An Investigation of the Effect of Project-Based Learning Approach on Children's Achievement and Attitude in Science

Yılmaz ÇAKICI*, **Nihal TÜRKMEN****

*Trakya University, Faculty of Education, Edirne-Turkey
**Sipahi Primary School, Edirne-Turkey

*yilmazcakici@trakya.edu.tr, **nihal.tmn.22@hotmail.com

Abstract: The aim of this study is to examine the effect of project-based learning activities on the fifth grade children's science achievement and their attitudes towards science course for the unit on 'Sound', and to compare the effectiveness of project-based learning over more traditional teaching methods. The study was carried out with 44 fifth grade students at a public primary school in the Northwestern part of Turkey, during the spring term of the 2011-2012 academic year. Students were randomly divided into two groups as control group (CG, n=22) and experimental group (EG, n=22). Initially, pre-tests (an achievement test and an attitude scale) were applied to both the CG and EG. Following the four weeks, the EG was taught using the project-based practices, while the CG was taught using more traditional teaching practices. Children in the EG carried out three science projects for the science unit on 'sound': *Bite and hear, making music with glass bottles,* and *designing a house with sound insulation.* Then, the post-tests were carried out in order to determine the effect of a project-based learning approach on children's learning. The research findings revealed that children's science achievement significantly improved with the project-based activities, but their attitudes toward science did not change.

Key words: Project-based science, science teaching, sound unit.

Introduction

Over the last three decades, project-based learning has been widely supported in science education (Egenrieder, 2007), and today it is an important component of science education. Many current curricula emphasize project-based teaching as a favored method for "motivating students and facilitating greater retention of learning" (Barak & Raz, 2000, p.28). In this context, the American Association Advancement of Science [AAAS] (1993), the National Research Council [NRC] (1996) and the Turkish Ministry of National Education [MNE] (2005) emphasized inquiry based instructional methods to improve student learning in science and to enhance the success of educational reforms movements. Many research revealed that the integration of inquiry based approaches via project-based studies in science courses improves students' deeper understanding of science (Alozie, Moje, & Krajcik, 2010).

Project-based science teaching is grounded in constructivist theory and provides many opportunities for transforming classrooms into active learning environments (Krajcik, Blumenfeld, Marx, & Soloway, 1994). According to constructivist approach, learner constructs knowledge personally, through relating new knowledge to prior experience, or socially, through interaction with people around, such as friends, teachers, family, etc. (Bates, 2005). Project-based learning supports the constructivist principles; working collaboratively with others, reflecting on what have been learned, personal autonomy and active engagement. Therefore, project-based learning is viewed as a type of inquiry learning (Egenrieder, 2007). Rather than rote procedures, it encourages students to construct their own knowledge and understanding.

Project-based teaching is based on challenging and driving questions that involve students in problem-solving and decision making process (Thomas, 2000). Through project-based teaching, students find solutions to real world problems by asking open-ended questions, designing and conducting investigations, researching problem, gathering information, drawing conclusions based on the findings, and reporting results (Schneider, Krajcik, Marx, & Soloway, 2002). Ladewski, Krajcik and Harvey (1994) pointed out that projects require an authentic real-word problem that drive activities and result in a series of products related to the problem. Projects represent students' emerging understandings and allow students to engage in investigations. According to Solomon (2003), by examining work of others, students learn to improve the quality of their work and to communicate more clearly and effectively. Furthermore, many researcher (Kucharski, Rust, & Ring, 2005; Papastergiou, 2005) emphasized that project-based learning plays a crucial role in increasing motivation of students. Project-based learning increase student motivation, improve achievement, and provide positive learning experiences and authentic problem-solving opportunities (Gulbahar & Tinmaz, 2006).

One of the crucial factors in learning science is children’s attitude (George, 2006). A positive attitude toward science is commonly considered as a predictor of behavior, and thus they influence science achievement and interest in science (Carey & Shavelson, 1988; Koballa, 1992). On the other hand, negative attitudes may lead to lack of interest for science learning (Weinburgh, 1998). Koballa and Crawley (1985) emphasized that attitude toward science “fulfills basic psychological needs, such as the need to know and the need to succeed.” Therefore, attitudes toward science are considered “to influence future behaviors, such as interest in working on a science project” (p.224). A high number of studies has investigated the importance of attitudes in learning science and the relationship between attitude and science achievement (Oliver & Simpson, 1988; Papanastasiou & Zembylas, 2004). In this context, a comprehensive work carried out by Weinburgh (1995), based on meta analysis of 43 studies, showed that a positive attitude towards science appears to be a predictor of higher achievement.

