

The Effect of Project-Based Educational Applications on the Scientific Literacy of 2nd Grade Elementary School Pupils*

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ABSTRACT

In this study, the effect of science projects to the scientific literacy level of elementary school pupils was examined. The research was designed according to the experimental research model of pre-test post-test design, with a control group. The sample of the research consists of a total of 32 pupils from the 2nd grade of an elementary school in Istanbul. A total of six project groups with two or three individuals were formed from the class. The control group of the research was formed by the other members of the class, who did not participate in the application. Articles from scientific magazines by the researchers were referenced, and a scientific literacy test (SLT), to measure the scientific literacy of the elementary school pupils, was prepared under the examples of PISA (the Programme for International Student Assessment) questions. SLT was applied to all groups before and after the project applications. The study was conducted under the guidance of researchers by a total of six project groups with six project topics determined by the researchers. When the scientific literacy points of the 2nd grade pupils were compared by the Mann-Whitney U test, a significant difference was found in favor of the experimental group. This result demonstrates that the project studies are significantly effective in increasing the scientific literacy of 2nd grade pupils.

Keywords: Elementary school pupils; scientific literacy; project based learning; science education.

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1. INTRODUCTION

Project Based Learning is an approach formed according to the progressivism philosophy and has been mentioned since the twentieth century. American psychologist and philosopher John Dewey is one of the pioneers who speaks about active methods, particularly project management. His doctrine “learning by doing: learning mandatory lessons not by listening but by doing” is famous. According to him, the child should behave in a way to learn how to form, manage, experience and interpret projects. Belgian psychologist and educationalist Ovide Decroly suggests that project management steers students into experiences and taking initiatives, and at the same time forces the students into cooperation while doing

projects. French pedagogue Roger Cousinet states that the students must have total freedom in order to form projects and ask and answer questions about the projects. At this point, the teacher must cooperate with the students. French pedagogue Célestin Freinet says that students must be active and prioritized in a project. Freinet develops a basic system on three dimensions; according to this system “the class must be organized like a cooperative, information must be organized, the school must produce and spread their own working elements” (Bru, & Not, 1987).

According to Proulx (2004), learning theories have confirmed interest in projects. As a matter of fact, the valid learning theories, based on Piaget and Bruner, agree on gaining information being based on the nature of a constructivist approach. According to Bruner, a child develops its learning through social interaction. Thus, it can be said that project based learning eases permanent learning by placing the student in situations as a researcher in order to form their own information (Bensalem, 2010).

There are many definitions for project based learning, but the definition of Arpin and Capra (2001) is much more comprehensive than the others. They defined this pedagogic method: project based learning is an approach that gives students the opportunity to develop their own information by interacting with their group mates and environment, and which recognizes the teacher as a pedagogic mediator between the student and the information objects (cited in Lanaris, Savoie-Zajc, Dumouchel, & Dupel, 2007).

In order to be able to implement project applications, first it is necessary to combine past learning theories that question the distinction between teaching and learning. This distinction in particular changes the didactic relationship between the student, the teacher, and the information. From this perspective, the teacher will no longer be the one forwarding the information, the student will not be learning more or less passively, and access to information will no longer be as subsequently given notions (Dubois, 2002).

There is teaching the information in the project; the students, as a result, obtain the information they need by being steered towards the solution of the problem and acting towards this while at the same time participating in the learning process.

Students involved in the project begin using their scientific process skills while solving problems about the project. The student will especially use skills such as research, questioning, critical thinking, problem solving and decision making during the project. Thus, project based learning will add to increasing the number of students with scientific literacy, as underlined in the key vision of the 2005 Science and Technology Education Program. According to the program (MEB, 2006), it is the key vision to educate all students, regardless of their personal differences, with science and technology literacy. A student having science and technology literacy means students having skills, attitude, values, understanding and information about science which are necessary to be persons who have researching, questioning, critical thinking, problem solving, and decision making skills, and who are life-long learners, continuing to be curious about their environment and the world (MEB,2006).

In science, while forming scientific information, the following are used: thinking about the nature of the information, understanding the existing information, and producing new information. As a result, the ways of obtaining information will be used while producing information. The fundamental purpose of the latest reform movements regarding science education is to raise individuals with high-level thinking skills and scientific literacy (Cepni, Ayas, Johnson, & Turgut, 1996).

