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Innovation Practices in Elementary School Science and Technology Course and Their Effects on Students

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Abstract

The purpose of this study is to investigate effect of innovative projects that groups attended on students' achievement, creativity, academic self concept and attitudes towards Science and Technology course. 67 sixth grade primary school students participated in this study. For this study the quasi experimental design with pre test and post test was applied in this research. Qualitative and quantitative methods were used for data analysis. There was no differences between experimental and control groups before the application. After the application significant differences were found in terms of achievement and academic self concept in the favor of experimental group. In addition, between pre test and post test aritmethic mean scores of experimental and control groups, significant differences were found. It was also found that students in experimental group had positive opinions regarding innovative or innovation projects.

Keywords

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Introduction

In today's rapidly changing world, knowledge itself is in a process of continuous change and development. Learning how to learn is as important as learning the information itself. It is possible to assist students in obtaining the desired knowledge through the implementation of innovative applications. Restructuring is one of the innovations in education that provides students with more liberal, reliable, practical, and creative learning environments. Innovation, together with the implementation of the new program, has become an important subject in pre- and in-service training of teachers. The word "innovation" has found a place in National Education to describe renewal.

The word "innovation" derives from the Latin "innovatus", which refers to the introduction of new methods into public, cultural and administrative spheres (Aydar, 2008; Elçi, 2006). Even, not giving the right meaning, the words such as renewal, innovation are used in Turkish (Elçi, 2006). Innovation is expressed as innovation by Turkish Language Institution and described as;

"In order to adapt the changing conditions, using new methods in social, cultural and administrative environments" (TDK, 2012). Aydar (2008) also defined innovation as the development of new products in the result of the use of new ideas and knowledge together. According to the definition of a scientific organization, innovation is transformation process of knowledge into

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products by using labor and infrastructure (NSF, 2001, cited by Arıkan, Aksoy, Durgut, Göker, 2003, p. 24). In the Oslo Manual, innovation was defined as "renewal" and described as:

> "A new or significantly improved product (goods or service), or process, new marketing method or implementation of a new organizational method in operational practice in a facility, workplace organization, or external relations" (OECD, 2005, p. 50).

According to Yalcinkaya, innovation is comprehensive, and has a broad meaning. However, the author emphasized that innovation, apart from being goods or services, is also a process, which relates to putting new ideas into practice for the first time (Yalcinkaya, 2010). Musoglu (2008) mentioned that since it is not exactly equivalent in Turkish, the word innovation is confused with the word creativity. He also indicated that creativity is one of te factors that make up DNA of innovation. In this study the innovation word was preferred to protect the integrity of the study, since this word did not present clear provision in Turkish.

The concept of innovation includes basic elements such as innovation, economic and social values. This concept is the combination of existing elements and information in different ways rather than created from scratch that something original. This combination also needs economic and social values (Aygören, Şenyürek, Ercil, Kara, 2009, p. 8)

Researchers stated the relationship between education and innovation and expresses that education is the main driver of innovation which is seen as a way of thinking (Gümüştekin, 2009). A relationship exists between training and innovativeness. Musluoğlu (2008) explained that the purpose of innovation in education is to provide high quality training, develop creative minds, and train self-confident students who establish good communication within their environment, who can adapt to team work, who successfully make use of information technologies, and produce creative ideas pursuant to the capacities of the 21st century. It is important to create appropriate learning environments and selecting instructionanl strategies in order to realre education and innovation. One of the applications that can provide innovation in modern science education is project works. In project based learning model, subjects are associated with real life and students can reach the information through their efforts. These characteristics make the learning unique and valuable (Bell, 2010; Özden, Aydın, Erdem & Ekmekçi, 2009). Studies related to project based learning indicated that the method is effective in the process of collaboration, project management, innovation, creativity and communication (Butun, Erkin, Altıntaş, 2008; Graaff & Kolmos 2003). Project based learning can be carried out individually, it can also be carried out with group activities in which students helps each other by taking different tasks and exchange information. Studies show that, comparing with traditional methods, students have better understandings, higher motivations, higher self- confidence in group works. In addition, provision of heterogenity has affect social relationship positively and also it has positive effect on students' learning level and attitudes towards science (Bilgin & Karaduman, 2005; Salan, Birbir & Birbir, 1999; Catherine & Barry, 2008). In this context, it can be thought that group based projects works have positive effects on students' achievement and attitudes towards science. Çağlar (2010) also stressed the relationship between achievement, attitudes and academic self concept and found positive relationship between academic self concep, achievement and attitudes towards science lesson.