When the science education literature is reviewed, it is seen that growing amounts of research explored the effect of project-based science teaching on science achievement and attitudes towards science course abroad and in Turkey. For example, Doppelt (2003), aiming to advance low-achieving students, defined significant goals for the pupils and the teachers, and then carried out original projects taking advantage of the pupils' special skills and abilities. He reported that project-based learning elevated pupils' motivation and self-image at all levels and achieved significant affective learning. Most of the low-achieving pupils succeeded with distinction in the same matriculation exams that the high-achievers did in the same school. The study conducted by Rivet and Krajcik (2004), with 24 teachers and over 2500 students by designing project-based curriculum materials that contextualize the learning of science in meaningful real-world problems, revealed that project-based curriculum materials promoted learning of important and meaningful science content aligned with standards. In another research, Papastergiou (2005) investigated a project-based learning environment and its impact on student teachers. The participants were 46 student teachers. The research indicated that the project-based learning approach has been motivational and effective regarding the acquisition of design and development skills. The participants became more interested in and self-confident about project subject. In a similar study, Kanter and Konstantopoulos (2010), aiming to determine the effect of a project-based science curriculum on students’ science achievement and attitudes, provided professional development to bolster urban teachers’ science content knowledge and science pedagogical content knowledge. They found that students’ science achievement improved with the project-based science curriculum, but that their attitudes toward science and plans to pursue science did not.

In Turkish literature, Korkmaz and Kaptan (2002) examined the effect of project- based learning approach on the academic achievement and academic self-concept and study time of 7th grade students. While the control group followed textbook and teacher-centered activities, the experimental group students experienced a project-based learning. After the project process, they reported that there was a significant difference in favour of experimental group in terms of academic achievement, academic self-concept and study time. In a similar study, Altun Yalçın, Turgut and Büyükkasap (2009) aimed to determine the effect of project based learning on the first year science undergraduates’ attitudes towards physics, electricity achievement, and development of scientific process skills. They used quasi-experimental nonequivalent groups pretest-posttest design study, and the sample consisted of total of 90 first year science undergraduates enrolled in the Science Teacher Training Department in Bayburt Education Faculty in 2006–2007 academic year in Turkey. Their research findings revealed that there were statistically significant differences between experimental and control group with regard to students’ attitude toward physics, electricity achievement and scientific process skills. The experimental results also support the idea that the project based learning improved the students’ learning and helped their attitudes towards physics and research skills to enhance. Sert Çıbık (2009) investigated the effect of project based learning approach to the development of attitude of seventh grade students towards science. A total of 44 students (22 in the experimental group and 22 in the control group) participated in the study. At the end of the study, when the experimental and control group results are compared, there was a meaningful difference in favor of experimental group.

Similar to the present study, Deniş Çeliker and Balım (2012) investigated the impact of project-based learning of the “Solar System and Beyond: Space Puzzle” unit on the seventh grade students’ achievement. They used quasi-experimental pre-test - post-test control group design. At the end of the study, they reported that academic achievement of students in the experimental and control groups regarding the unit was found to be significantly different in favor of the experimental group. Karaçallı and Korur (2012) carried out a study to explore the effect of project based learning approach on the 4^{th} grade students' academic achievement, their attitude and persistency for the unit electricity. While the unit electricity is taught with project based learning approach in experimental group (73 students), the control group followed the traditional method (70 students). The results showed that project based learning increased students' achievement and retention of knowledge. However, there was no statistically significant difference among groups in terms of their attitudes toward science. In another study, Şahin and Benzer (2012) investigated the effect of project development strategy of the four questions on the scientific process skills of science teachers and elementary students. The study group consisted of 14 teachers studying in the graduate programme and 111 middle elementary school students. Through the use of quantitative and qualitative research techniques, they found that project implementation with the four questions strategy has a positive effect on the scientific process skills of each working group. However, as different from many studies in the literature, Ayan (2012), in her research about the effect of project-based learning approach on the academic achievement of fifth grade students, did not report any significant differences between control and experimental groups.

In sum, many research in the literature examined the impacts of project-based teaching and more traditional learning activities on student achievement and attitudes. These studies commonly emphasized the project-based science teaching as a useful pedagogical strategy enabling students to improve meaningful learning and to make connections between their real-life experiences and new information. As Tamir (1998) stated, teaching style affects both students' achievement and attitudes toward science. In this context, this study explored the effect of project-based learning activities on the fifth grade children's science achievement and attitude towards science for the science unit on 'Sound'.

