thought to contribute to this overlap of the data.

5. Conclusion and Suggestions

In this study, teacher and students' views on a practice carried out by using group investigation technique of cooperative learning method were explored. Following this aim, the conclusions and the recommendations based on results were presented as follows:

The data obtained from the interviews show that the students found the group investigation technique useful. The codes stated by the students to express that they found this technique useful were derived from "*Making the knowledge more meaningful*", "*Enjoying working more*" and "*Learning new knowledge*". For this reason, group investigation technique is recommended to be used in mathematics teaching at the level of primary school and higher education.

The interviews showed that some of the hardworking students preferred both group study and individual study whereas all unsuccessful students preferred working in groups. It was determined that hardworking students preferred group study in the subjects they know well to help friends and they preferred individual study where they do not know the subject well. While good students work in groups they found some opportunities such as "*Catching different points related with problems*" and "*Increasing self-confidence*". Unsuccessful students stated that they wanted to work in groups because of reasons such as "*Creating a common synergy / power*" and "*Enabling efficient study*". This shows that group investigation technique have many benefits for both successful and unsuccessful students. For this reason, the teachers are recommended to prepare heterogeneous groups made up of both successful and unsuccessful students.

It was observed that students undertake many roles during group investigation technique. Moreover, successful students were found to undertake more roles than unsuccessful students. This shows that successful students take more responsibility during group study and this method develops the sense of responsibility of the students. In order to allow the students to attain the consciousness to fulfil the responsibilities required by different roles, teachers should give assignments in a balanced way to the students in the group.

Students are determined to shift from a individual stance to a more cooperative one during group study. At the beginning of group study, unsuccessful students did not try to solve the problems since they thought they could not. However, after they heard what had been spoken and saw what could be done in the group, they understood that they could contribute to the group process and found encouragement to participate in problem solving process. For this reason, teachers are recommended to give assignments to unsuccessful students to encourage them to work with friends during group study and taste the feeling of success.

The data obtained from the observation forms and interviews were found to be in accordance and supported each other. Therefore, the teachers may be advised to use the observation forms utilized in this study in their classes, observe their classes and compare

their results with the results of this study and other similar studies.

The data in this study are limited with the worksheets, group interviews and in-class observations. Therefore, it's recommended to carry out similar studies on different samples and for different subjects of mathematics. In other words, it's recommended to prepare materials that will establish a cooperative learning environment for the students from elementary to college level, implement these materials and compare the results with previous findings.

References

Açıkgöz, K. (1990). *The effects of cooperative learning and traditional instruction on university students' academic success, memorization levels and affective qualities.* Paper presented at the meeting of 1st National Educational Sciences Congress, Ankara University, Ankara.

Aksoy, G. (2006). *The effect of cooperative learning on students' achivements, identifications and use of laboratory equipments in general chemistry laboratory course.* Unpublished Master's Thesis, Atatürk University, Graduate School of Natural and Applied Sciences, Erzurum.

Artut, P. D., & Tarım, K. (2007). Effectiveness of jigsaw II on prospective elementary school teachers. *Asia-Pacific Journal of Teacher Education*, *35(2)*, 129-141.

Artz, A. F., & Newman, C. M. (1990). Cooperative learning. *Mathematics Teacher*, *83*, 448-449.

Baki, A. (2008). *Mathematics education from theory to practice.* Ankara: Harf Educational Publications.

Bligh, D. A. (1998). *What's the use of lectures*?. England: Intellect.

Bourner, J., Hughes, M., & Bourner, T. (2001). First-year undergraduate experiences of group project work. *Assessment and Evaluation in Higher Education*, *26*, 19-39.

Bowen, C. W. (2000). A quantitative literature review of cooperative learning effects on high school and college chemistry achievement. *Journal of Chemical Education*, *77(1)*, 116-119.

Burron, B., James, L., & Ambrosio, A. (1993). The effects of cooperative learning in a physical science course for elementary/middle level preservice teachers. *Journal of Research in Science Teaching,* 30(7), 697-707.

Carlan, V., Rubin, R., & Morgan, B. (2004). *Cooperative learning, mathematical problem solving, and Latinos*. Paper presented at the annual meeting of the American Educational Research Association. San Diego, CA.

Cooper, J., & Mueck, R. (1990). Student involvement in learning: Cooperative learning and college instruction. *Journal on Excellence in College Teaching*, *1(1)*, 68-76.

Çepni, S. (2007). *Introduction to research and project studies.* (Extended 3rd edition), Trabzon: Celepler Press.

Çepni, S., Ayas A., Ekiz, D., & Akyıldız, S. (2008). *Instructional principals and methods.* Trabzon: Celepler Press.

Coştu, B. (2002). *A related to lycee students' levels of understanding of the "evaporation, condensation and boiling" concepts.* Unpublished Master's Thesis, Karadeniz Technical University, Graduate School of Natural and Applied Sciences, Trabzon.

Davidson, N. (1990). *Cooperative learning in mathematics: A handbook for teachers.* Menlo Park, CA: Addison-Wesley.

Doymuş, K., Şimşek, Ü., & Bayrakçeken, S. (2004). The effect of cooperative learning method on academic success and attitude in science classes. *Journal of Turkish Science Education*, *1(2)*, 103-115.

Faust, J., & Paulson, D. (1998). Active learning in the college classroom. *Journal on Excellence in College Teaching, 9(2)*, 3-24.