Creativity is important in realization of these features students should have in science education. Studies in literature emphasized that creativity and creative thinking are important elements that should be included in all levels of education. In addition, developing creativity not only provides original ideas but also provides students overcome 21st century problems successfully (Shieh & Chang, 2014). However, studies indicated that creative thinking based learnin activities increase students creative thinking levels (Koray, 2004). Especially, it is emphasized that there is a significant relationship between students' scientific process skills and creativity (Şahin Pekmez, Aktamış, Can,

2010; Yaman & Yalçın, 2003). Through these information it is considered that creating innovation projects process has an effect on students' creativity.

A thorough literatures search reveals that the number of studies evaluating innovation in the development of education is very limited. These studies intended to guide teachers in in-class activities for effective education and training (Istance, Kools, 2013). One of the studies conducted with this purpose was in the form of a project, which included numerous workshops for teachers to provide effective science education and training, and this project suggested improvements to education and training. For effective science training and education, this study emphasized the need to cover a wide area range, which takes into account the participation, life, perspective, and interests of the students, and their relation to the community (Tytler, 2009). In a study conducted Austria, an innovation project was carried out involving Math, Science, and Technology Education between 2000 and 2004, considering the failure of the students in TIMSS (Third International Mathematics and Science Study) and PISA (Programme for International Student Achievement) exams. The aim of this project was to conduct activities in order to improve the in-class practice of math, science, and technology teachers (Krainer, 2003). In a project carried out in the context of the European Union 7th Framework Program (Kids INN Science, 2009), unlike other studies, workshops were held with the joint participation of students and teachers on the subject of innovation in science. The main purpose of the project was to perform approximately 80 applications intended for science training through research-oriented training and problem solving-oriented training by taking into account the needs of the relevant country and cultural differences. This project considered that science training and education is a complex process, and innovation has been taken as a new condition under which children worked as a group on their favorite subject, searched for solutions to the problems, and developed new attitudes towards their teachers, the subject studied, and the place of science in the community (Kids INN Science, 2009).

In an attempt to promote scientific literacy, information devices (modeling, simulation, and real time experiments) and innovative teaching have been employed at the secondary education level in an international study project based on the notion that innovation is needed in science education. In the project conducted with the participation of five countries (France, Italy, Norway, Spain, and he UK), the experiences of science teachers have been observed in a real class setting. The study concluded that incorporating innovative teaching into the education system is a complex process, and therefore, it may take longer to utilize innovative teaching as an appropriate means or strategy of training/teaching, and teachers willing to implement this teaching method in their practice should exhibit flexibility (Understanding innovation in science teaching, 2002). On the other hand, it is considered that innovation studies could be improved by designing a training environment to help students gain skills for today and the future, and by linking the teaching-learning process in the school with the reality of the external world (Pehlivanoglu, 2011).

When the literature examined, many studies can be seen related to project work in science education, but it seems that there are limited studies related to innovative projects. Studies related to innovation projects are mainly about engineering and industrial applications revealed the need for innovation projects related to instructional programmes in education. In light of these thoughts, it was investigated the efficacy of utilizing innovative study project applications in teaching science and technology lessons with the purpose of revieving the creativity of students and help them gain team-work skills. It was also evaluated the group on the effects of creating innovative projects on success, attitude, and academic self-concept. This study is expected to be an example of innovative project applications and contribute to education.

Research Questions

What are the effects of group creating oriented innovative projects throughout Matter and Heat unit in Primary Education Science and Technology course?

1. Is there any difference between control and experimental groups' post test analysis results in terms of achievement, creativity, attitudes towards Science and Technology course and academic self concept?
2. Is there any difference between pre-test and post-test mean scores of experimental group in terms of achievement, creativity, attitudes towards Science and Technology course and academic self concept?
3. Is there any difference between pre-test and post-test mean scores of control group in terms of achievement, creativity, attitudes towards Science and Technology course and academic self concept?
4. What are the opinions of students in experimental group regarding group oriented innovative project?

Methodology

This study was conducted as a quasi experimental design. Quasi experimental studies are used when in the case of actual experiment models' controls are not maintained or insufficient (Karasar, 1998, p. 99).