Materials and Method

Research design

In this study, the pre-test post-test control group of quasi-experimental research design was used (Cohen & Manion, 2000).

Participants

This study was carried out to improve the learning experience for the children through the project-based learning strategies during the spring term of the 2011-2012 academic year. Participants consisted of 44 fifth grade students at a public primary school in the Uzunköprü-Edirne district located in the Northwestern part of Turkey. Students were divided into two groups, a control group (CG, n=22) and experimental group (EG, n=22). The control and experimental groups were regular classrooms.

Instruments

In this study, data were collected through the use of two instruments; an attitude scale and an achievement test. Children's science achievement was measured by *the Light and Sound Achievement Test* developed by Salgut (2007). Reliability coefficients of this test were determined by the KR-20 method. The KR-20 coefficient of the test was .92 (Salgut, 2007). Children's attitude was measured by *the Scale for Attitudes towards Science Course* which was developed by Altınok (2006). The Cronbach alpha reliability coefficient of the attitude scale was .92 (Altınok, 2006). Students' responses on the Attitudes toward Science Course scale ranged from strongly agree (5) to strongly disagree (1).

While the class teacher taught in the CG, the courses in the EG were conducted by the researcher. The researcher was also a class teacher and had ten years of teaching experience. It is worth noting that the researcher had participated in science project competitions before, and thus had the experience of the project-based learning approach, and knew how to properly conduct children's project works. During the application of project works, the researcher carefully observed the all students, and guided them sometimes by giving clues, sometimes by encouraging them to find solution by themselves.

The Application of Teaching Activities

This study continued five weeks. The first week, initially children were given a brief information about the aim of the study and process of conducting a science project. Then, pre-tests consisting of attitude scale and achievement test were applied to both the CG and EG. During the following four weeks, the EG was taught using the project-based activities in science lessons (a total of four hours per week). As for the CG, science courses were carried out through the routine course plans in accordance with Science and Technology course instruction program. The CG followed the activities in the fifth grade Science and Technology textbook. The children in the experimental group completed project planning and preparation form and project evaluation form for each project work. Three science projects conducted with children are briefly explained below.

Making Music with Glass Bottles. The first project work children undertake for the unit sound was "*Making Music with Glass Bottles"*. The previous week the researcher had instructed pupils to search about 'what is sound', 'how sound is produced' and 'how sound travels' using internet, textbooks or other reachable materials. The researcher had also requested children to bring identical glass bottles to science course. At the beginning of the science course, the children in groups filled in the project forms, which explain aim of the project and roles of project team members. Later, the researcher let children enjoy with glass bottles for a while. During this process, she instructed children to hit the different parts of bottles e.g. while holding a bottle in hand and while a bottle standing on table, and directed some questions to them as well. For example, "What happens when you hit the bottle standing on the table or while you are holding bottle in your hand?" "Do you hear a different sound?" "Is there a difference between sounds?".

Using bottles to make music is an interesting science project for children, and thereby, explores how volume and liquid affect sound waves. In this project, children use only seven-eight empty bottles and some water. The bottles must be all the same, such as empty glass soda or fruit juice bottles. At the beginning, children stand eight empty bottles side by side on a table, and then fill the bottles with different amounts of water. Fill the bottle on the left with some water, and add water to the next bottle so that the water level is a bit higher than in the first bottle. Each bottle must have a little bit more water in it than the bottle to its left. There is one variable, which is the amount of water. Initially, using a metal spoon, children tap the each bottle with a metal spoon and compare the pitch of the sounds produced. Tapping the bottle causes the bottle and its contents to vibrate. The pitch of the sound is determined by how fast the bottle and its contents vibrate. As the water inside the bottle decreases the vibrations increase, and this causes to a higher pitched sound. Sound is a form of wave energy that moves outward from the vibrating bottles.

Later, children blow across the each bottle and compare the pitch of the sounds produced. When they blow across the bottles from left to right, the bottles with more air produce low sounds, and the bottles with less air produce high sounds. Blowing bottles cause the air inside to vibrate and the amount of air in the bottle affects the sound it makes. The bottle with the most water has the least amount of air, thus it produces a sound with the highest pitch, due to faster vibration of air molecules. In sum, blowing across the tops of the bottle instead of tapping them change the sound produced. During this project work, by adjusting the amount of water in each bottle, children produced a whole musical scale.