According to Baumert (1997), scientific literacy prevents the use of distracting details and credibly realizes a complicated idea that seems intuitively correct. Baumert knows that the idea behind scientific literacy is an analogy about basic literacy (cited in Holbrook, & Rannikmae, 2009). Many definitions of scientific literacy have been made since Paul de Hard Hurd has used this term in 1958. However, there is still confusion about its complete meaning. According to Norris and Philips (2003), a definition of scientific literacy must contain the following various components (cited in Holbrook & Rannikmae, 2009);

- (a) Knowledge of the substantive content of science and the ability to distinguish from non-science;
- (b) Understanding science and its applications;
- (c) Knowledge of what counts as science;
- (d) Independence in learning science;
- (e) Ability to think scientifically;
- (f) Ability to use scientific knowledge in problem solving;
- (g) Knowledge needed for intelligent participation in science-based issues;
- (h) Understanding the nature of science, including its relationship with culture;
- (i) Appreciation of and comfort with science, including its wonder and curiosity;
- (j) Knowledge of the risks and benefits of science; and
- (k) Ability to think critically about science and to deal with scientific expertise

Furthermore, according to the definition made in the national pre-report about PISA 2006, an individual who has scientific literacy shall be able to:

- Use existing scientific knowledge to identify questions, obtain new information, explain scientific phenomena and find results based on evidence on subjects about science.
- Understand the characteristic properties of science.
- Show how science and technology shapes our material, intellectual, and cultural environment.
- Show interest on scientific subjects and scientific ideas as a considerate citizen.

In this context, individuals with scientific literacy shall be able to differentiate scientific and non-scientific elements in a document, while, for example, reading about health. They can use this information in their personal decisions, differentiate statements based on evidence and personal thoughts, be aware of, and can explain the role of technology, which effects the economy, social structure and culture, they can be aware of the environmental changes and the effects of these changes on economic and social stability (PISA 2006, 2007). However, in the PISA 2006 results, it can be seen that Turkish students are behind OECD countries in scientific literacy (PISA 2006, 2007).

General education methods, such as teacher-based regular lectures, note taking, and verification-type laboratory activities are not effective in developing the science and technology literacy of the students. Today, the goal is to raise individuals who can research and question by themselves using methods that increase their self-confidence (MEB, 2006).

According to Koseoglu et al. (2003), individuals with scientific literacy are researching, questioning, critical thinking, problem solving and lifetime learning individuals, thus, these individuals must have the skills, attitude, value, understanding and information about science in order to continue their curiosity about the world around them (cited in Kavak, Tufan & Demirelli, 2006). One of the fundamental purposes of the 2005 syllabus is to raise individuals with science and technology literacy. Thus, it is necessary to give priority to methods and techniques that will increase the scientific literacy of the students in science and technology lessons.

In this study, based on scientific literacy being one of the fundamental visions of the new program, and on the scientific literacy level of Turkish students being low in PISA results, the project based learning method, which is thought to increase the scientific literacy, is used. The aim of this research was to examine the effect of doing science projects to the scientific literacy levels of 2nd grade elementary school pupils. According to this, the problem of the research was formed by the question, “what is the effect of doing science projects to scientific literacy levels of elementary students”.

2. METHOD

This study; which was carried out in order to determine the effect of science project applications on scientific literacy levels of 2nd grade elementary school pupils; was designed and executed according to one of the experimental models: the pre-test post-test model with a control group.

2.1. Sample

The sample of this research consisted of 32 pupils from the 2nd grade of an elementary school in Kadikoy, Istanbul. A total of 15 elementary school pupils selected from the volunteer pupils of the 2nd grade form the experimental group. A total of six groups, mostly consisting of 3 people, were formed in the class with these pupils. These pupils are regarded as experimental group. The control group of the research was the rest of the class who did not included in the experimental group with a total of 17 pupils from the same class. The study conducted with 2nd grade students because it was aimed to show that science projects could be done with the children of those in the early ages. These pupils hadn't got introduced with science and technology lesson and also it was aimed to determine if the science projects being done in these groups have an effect on scientific literacy.

2.2. Data Collection Tools

The scientific literacy test (SLT) was prepared by the researchers in order to measure the scientific literacy of the elementary school pupils, by taking the PISA questions as an example, and by using four articles about different topics (obesity, robots, extraterrestrial life, and the greenhouse effect) taken from current science magazines, and the content validity was checked by considering the opinions of two experts. The SLT consists of a scientific text and a total of 16 questions about this text, which are multiple choice and true-false questions. The SLT was applied to all groups before and after project applications.