Sampling

This study is conducted in 2011-2012 educational term, at the same level of two sixth degree classes at Mersin city, Mezitli state Dr. Hakan Kundak Primary School. There are 35 students in experimental group and 32 students in control group. The students have not participate innovation projects application before. Equivalence of the groups was determined with pre test by applying the scales at the first stage of study. The equivalence of the groups was verifies by the result of pre test achievement test (t: .20, p = .84), pre test creativity scale (t: .84, p = .41), pre test attitude scale (t: .92, p = .36) and by pre test academic self concept scale (t : .48, p = .63). No statistically significant differences were found among the groups in terms of pre tests.

In this study, it is assumed that the students reflect their actual performance and answer the data collection tools.

Limitations

This study is limited with:

- The students sixth grade students from two classrooms in one primary school in Mezitli district located in the city of Mersin in 2011-2012 academic year.
- Matter and Heat unit in Science and Technology program
- 4 hours a week in 12 weeks which include generating project ideas and the process of project presentations

Data Collection Tool

Data collection instruments used in this study as follows:

Achievement test

For this study Matter and Heat Unit test was prepared by the researchers and applied as an achievement test. In the preparation phase of achievement test, to measure the outcomes of Matter and Heat Unit 33 multiple choice questions were prepared. Minimum 2 questions for each outcome were considered in this phase and experts' opinions were taken. Prepared test was applied to 129 eight grade students. Item analysis was carried out and some of the items were eliminated whose distinctiveness index was under 0,32 and test including of 25 items was created. Test items were consisted of four options. In achievement test, each correct answer was accepted as (1) point and each incorrect answer was accepted as (0) point. KR 20 reliability value of the test was found to be ,93. Sample questions of achievement test is presented in Appendix 1.

Creativity Scale

Creativity scale was developed by Whetton and Cameron (2002) and adopted into Turkish by Aksoy (2004). This scale was consisted of 39 items and reliability of the scale (Cronbach Alpha) was found ,94. The scale based on Likert type of agree (3), undecided (2), disagree (1).

Attitudes Towards Science and Technology Scale

This scale was developed by Şahin Yanpar, Çakır and Şahin (2000) and consisted of 14 positive and 13 negative items. Positive items in the scale were assessed as strongly agree (5), agree (4), undecided (3), disagree (2), strongly disagree. Reliability of the scale was found to be ,95 in original study. In this study reliability was found to be ,86.

Science and Technology Academic Self Concept Scale

Academic self concept means that somebody has a perception if he/she learn a unit (field, subject, discipline) and also is an important factor that effect the success (Koç, Yavuzer, Demir & Çalışkan, 2001; Pehlivan & Köseoğlu, 2010). This scale was developed by Brookover et al (1964) and adopted into Turkish by Senemoğlu (1989) and also Science lesson adoptation has been done by Şahin Yanpar, Çakır & Şahin (2000). The scale based on Likert type and consists of 8 items. The two half reliability coefficient of the scale was found to be ,83. In this study this value was found ,91.

Open- Ended Questions

In this study, four open-ended questions were prepared for students to determine their opinions related with problems students faced with generating innovation project process, positive effects and contributions of innovation projects. For these questions, experts were consulted to get their opinions. After preparation phase, the questions were asked to answer these questions.

İnnovation Projects Evaluation Form

The innovation projects evaluation form was prepared to evaluate the students' projects. This form was prepared by using innovation project works that exist in literature. After preparation phase, three experts were consulted to get their opinions and through their opinions necessary corrections were made. The form is presented in Appendix 2.

Study Procedures

The two groups included in the study had similar baseline characteristics. The same lesson content was used to teach the unit on matter and heat. The following procedures were carried out during the research:

1. Initially, the two groups were checked for matching baseline characteristics. Accordingly, the groups were equivalent in terms of baseline success (t: 0.20; p: 0.84>0.05), baseline creativity (t: 0.84; p: 0.41>0.05), baseline attitude (t: 0.92; p: 0.36>0.05), and baseline self-concept (t:0.48; p: 0.63>0.05).

2. The students in the second experimental group performed group work. Students' 4th and 5th grade mean scores were taken into consideration while creatin the groups. Student list ranked considering students' mean scores and in this list first 7 students were enumerated 1 to 7 and also other students enumerated 7 to 1. After enumerated all of them, students who have same number were included in the same group. Thus, the students worked as heterogeneous groups (low, medium, high level) consisting of five students each.