Making Headphone / How Headphone Works. In this project work, children learn how headphones carry the sound from the music player to the headphones. Headphones and speakers have a similar design. Children have initially taken apart a headphone and observed the components in the classroom. Taking a headphone apart is an effective way to find out how they work. Then, they started to construct a model of headphones to be able to better understand how headphones function. Materials needed to make a headphone are a coil of copper wire, a magnet, an audio cable and a dry branch. A headphone contains a magnet and metal coil just above of the magnet. First, by winding the copper wire around the dry branch, we composed a kind of coil on the branch. Then, we attached a strong magnet on the coil by using a tape. The coil is just below the magnet and the each end of the copper coil was connected to two tiny copper wires from the audio cable that connects the headphone to the music player.

When electricity (audio wave) passes through the wire or travels from the music player to the coil, a small magnetic field is produced around the metal coil, and the coil becomes electromagnet. The magnetic coil, then, interacts with the original magnet, causing them to rotate between repelling and attracting each other. In the headphones, the coil is attached to a diaphragm and this rotation causes to the vibration of diaphragm. This movement vibrates the surrounding air, and produces sound waves out from the headphones, or in our case, straight into our ears. In essence, the electrical signal representing an audio wave in the coil is turned into sound waves. When we bite dry branch, the vibrations reaches to our eardrum, and our ears interpret these vibrations, and thereby, listen to the music playing. Children really appeared to be very enthusiastic about this project work. They worked willingly during the project activity and asked many questions concerning how sound travels from one material to another.

Developing Sound Insulation in Our House. In this project activity, children tried to answer the question how to reduce or minimize sound traveling in a house. Initially, children in groups talked about what is noise, the noise pollution in the environment, and how the noise affects our life negatively. Later, they discussed about how to develop sound insulation in a house. Then, they put quartz clock in a box and, using everyday materials such as carpeting, cotton, fabric, cloth etc., tried to insulate tic tac sound of quartz clock that should not come out.

Sound travels as waves through the air. Sound is either absorbed or reflected by a surface. Sound insulation is the resistance to sound. Sound insulation materials act as a sound absorber. The best materials are those that absorb the sound waves effectively: carpeting, cotton, fabrics, cloths, cork board, rock wool and fibreboard, etc. Following the week, the post-tests were administrated to both the EG and CG in order to reveal the effect of project based activities on children's achievement and attitude.

Findings

The independent samples t-test compares the mean scores of two groups on a given variable. At the beginning of the study, independent samples t-test was used to determine whether two groups were equal in terms of their attitudes towards science course and achievement on the 'sound' topic. The pre-test results are presented in Table 1 and 2 below.

Table 1. Pre-test results of the independent samples t-test for students' achievement in the sound topic.

Pre-test	Groups	n	Mean	SD	t	df	p
Achievement	Control G.	22	12,00	4,74	-,072	42	,94
	Experimental G.	22	12,09	3,60			

Table 2. Pre-test results of the independent samples t-test for students' attitudes towards science course.

Pre-test	Groups	n	Mean	SD	t	df	P
Likeness	Control G.	22	50,18	4,76	,749	42	,46
	Experimental G.	22	48,95	6,04			
Participation	Control G.	22	71,59	6,64	,801	42	,43
	Experimental G.	22	69,77	8,33			
Determination	Control G.	22	6,23	1,57	-1,257	42	,22
	Experimental G.	22	6,86	1,78			

As seen in Table 1 and 2, there was not a significant difference between the two groups' pre-test scores [$t(42)_{(achievement)}$=.-072, p>.05; $t(42)_{(likeness)}$=.749, p>.05; $t(42)_{(participation)}$=.801, p>.05; $t(42)_{(determination)}$= -1.257, p>.05] which indicates two groups were equal in terms of students' attitudes towards science course and achievement in the sound subject.

At the end of the project-based activities, the independent samples t-test was used to determine the differences, if any, between the experimental and control group scores. The results are given in Table 3 and 4 below.

Table 3. Post-test results of the independent samples t-test for students' achievement in the sound topic.

Post-test	Groups	n	Mean	SD	t	df	P
Achievement	Control G.	22	13,00	4,44	-8,056	33,30	,00
	Experimental G.	22	21,77	2,52			

Table 4. Post-test results of the independent samples t-test for students' attitudes towards science course.