Gillies, R. (2002). The residual effects of cooperative learning experiences: A two year follow-up. *The Journal of Educational Research, 96(1)*, 15-20.

Gillies, R., & Ashman, A. (1998). Behavior and interactions of children in cooperative groups in lower and middle elementary grades. *Journal of Educational Psychology, 90*, 1-12.

Johnson, R. T., & Johnson, D. W. (1989). *Cooperation and competition theory and research.* Edina, MN: Interaction Book Company.

Johnson, R. T., & Johnson, D. W. (1991). *Learning together and alone: Cooperative, competitive, and individualistic learning*. (3rd Ed.), Englewood Cliffs, NJ: Prentice-Hall.

Johnson, D. W., Johnson, R. T. & Holubec, E. J. (1994). *The new circles of learning: Cooperation in the classroom and school.* VA: Association for Supervision and Curriculum Development.

Kessler, R., Price, R., & Wortman, C. (1985). Social factors in psychopathology: Stress, social support and coping processes. *Annual Review of Psychology*, *36*, 351-372.

Kishore R., Agrawal, M., & Rao, H.R. (2005). Determinants of sourcing during technology growth and maturity: An empirical study of e-commerce sourcing. *Journal of Management Information Systems, 21(1)*, 47-82.

Klein, J. D., & Schnackenberg, H. L. (2000). Effects of informal cooperative learning and the affiliation motive on achievement, attitude, and student interaction. *Contemporary Educational Psychology*, *25*, 332-341.

Lazarowitz, R., Baird, J. H., & Bowlden, V. (1996). Teaching biology in a group mastery learning mode: High school student's academic achievement and affective outcomes. *International Journal of Science Education, 18*, 447-462.

Lazarowitz, R., Hertzlazarowitz, R., & Baird, J. H. (1994). Learning science in a cooperative setting: Academic achievement and affective outcomes. *Journal of Research in Science Teaching, 31*, 1121-1131.

Leikin, R., & Zaslavsky, O. (1997). Facilitating student interactions in mathematics in a cooperative learning setting. *Journal for Research in Mathematics Education*, *28(3)*, 331-355.

Lejk, M., Wyvil, M., & Farrow, S. (1996). A survey of methods of deriving invidividual grades from group assessments. *Assessment and Evaluation in Higher Education*, *21(3)*, 267-280.

Leonard, J. (2001). How group composition influenced the achievement of sixth-grade mathematics student. *Mathematical Thinking and Learning*, *3(2/3)*, 175-200.

Mallinger, M. (1998). Collaborative learning across borders: Dealing with student resistance. *Journal on Excellence in College Teaching*, *9(1)*, 53-68.

Miles, M., & Huberman, M. (1994). *An expanded sourcebook qualitative data analysis.* (2th edition), America: Person Education.

Özsoy, N., & Yıldız, N. (2004). The efffect of learning together technique of cooperative learning method on student achievement in mathematics teaching 7th class of primary school. *The Turkish Online Journal of Educational Technology*, *3(3)*.

Panitz, T. (1999). The motivational benefits of cooperative learning. *New Directions for Teaching and Learning, 78*, 59-67.

Ross, J. (1995). Impact of explanation seeking on students achievement and attitudes. *The Journal of Educational Research, 89(2)*, 109-117.

Salend, S. J., Gordon, J., & Lopez, K. (2002). Evaluating cooperative teaching teams. *Intervention in School and Clinic*, *37*, 195-201.

Slavin, R. (1990). *Cooperative learning: Theory, research and practice*. NJ: Prentice Hall.

Slavin, R. E., Madden, N. A., & Leavey, M. (1984). Effects of cooperative learning and individualised instruction on mainstreamed students. *Exceptional Children, 50(5)*, 434-443.

Sharan, S. (1980). Cooperative learning in small groups: Recent methods and effects on achievement attitudes and ethnic relations. *Review of Educational Research*, *50(2)*, 241-271.

Şimşek, A. (2001). *Democracy in the class.* (2nd edition), Ankara: Egitim-Sen Publications.

Tarım, K. (2003). *Effectiveness of cooperative learning method on teaching mathematics and meta analytic study for cooperative learning method.* Unpublished PhD Thesis, Çukurova University, Graduate School of Natural and Applied Sciences, Adana.

Tarım, K., & Akdeniz, F. (2003). Using cooperative learning in primary school math courses. *Hacettepe University Journal of Education*, *24*, 215-223.

Tok, Ş. (2008). Effects of cooperative learning method of pairs check technique on reading comprehension. *Elementary Education Online*, *7(3)*, 748-757.

Webb, N. M. (1982). Group composition, group interaction, and achievement in small groups. *Journal of Educational Psychology*, *74(4)*, 475-484.

Whicker, K., Nunnery, J., & Bol, L. (1997). Cooperative learning in the secondary mathematics classroom. *The Journal of Educational Research*, *91(1)*, 42-48.

Yager, S., Johnson, D. W., & Johnson, R. (1985). Oral discussion, groups-to-individual transfer, and achievement in cooperative learning groups. *Journal of Educational Psychology, 77(1)*, 60-66.

Yıldırım, A., & Şimşek, H. (2005). *Qualitative research methods in social sciences.* (5th edition), Ankara: Seçkin Publications.

Yılmaz, A. (2001). Learning based on cooperation; an effective but often neglected or misused method. *Journal of National Education, 150*.