While determining the project, the "Matter and Heat" lesson included of the following subjects: particle structure of matter, particle structure-heat relationship, heat conductor-insulator, means of thermal radiation, light-dark color/radiant surface relationship, heat insulation, and insulation materials. The teaching methods in the study group consisted of questions-answers, lecturing, modeling, and experimentation.

3. After administering pre-test (achievement test) and measurement scales (creativity, attitudes and academic self concept), the students in the study group were asked to consider what types of projects could be conducted. Then, the students were provided training on innovation, production of innovative products, features of innovative products, and examples of such products. During the educational process, the students' concerns about inability to made a project have attempted to be resolved by emphasizing that it was not expected from them an invent. However, they were expected to create useful products by making changes on existing products and perform products which provide new usage opportunities. After training, students were given time to generate project ideas. Students in study groups were come together in order to decide the projects they want to make. The project ideas reported by the students at the end of this period are listed below:

- Watch heat the wrist
- Heated bathrobe
- Pen with hot water tank
- Heated shoes/slippers
- Electric sheath for chair
- Solar furnace
- Nursing bottle thermometer system
- Insulated cover for saucepan
- Heated screen
- Non-melting package for chocolate

The students in the study group were provided with information about group work, scientific steps of project preparation, preparing posters, literature search, and the students were guided for the supply of materials. In this way, students were informed about the research that they need to do, planning projects, how they choose and supply the materials, and how they present the projects. During the working process, since groups showed the adequate attention to the project planning and create conflict between them, they were followed and necessary assistance and guidance were made.

In the fourth week of the project during which the products began to appear, project groups continued their work on the products while the students who failed in the first attempt continued their projects by performing a second trial or using different materials. The groups who completed the projects directed through the poster preparation process and necessary information was made on how to prepare a poster. The projects were completed and presented in the second week of the second semester. Presented projects were evaluates by three experts in science education considering innovation project evaluation form.

4. The existing teaching program was used in the control group mostly based on lecturing by the researcher; the lectures were conducted using concrete examples as in the study group, and active participation of the students to the lesson was ensured by questions-answers, lecturing, modeling, and experimentation methods. Providing students participate actively in lessons, specified applications were attempted in accordance with Ministry of Education Teachers' manual book

5. A post-test was administered to the students in the two groups.

Analysis of Data

Qualitative and quantitative data analysis was used for this study. SPSS 17 was used for quantitative analysis of the data. The significance level was p<.05. Firstly, Kolmogorov-Smirnov analysis to check the distribution of the sample for pre- and post-test applications. Secondly, to find the differences between experimental group innovation projects were applied and control group existing program was applied in terms of achievement test, creativity scale, attitude scale and academic self concept scale, independent sample was used for data analysis. Since test istatistics of independent sample t test will vary depending on whether intergroup variance is equal or not, the equality of variance was tested before the t test (Sipahi, Yurtkoru & Çinko, 2006, p. 118). For this purpose, Levene test was used. Thirdly, paired sample t test was used to find the differences pre and post scores of experimental group in terms of achievement test, creativity scale, attitude scale and academic self concept scale. Same procedure was applied to determine the differences pre and post test scores of control group.

Qualitative data analysis was used for open- ended questions to evaluate the innovative projects development process and positive and negative situations students experience during this process. Content analtsis was used for detailed analysis of the data obtained from open ended questions. Content analysis process steps are as follows (Yıldırım & Şimşek, 2008, pp. 227-228): Coding the data, generating themes, organization of codes and themes, interpretation of the findings. To determine the reliability of coding, an expert read the data and encoded the data considering related theme in the coding list. After filling the coding list for all te data, consistency of coding list was compared. At this stage, researchers need to code the same data set and reach at least 70% level by comparing similarities and differences (Yıldırım & Şimşek, 2008, p.233). For this study to check the reliability of qualitative data analysis Miles and Huberman (1994) formula was used: Reliability=Consensus/(Consensus+Dissidence). The reliability of the research found using this formula, that means correspondance percentage was calculated to be 90.1% for open-ended questions. These results also indicated that the researchers' coding were reliable.

Results

The Findings Related to the First Sub-Problem

The first sub-problem of the study was stated as, "Is there any significant difference between the control and the study groups in terms of success, creativity, and attitudes towards the science and technology lesson, and academic self-concept scores in Science and Technology in the analysis of the post-test scores?" The independent t-test was performed to determine the answer to this sub-problem. Analysis results are presented in Table 1.