Post-test	Groups	n	Mean	SD	t	df	P
Likeness	Control G.	22	50,00	4,48	-,070	42	,95
	Experimental G.	22	50,14	8,02			
Participation	Control G.	22	70,95	8,34	-,581	42	,56
	Experimental G.	22	72,55	9,76			
Determination	Control G.	22	6,23	1,82	-1,508	42	,14
	Experimental G.	22	7,18	2,34			

According to Table 3, there was a significant difference in terms of achievement between the control and experimental group [$t(33.30)= -8.056$, $p<.001$]. Project-based learning seemed to increase children's achievement in science as a result of making learning more enjoyable and meaningful e.g. motivating children to take responsibility for investigation, giving them opportunity to negotiate about the possible solutions to the problem, to address their ideas and to form their own models, etc. These findings support the previous studies conducted by Doppelt (2003), Kanter and Konstantopoulos (2010), Rivet and Krajcik (2004), Deniş Çeliker and Balım (2012), Sert Çıbık (2009), and Turgut and Büyükkasap (2009). However, as seen in Table 4, no significant difference was found between the post-test results of the control and experimental group for attitudes towards science course [$t(42)_{(likeness)}=-.070$, $p>.05$; $t(42)_{(participation)}=-.581$, $p>.05$; $t(42)_{(determination)}=-1.508$, $p>.05$]. One reason for this situation might be the difficulties children experienced during the project works. It is worth noting that although the findings of the experimental group were not significantly higher for attitudes, the mean results for the experimental group were slightly higher than the control group. Similar to the findings of the present study, Karaçallı and Korur (2012) reported that project based learning increased 4th grade students' achievement but there was no statistically significant difference among groups in terms of their attitudes toward science.

Discussion and Conclusion

This study revealed that students carrying out project-based activities had significantly higher achievement than those who continued taking routine teaching in science courses. On the other hand, there was not a significant difference between the control group and experimental group for their attitudes towards science course. This indicates that the use of project-based learning experiences for relatively short term (four weeks) do not lead to a significant increase in students' attitude towards science course. However, learning appears to be more effective with the use of project-based activities.

The outcomes of project-based learning in this study suggest that teachers need to alter their teaching styles towards more student-centered and project-based activities. According to Putnam and Borko (1997 in Tal et al. 2006), teachers should change their knowledge, beliefs, and practice in order to help students to improve their understanding, and their use of higher cognitive skills. This change includes not only learning new techniques, but also the overall perception of new teaching beliefs that direct future practice.

Project-based learning urges students to take responsibility for their own learning (Gonzales & Nelson, 2005). According to Kanter and Konstantopoulos (2010) the inquiry-based aspect of project-based teaching provides knowledge construction and allows students doing science rather than memorizing facts. In this process, teachers play a crucial role in enacting the intended curriculum and taking over the centrality of inquiry and active construction of knowledge. Furthermore, they guide students to work on task, present the ideas, and build relationships (Tal, Krajcik, & Blumenfeld, 2006). During the project work process, teacher should play the role of a guide and facilitator giving feedback on goals pursued (Kurzel & Rath, 2007). Similarly, Solomon (2003) and Grant and Branch (2005) emphasized that teachers need to help students to set goals and to break the project into attainable steps and to serve as a facilitator, guiding and advising students. Kanter and Konstantopoulos (2010), based on their research findings, emphasize that the extent of the success of a project-based science curriculum appears to be dependent on elements of both teacher content knowledge and pedagogical content knowledge, and teachers' frequency of use of inquiry-based activities.

Many factors affect a child's motivation and interest to work together and to learn new things in class. In this study, the new project experiences or challenges which are different from classical class activities seemed to enhance children's self-motivation. The children showed different levels of interest in different project works. Making headphone activity was the most interesting project work from children' point of view. It is widely agreed by the educators that children take greater ownership in their projects when the project is attracting them, interesting for them. Therefore, science teachers who take on a broad scope for science projects can be better able to motivate students whose interests may be in the different topics. This also enables students to make connections between their classroom experiences and their interests (Egenrieder, 2007, 5).

Given that many studies have found positive relationship between attitude toward science and higher science achievement (Schibeci & Riley, 1986; Oliver & Simpson, 1988; Schibeci, 1989; Freedman 1997), teachers should give particular attention to both student-centred teaching strategies and students' attitudes in science lessons. Traditional science teaching practices diminish students' attitude toward science and achievement in science (Kahle, Meece & Scantlebury, 2000). Therefore, teachers have the responsibility of making the curriculum as relevant and as exciting for students as possible (Trumper, 2006). In this context, project-based teaching activities may provide great opportunities to students for effective science learning, and eventually to enhance positive attitudes towards learning science.