2.3. Procedure

Six project topics were determined by the researchers before the beginning of the study. A total of six project groups also were formed. The researchers worked with each of these groups separately. On the first day, after an introduction and distributing the project subjects, they were asked to conduct brief research about this topic. On the second week, the pupils were asked to present their research. The problem scenarios prepared about the projects to be done by the children were used by the researchers before moving on to the project application. The purpose of these scenarios was to direct the solution proposals of the pupils to a problem about their project topic, to teach them how to produce solutions for a problem, and to attract the children's attention on the subject. For this purpose, the problem scenarios were read to the children in the experimental group before the beginning of the application, and the children were asked to detect the problem in these problem scenarios and to propose a solution to this problem. The goal was to arrange for a pre-study of the children's awareness of the problem and presenting solution proposals. After the project topics were given and the tasks were distributed, they were asked to provide the materials for the next week. The materials were brought to school and the experimental projects, except for the projects about food, were done at school. In the project about food, each student was asked to pick a fruit and to observe these fruits in three different surroundings in their home and take a photograph each day. For the bread mold project, the breads were kept at the school and were controlled and photographed every day by the pupils in the group. Because the other four projects were short term, they were executed and finalized at school in one day. The projects were done completely by the pupils, with the guidance of the researchers. Project subjects and periods are given in Table 1.

Table 1. Project subjects and periods

Project Subjects	1 st Week	2 nd Week	3 rd Week	4 th and 5 th Week
<ul style="list-style-type: none"> • Food • Colors • Bread Mold • Condensation • Rockets • Magnets 	Introduction, distributing the subjects and pre-research homework	<ul style="list-style-type: none"> • Research presentations • Problem scenarios • Task distribution • Material list 	<ul style="list-style-type: none"> • Materials were completed • For Four Projects: Projects were started and completed on the same day • Two projects (Mold and Food) observations continued for 15 days. 	Project boards were prepared and presented

The problem and the hypothesis sentence were written by the pupils with their own words during the project study. After the project study, the pupils prepared their project board. It was observed that they liked and enjoyed preparing the project board. At the end of the project, the pupils verbally stated that they wanted to do a project again and that they enjoyed this study very much. The projects studies were presented by the project groups. The parents were also invited to this presentation. The attendance rate of the parents was very high and the parents have stated to the researchers that they are very glad that their children were involved in a study such as this.

2.4. Data Analysis

The data obtained from the SLT during the research were analyzed with the SPSS package program. Total SLT points constructed for each students. For that; if the answers given to the scientific literacy test (SLT) were correct, they were graded as 1 point and if they were wrong or empty, they were graded as 0 point. After processing the data to SPSS program they were analyzed using appropriate statistical tests. Before the statistical analysis of the data normality tests conducted for the groups' scientific literacy test points. For that Shapiro Wilks test was used because of the participants of the groups were less than 50. The Table 2 shows the normality results:

Table 2. Normality results

Data collection tool	Grade level	Shapiro-Wilks		
		Statistic	N	Sig. (p)
Scientific Literacy Test	Control group pre-test	0,882	17	0,035*
	Control group post-test	0,886	17	0,041*
	Experimental group pre-test	0,940	15	0,388
	Experimental group post-test	0,963	15	0,748

As seen on the table above it was understood that all 2nd grade control group both for pre-test ($p=0,035<0,05$) and post-test ($p=0,041<0,05$) didn't show normal distribution, and thus, for 2nd grade control group comparisons non-parametric tests were used. The other groups' SLT test distributions showed normal

distribution ($p > 0,05$) and for these groups' comparisons parametric tests were used. The information about the tests those were used in the study are given below on the Table 3:

Table 3. The statistical tests those were used in the study

Compared groups	Applied statistical tests
Control group pre-test - experimental group pretest	Mann Whitney U test
Control group pretest –posttest	Wilcoxon Signed-rank test
Experimental group pretest –posttest	Dependent variable t-test
Control group posttest- experimental group posttest	Mann Whitney U test

3. RESULTS

The data obtained from the SLT were analyzed with SPSS 17.00 program and the obtained findings are presented in tables.

Table 4. Mann-Whitney U test results of SLT for the comparison of the control group's and experimental group's pre-tests.