Table 1. The results of the t-test between the control and study groups

	Groups	$\overline{X}$	**N**	**ss**	**Sh$_x$**	**t-test**		
						t	**df**	**p**
Success	Control	49,8750	32	18,51198	3,27249	2,118	65	,038*
	Experiment	60,0000	35	20,44217	3,45536			
Creativeness	Control	80,6875	32	7,25320	1,28220	1,280	65	,205
	Experiment	82,7143	35	5,67021	,95844			
Attitudes	Control	116,656	32	13,38417	2,36601	,010	65	,992
	Experiment	116,685	35	11,07666	1,87230			
Academic Self-concept	Control	33,6875	32	4,65893	,82359	2,472	51	,017*
	Experiment	36,0571	35	2,89972	,49014			

*(p<0.05)

As shown in Table 1, the comparison of the post-test scores between the study and the control groups revealed a significant difference in favor of the study group in terms of success and academic self-concept scores ($t_{\text{success while}}$ = 2,118; $t_{\text{academic self-concept}}$ = 2,472; p<0.05), but there was no significant difference in terms of creativity and attitude scores.

The Findings Related to the Second Sub-Problem

The second sub-problem of the research was stated as, "What are the differences between the mean pre-test and post-test scores of the study group in the domains of success, creativity, attitude toward the science and technology lesson, and academic self-concept for the science and technology lesson?" The dependent t-test was performed to determine the answer to this sub-problem. Analysis results are presented in Table 2.

Table 2. The results of the paired t-test in the study group

	Groups	$\overline{X}$	N	ss	Sh$_x$	t Test		
						t	df	p
Success	Pre-test	33,6000	35	15,1913	2,5678	8,04	34	,00*
	Post-test	60,0000	35	20,4421	3,4553			
Creativeness	Pre-test	79,9714	35	6,7103	1,1342	2,01	34	,052
	Post-test	82,7143	35	5,6702	,9584			
Attitudes	Pre-test	114,1714	35	20,7470	3,5068	,73	34	,468
	Post-test	116,6857	35	11,0766	1,8723			
Academic self concept	Pre-test	35,2571	35	4,3341	,7326	1,24	34	,221
	Post-test	36,0571	35	2,8997	,4901			

* (p<0,05)

According to Table 2, post-test scores were significantly higher in the study group (t success = 8,04; p<0.05) whereas post-test scores in creativity, attitude, and academic self-concept domains were not significantly higher compared to pre-test scores in the relevant domains.

The Findings Related to the Third Sub-Problem

The third sub-problem of the research was stated as, "What are the differences between the mean pre-test and post-test scores of the control group in the domains of success, creativity, attitude toward science and technology, and self-concept in science and technology?" The dependent t-test was performed to determine the answer to this sub-problem. Analysis results are presented in Table 3.

Table 3. The results of the paired t-test in the control group

	Groups	$\overline{X}$	N	ss	Sh$_x$	t Test		
						t	df	p
Success	Pre-test	32,8750	32	14,0683	2,4869	5,81	31	,000*
	Post-test	49,8750	32	18,5119	3,2724			
Creativeness	Pre-test	81,2813	32	6,0547	1,0703	,45	31	,649
	Post-test	80,6875	32	7,2532	1,2822			
Attitudes	Pre-test	118,0625	32	12,2156	2,1594	,68	31	,501
	Post-test	116,6563	32	13,3841	2,3660			
Academic Self concept	Pre-test	34,7813	32	3,7651	,6655	1,94	31	,061
	Post-test	33,6875	32	4,6589	,8235			

*(p<0,05)

According to Table 3, post-test scores in the success domain were significantly higher compared to the pre-test scores in the control group *($t_{success}$ = 5,81; p<0.05);* however, post-test scores in the creativity, attitude, and academic self-concept domains were not significantly higher compared to the pre-test scores.

The Findings Related to the Fourth Sub-Problem

The fourth sub-problem of the research was stated as, "What is the opinion of the students in the study group about conducting innovative projects as a group?" The students were provided a questionnaire consisting of four open-ended questions, and they were asked to answer the questions relating to the time period from the beginning until the end of the project development. The responses of the students were analyzed using a qualitative method, and the results are presented below.

Table 4. Student comments on creating innovative projects with a group

Theme and Sub-Themes	**f**
A.Comments on the Process of Creating Innovative Projects	
A.1.Creating a project	
A.1.1.Preliminary preparation	
A.1.1.1. Reference research	15
A.1.1.2. Identifying needs	6
A.1.2.Group work	2
A.1.2.1.Task sharing	2
A.1.2.2.Sharing ideas	1
A.1.3.Implementation	
A.1.3.1.Supply of materials	5
A. 1.3.2.Construction	2
A.2.Blank	3
B.Opinions about Creating Innovative Projects	
B.1.Positive feedback	5
B. 1.1.Positive feedback about the project	
B.1.1.1.Creating a new product (interesting)	7
B.1.1.2.Useful for people	1
B.1.1.3. Research	1
B.1.1.4. Production	3
B.1.2.Positive feedback about the group work	4
B.1.2.1.Solidarity	1
B.1.2.2.Communication	2
B.1.2.3.Entertainment	4
B.2.Partially positive comments	2
B.3.Negative comments	3

As shown in Table 4, the opinions of the students about creating an innovation project were more intense about the project preparation phase, and reference research was mentioned most in this group. One student expressed the following about the research:

> *... We conducted research to create projects. We made use of many resources. We worked a lot while creating these projects. We made heated slippers by implanting a circuit inside it...*

When the opinions of the students about creating innovative projects were examined, they mostly reported that they liked this research because they created new and interesting products. In addition, some of the students commenting positively on the project did not specify a reason for their thoughts, while some students specified group work, and some other students specified having a good time during the project as the reason for their positive statements. One student expressed the following about group work:

> *...I liked it because we collaboratively made something that did not previously exist.*

Table 5. Student comments on creating innovative projects with the group

Theme and Sub-Themes	**f**
C.Comments on Problems Faced During the Process of Creating Innovative Projects	
C.1.Those reporting problems	3
C.1.1.Problems related with the application	
C.1.1.1.Air-conditioning	1
C.1.1.2.Finding materials	2
C.1.1.3.Inability to use materials	1
C.1.1.4.Failed trials	13
C.1.1.5.The difficulty in creating a product	1
C.1.1.6.Preparing presentation	2
C.1.2.Problems related to the group work	
C.1.2.1.Non-participation of the group members in the study	3
C.1.2.2.Group members not performing their tasks	2
C.2.Those not reporting a problem	5
D. Comments on the Benefits of Creating Innovative Projects	
D.1.Positive/Helpful	2
D.1.1.Learning/Comprehension	
D.1.1.1.Learning/discovering new things	11
D.1.1.2.Learning to conduct a research	3
D.1.1.3.Learning group work	2
D.1.1.3.1.Solidarity	2
D.1.1.3.2.Friendship relation	4
D.1.1.3.3.Entertainment	3
D.1.1.4.Learning to execute a project	2
D.1.2.Creativity	
D.1.2.1.Producing new things	3
D.1.2.2.Finding solutions to the problems	5
D.1.2.3.Generating ideas	2
D.1.3.Development	
D.1.3.1.Mental development	1
D.1.3.2.Revealing talents	2
D.1.3.3.Development of psychomotor abilities	1
D.1.3.4.Ability to work	2
D.2. Partially positive	1
D.3.Negative	2

As shown in Table 5, when the opinions of the students about the problems faced during creating a project were examined, many students reported their failure in trials related to the project. One student, who experienced failed trials during the project, expressed the following:

> *Yes, we did face some troubles. We were the first to complete the project, but it broke down for some reason; we re-made it from the beginning, but we got the job done...*

Another student expressed the following:

> *Yes, it got fire for once. And, it did not work in another attempt, but we made it happen on the 29th trial.*

When the opinions of the students about the benefits of creating innovative projects were examined, they regarded innovative projects as helpful to the students, and they mostly expressed learning/discovering new things as being the greatest benefit. In addition, they pronounced the

benefits of producing new things to solve problems, cooperation in group work, and favorable effects of promoting friendship in such projects.

One student, who made a statement about learning, expressed the following:

... Yes, it is helpful, both collecting and presenting knowledge; conducting useful projects. We have learned that our project was very useful.

One student, who presented an opinion on revealing one's talents and friendship, expressed the following:

... Yes, it is helpful. Because, it revealed our talents... It let us perform projects for the good of people. It developed our friendship...