Test	Groups	N	Rank Average	Rank Total	Z	U	P
Pre-test	Control Group	17	15.29	260.00	-.788	107.000	0.431
	Experimental Group	15	17.87	268.00			
	Total	32					

$p < .05$

In Table 4 above, the Mann-Whitney U test values demonstrating the difference between the SLT pre-test points of the experimental group and control group are given. When the table is examined, it is revealed that there is no significant difference between the rank averages of the two groups. The rank average of the pre-test points of control group pupils is 15.29 and the rank average of the pre-test points of the experimental group pupils is 17.87. No significant statistical difference ($U=107.000$ $p > .05$) between the pre-test points of the experimental and control group pupils, means that the scientific literacy levels of both groups are at the same level prior to the beginning of the study.

Table 5. Wilcoxon Signed-Rank Test results of SLT for the comparison of the control group's pre-test and post-test.

Post-Test_ Pre-Test	N	Rank Average	Rank Total	Z	P
Negative Rank	9	7.11	64.00	-1.320	.187
Positive Rank	4	6.75	27.00		
Equal	4				
Total	17				

*Based on positive rank basis

The difference between the scientific literacy level of the second grade control group pupils before and after the study was analyzed with the Wilcoxon signed-rank test, as seen in the results in Table 5. There is no significant statistical difference between the points the pupils obtained from SLT before and after the study ($Z=-1.320$, $p>0.05$). This result can be interpreted as the lessons those not supported with the project based teaching method had not any effect in changing the scientific literacy levels of 2nd grade pupils.

Table 6. Paired Samples t-test results of SLT for the comparison of the experimental group students' pre-test and post-test.

Test	N	Mean	SD	Paired Samples t-test		
				df	t	P
Pre-test	15	9,20	2,30	14	-2,646	0,019*
Post-test		10,53	2,09			

* $p<0,05$

The difference between the scientific literacy level of the experimental group pupils before and after the study was analyzed with the Paired Samples t-test, as seen in the results on Table 6. Analysis results show that there is a significant difference between the pre-test and post-tests of the experimental group SLT points of the pupils on behalf of the post-test ($t=-2.646$, $p<0.05$). According to these results, it can be said that the project done by the experimental group pupils have a significant effect on increasing the scientific literacy of the pupils.

Table 7. Mann-Whitney U test results of SLT for the comparison of the control group's and experimental group's post-tests.

Test	Groups	N	Rank Average	Rank Total	Z	U	P
Post-test	Control Group	17	11.44	194.50	-3.294	41.500	.001*
	Experimental Group	15	22.23	333.50			
	Total	32					

$p< .05$

In Table 7 above, the Mann-Whitney U test values demonstrating the difference between the SLT post-test points of the experimental group and control group of pupils are given. The rank average of the post-test points of control group pupils is 11.44 and the rank average of the pre-test points of the experimental group pupils is 22.23. According to these data, there is a significant statistical difference between the post-test points of the two groups in favor of the experimental group ($U= 41.500$, $p< .05$). This difference can be interpreted in a way that the application done with the experimental group pupils is more effective in developing scientific literacy than the lessons used with the control group those not supported with the project based teaching method.

In addition to these findings, after the project presentations, the class teacher stated that they were very satisfied with the project studies and pleased that such a study was conducted with their pupils, and no such project studies were being administered in any elementary classes in the chosen school.

It was seen that prior to the beginning of the study, the pupils could not define the word “project” but that they have learned the project steps and that they gained experience on how to do a project. Furthermore, the control group pupils demonstrated interest in the conducted project studies and stated that they would also like to do projects.

4. CONCLUSION AND DISCUSSION

In this study, the project based learning method, which is believed to be very effective in raising “individuals with scientific literacy”, which is the vision of the new science and technology program, is used. Project applications were conducted with 2nd grade pupils, who are usually not included by their teachers in the project studies due to their young ages especially in public schools. The effect of project studies conducted with groups chosen from the 2nd grade of a public school, on scientific literacy levels was researched. The reason for doing the study with 2nd grades is to demonstrate that project studies can also be done in younger classes. Sahin, Guven and Yurdatapan (2011) have also stated in their studies that projects can also be successfully done with preschool children. In this study, applying science projects to 2nd grades, also it was proven that science subjects can be taught in the early elementary education. A similar concept of studying science in the early elementary education with compulsory and optional courses exists in the countries like Serbia, Russia and Bulgaria (Cvjetićanin, Segedinac & Segedinac, 2011). As a result of this study, it can be said that the 2nd grade children are successful in applying and understanding the project. At the end of the study, it was revealed that the project studies done with the 2nd grade pupils significantly increase the scientific literacy levels, and that there was no significant increase in the scientific literacy levels of the pupils in the control group. Furthermore, there was a significant difference between the post-test scientific literacy points of the control group and the experimental group, in favor of the experimental group. After these results, it can be said that the project studies done with the elementary school pupils have a positive effect on increasing the scientific literacy of the pupils.