Discussion, Conclusion and Suggestions

In the present study, experimental and control groups were compared who either conducted innovative projects or participated in the existing teaching program in science and technology, the matter and heat lesson in the 6th grade of the elementary school. There was significant difference between the two groups in favor of the of study group in terms of post-test scores. This finding suggests that innovative project applications make a greater contribution to the existing teaching practice. Likewise, many studies evaluated the impact of project studies on the success of students, and reported significant differences in terms of academic success at the end of the experimental project studies (Çakallıoğlu, 2008; Gültekin, 2007; Keser, 2008; Korkmaz and Kaptan, 2002; Öztürk, 2008). These studies emphasized that science lessons based on project studies are more efficient compared to traditional teaching methods and that project studies prompt students to think differently, and help students gain new skills such as questioning, interpreting, researching, producing a new product by linking old and new knowledge, and producing something from science in daily life (Gültekin, 2007). By using these skills students retain more information and construct their knowledge (Bell, 2010). In contrast to some of the studies in the literature, other studies evaluated students conducting project studies as opposed to those attending traditional educational programs at the elementary level, and did not report a difference between the groups in terms of academic success (Ayan, 2012; Toprak, 2007). However, the majority of students participating in such studies expressed that they learned more in such studies (Ayan, 2012).

According to the results of this study, post-test scores of the control and the study groups did not significantly differ in the creativity domain; however, the mean creativity score in the study group was higher compared to the mean score in the control group. The finding that the difference between creativity scores did not reach statistical significance could be explained by the requirement of a longer period of time to recognize creativity in an individual, to raise awareness of the person, and to improve creativity. In this case, duration of innovation project working hours was thought insufficient to create a significant difference on students' creativity level.

In the analysis of the attitude post-test scores in the study and the control groups, no significant difference was found between the groups. There are many studies in the literature suggesting significantly higher scores in the attitude against science domain compared to the control students. These studies evaluated the effects of project-based teaching method on the attitude against science in 5th, 6th, 7th, and 8th grades of the elementary school level, and yielded results to the favor of the study group (Çakallıoğlu, 2008; Dilşeker, 2008; Keser, 2008; Moralar, 2012; Serttürk, 2008). However, there are also studies that do not report a difference in attitude towards science lessons between the groups. In one study, the scores of students attending a project-based teaching program in their attitude towards science lessons was not significantly different compared to the students in the control group (Karacallı, 2011).

A significant difference was observed between the study group participating in the innovative project-based program and students participating in the existing teaching program in the control group in terms of post-test scores in the academic self-concept domain. According to these results, it could be stated that innovative projects conducted as group work significantly contribute to the academic self-concept of the students compared to the existing teaching methods. The research also indicated that project-based teaching methods produced a positive impact on the academic self-concept of the student (Baran, 2011; Basbay and Senemoglu, 2009). As the students improve their efficient studying habits, they attain higher academic success, spare more time for academic research, become more self-confident, and academic self-concept is positively affected (Korkmaz and Kaptan, 2002). Considering higher scores in the success domain of the students conducting innovative projects, higher scores in academic self-concept domain are in conformity with the remarks of the researchers.

The analysis of pre-test and post-test success scores in the study and the control group revealed a significant difference between pre-test and post-test scores. In this case, it could be articulated that both innovative projects and traditional teaching methods positively contribute to the success of the students. However, compared to the control group, significantly higher post-test success scores in the study group suggest that innovative project studies make a greater contribution to the success compared to traditional teaching methods. In another study, project studies have an effect on taking responsibility, thinking carefully, solving problems, sharing knowledge, using information technologies, enhance cognitive skills, integrating knowledge with life, and reasonable thinking, and these studies favorably affect success (Korkmaz and Kaptan, 2002).

In this study, pre-test and post-test scores in the creativity domain were not significantly different in the study group, but post-test scores were slightly higher, which may indicate that innovative projects conducted as group work have a positive effect on the creativity of the students. In the semi-experimental study by Yanpar (2009), significant differences in favor of the study group were observed between students who attended creativity-based material-developing activities compared to the students who attended individual material-developing activities.

Likewise, there was no significant difference between pre-test and post-test scores of the study and the control groups in the attitude towards science domain, and there was only a slight increase in the mean post-test score of the study group. This result is parallel to some studies in the literature. Similar results have been obtained in the studies by Görecek (2007), who evaluated teaching methods supported by the projects, and by Öztürk (2007), who evaluated the effects of experiments using simple materials on the attitude of the students.

The analysis of pre-test and post-test academic self-concept scores in the study and the control groups did not reveal a significant difference between the pre-test and post-test scores. However, the mean post-test score in the study group was slightly higher compared to the mean pre-test score. According to this result, it could be stated that innovative projects conducted as group work significantly contribute to the academic self-concept of the students compared to the existing teaching methods. Also, a similar result was reported by Aldan Karademir (2007). In this study, academic self-concept scores did not significantly differ between the study and the control groups. Studies have indicated that the academic self-concept scores of the students are generally positively affected by the study, and when pre-test and post-test scores in the academic self-concept domain are evaluated pursuant to the grade variable, the scores are higher in the 6th grade, and gradually decreased toward the 8th grade (Demirbaş & Yağbasan, 2010; Çağlar, 2010). On the other hand, it was indicated that academic self-concept scores vary depending on the success scores, and higher scores in the self-concept domain are attained with higher scores in the success domain (Caglar, 2010).

The study showed that the students in the study group appreciated creating new products, performing group work, conducting research, and having a good time during the study. In the study of Salan et al (1999) it was reported that student opinions on group work converged on the common ground of closing the knowledge gap, communication, interaction cooperation, mutualization, and exchange of ideas. The studies have concluded that group work greatly contributes to the students in conducting joint studies, evaluating data, preparing efficient plans and organization, conducting research, self-assessment, taking responsibility for self-learning, acquiring life-long learning skills, and producing a product (Kalaycı, 2008; Şimşek, Doymuş & Bayrakçeken, 2004). The presence of entertainment among the responses of the students may indicate that the process of conducting research is pleasurable and exciting for the students. Failed attempts and the difficulty of conducting a joint study were indicated as the problems faced during the preparation phase of the project. Parallel to these findings, one study reported difficulty in conducting the project, constructing the project mechanism, and the supply of materials were the difficulties faced during the project (Sülün, Ekiz, Sülün, 2009).

In conclusion, the success and academic self-concept scores of the students who conducted innovative project studies in the matter and heat lesson indicate that innovative project studies as group work contributed to learning this subject. Considering the student opinions on innovative projects, it appears that students gained the skills to execute projects and conduct group studies.

The following suggestions were made as a result of the study:

1. It may be useful to consider activities that would help students gain the skills of innovative research and team-work starting in the 1st grade of elementary school.
2. In accordance with inter-disciplinary association principle, innovative projects can be conducted as a joint study of science and technology, and technology design classes.
3. Creating heterogeneous groups could enhance the communication and cooperation skills of the students.
4. Students can be encouraged to develop an innovative projects portfolio for the assessment of their projects.
5. The preparation of guidelines for creating innovative projects can be suggested to be at the disposal of the teachers in the science and technology class.
6. Long-term studies can be conducted to evaluate the effects of innovative projects on different grade levels of students.
7. Studies can be conducted to examine individual practices toward the development of innovative project execution skills.

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Appendix 1. Achievement Test Sample Questions

6. Which of the following is the reason installing double glazing windows?

A) Provide thermal and acoustic insulation
B) Provide the window look more beautiful
C) Provide less breakage of solar radiation
D) Provide less sunlight transfer through the window

14. Which of the following is the reason of the inner surface of thermos like a brilliant mirror,

I. To make reflecting surfaces holds the rays
II. To make thermos look good
III. To make thermos transmis the heat quickly

A) I B) II C) II D) I and III

20."In a warm and sunny day, you feel more cool by wearing light-coloured clothing, because these clothes ……"
Which of the following should be place in dotted sentence

A) They reflect more rays
B) They prevent sweating
C) They are not heavy as dark clothes
D) They provide more ventilation

24. Temel wants to make the store stay cool to keep the fish he held in summer
According to this, to be able to save the energy;
Which of the following should be appied:

I. Instulation materials should be used in construction of the tank
II. Heat conductive materials should be used in construction of the tank
III. Exterior of the tank shoul be paint with light colours

A) I B)II C) I and III D) II and III

Appendix 2. Innovation Projects Evaluation Form

Product evaluation	**Weak (Performance)**	**Moderate (Performance)**	**Good (Performance)**
Originality in terms of topic choice or approach to the problem			
Creativity			
Applicability and being useful			
Utility (Economic, social, academic)			
New product			
Suitable for developing new product			
Suitable for developing new designing			