Science and technology lessons are lessons with which the project based learning method can easily be applied. In Turkey Science and Technology lessons start in the 4th grade but the introduction to basic science subjects are given in “Knowledge of Life” lessons in the 1st, 2nd and 3rd grades. With the “Knowledge of Life” Course program (MEB, 2009) it was aimed for the pupils to gain the knowledge of the basic science concepts those will be basis for the science and technology lessons in the future. So appropriate science projects can be helpfull in the early grades also. The Elementary Science and Technology Lesson Education Program and Guide (4th and 5th Grades) book defines the vision of the new science and technology lesson education program as “all students being raised with scientific literacy regardless of their individual differences”. In order for the students to have science and technology literacy, it is necessary to introduce them to this lesson and make them be able to make statements in this area (Sahin & Ozturk, 2009). Thus, it is mandatory to involve students in the studies aimed at improving them in this direction. According to Kurnaz, Sunbul, Sulak and Alan (2005) raising individuals as stated in the new science and technology lesson education program’s vision, “for them to develop research, questioning, critical thinking and decision making skills and for them to be life-long learning individuals”, will be possible by using the project based learning approach in science education. Furthermore, in the program, the definition is “individuals with science and technology literacy are individuals who are more effective in accessing and using information, solving problems, making decisions by taking possible risks, benefits, and existing choices into consideration about problems related to science and technology and in producing new information”. Kurnaz et al., (2005) stated in their studies, that when the Science and Technology Lesson Education Program is considered as a whole, the use of plain language and using the project based education approach term in some parts and indirect use of the said approach in some parts is a necessity. This study will hopefully contribute to the

literature in demonstrating that this necessity can be fulfilled without excessive trouble, and that these project studies have an important effect on increasing the scientific literacy of the students. Furthermore, there are studies that examine the effects of the executed project studies on the success, attitude and motivation of the student (Bartscher, Gould, & Nutter, 1995; Bas & Beyhan, 2010; Gultekin, 2005; Karacalli & Korur, 2012). However, a study that examines the effect of the project studies done with elementary students on scientific literacy has not been found.

Project studies present the students the opportunity to firstly be aware of a problem and propose solution methods for it, then attempting one of the proposed solution methods. Students, who actively do all these, work exactly like a scientist. Individuals with scientific literacy are individuals with thinking ability (Philips, 2003, cited in Holbrook & Rannikmae, 2009). This study demonstrates that project studies that support scientific thinking are effective in increasing the scientific literacy of students.

The general purposes of the Elementary Science and Technology Lesson Education Program are stated with eleven articles. The project based learning approach will have a great contribution in the realization of almost all of these purposes (Kurnaz et al., 2005). Thus, it is important for project based approach applications to exist in elementary schools, and more importantly it is critical to provide project based learning environments in all classes. With this research, it is observed that the education environments based on the project based approach that are suitable for the general purposes of the program, can be applied in the 2nd grades also.

In the study done in the Little Scientists Discovering project supported by TUBITAK, aimed to detect the perception of the students on science activities, it was revealed that the wish to research and the enthusiasm of the students increases significantly when the students enter discovery environments. Furthermore, they will be happy by explaining their activities to their friends and that they want to do scientific research in the future. It was detected that the students enjoyed the activities, found them educational, learned new information, their interest in the lessons increased, and they can use the information they gained in the future (Yildirim, Atila & Dogar, 2012). Also, in this study it was detected that the students greatly enjoyed the project studies both during the execution of the project studies and during the presentation, that they enjoyed doing them, and that they want to do this type of studies again in the future. In their research, Bartscher et al. (1995) also found that the project based education has positive effect on the motivation of the students.

The results of this study are in compliance with the results of the study of Karacalli and Korur (2012), which aims to demonstrate the effects on student success and permanence of project based learning in teaching the 4th grade science and technology lesson, "Electricity in Our Lives" unit,. Karacalli and Korur (2012) have stated in their studies that project based learning in science and technology education is very effective in making the students active and in providing the opportunity for the students to obtain the information themselves within the process (Karacalli & Korur, 2012).

By taking all these results into consideration, extending project studies in elementary schools is considered and encouragement of the teachers in this direction is proposed. For this, project studies in schools can be made mandatory. Organization of in-service seminars is proposed for the teachers to gain practice and those would demonstrate that the project studies can be done easily.

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