In conclusion, this study supports the view that project-based learning is an effective and motivating strategy for students. 2004 Turkish primary school curriculum was prepared in the light of the constructivist theory, and emphasizes the common use of student-centered and inquiry-based approaches in science courses. Furthermore, Turkish curriculum like the other curriculum design projects in the world requires students to engage in authentic science learning experiences in which students engage in inquiry-based research projects with interesting questions Moje et al. 2001). This situation increases the responsibility of teachers in science courses in order to provide students more enjoyable and effective science learning environments through project-based activities e.g. building student-centered, cooperative, critical, investigative, communicative and interactive learning experiments. However, as Tal, Krajcik and Blumenfeld (2006) emphasized, teachers' content knowledge and pedagogical skills are necessary for successful implementation of new practices, but not sufficient for science education reform. Teachers usually continue to teach in their traditional manner even though they use new textbooks and materials. Therefore, science teachers should be encouraged and supported to practice inquiry-based approaches, especially project-based science teaching to improve success of reform efforts at schools in Turkey or elsewhere (Schneider, Krajcik, Marx, & Soloway, 2002). In science courses, well-designed and well-implemented project-based learning experiences may be a significant catalyst to gain students critical thinking and problem solving kills, and finally to train them as scientifically literate individuals in accordance with the science curriculum requirements of 21st century.

References

Alozie, N. M., Moje, E. B., & Krajcik, J. S. (2010). An analysis of the supports and constraints for scientific discussion in high school project-based science. *Science Education, 94*, 395-427.

Altınok, H. (2004). *İşbirlikli Öğrenme, Kavram Haritalama, Fen Başarısı, Strateji Kullanımı ve Tutum*. [Cooperative Learning, Concept Mapping, Science Achievement, Use of Strategy and Attitude]. Unpublished Doctoral Thesis, Dokuz Eylül Üniversitesi Eğitim Bilimleri Enstitüsü, İzmir.

Altun Yalçın, S., Turgut, Ü. & Büyükkasap, E. (2009). The effect of project based learning on science undergraduates' learning of electricity, attitude towards physics and scientific process skills. *International Online Journal of Educational Sciences*, 2009, 1(1), 81-105.

Ayan, M. (2012). Proje tabanlı öğrenme yaklaşımının ilköğretim öğrencilerinin fen bilgisi dersi akademik başarı düzeyine etkisi. *Türk Eğitim Bilimleri Dergisi*, 10(1), 167-183.

Barak, M. & Raz, E. (2000). Hot-air balloons: Project-centered study as a bridge between science and technology education. *Science Education*, 84 (1) 27-42.

Bates, A.W. (Tony). (2005). *Technology, e-learning, and distance education* (2nd ed.). Abingdon, Oxon: Routledge.

Deniş Çeliker, H. & Balım, A.G. (2012). Effects of project based learning of the "Solar system and beyond: Space Puzzle" Unit on student achievement. *Journal of Theoretical Educational Science*, 5(3), 254-277.

Doppelt, Y. (2003). Implementation and assessment of project-based learning in a flexible environment. *International Journal of Technology and Design Education*, 13(3), 255-272.

Egenrieder, J. A. (2007). Community-focused, project-based learning to promote diversity in STEM. *Journal of Virginia Science Education*, 1(2), 5-16.

Freedman, M. P. (1997). Relationships among laboratory instruction, attitudes toward science, and achievement in science knowledge. *Journal Research in Science Teaching*, 34, 343-357.

George, R. (2006). A cross-domain analysis of change in students' attitudes toward science and attitudes about the utility of science. *International Journal of Science Education*, 28(6), 571-589.

Gonzales, A. H., & Nelson, L. M. (2005). Learner-centered instruction promotes student success. *T.H.E Journal*, 32(6), 10, 12, 14-15.

Grant, M. M., & Branch, R. M. (2005). Project-based learning in a middle school: Tracing abilities through the artifacts of learning. *Journal of Research on Technology in Education, 38*(1), 65-98.

Gulbahar, Y. & Tinmaz, H. (2006). Implementing project-based learning and e-portfolio assessment in an undergraduate course. *Journal of Research on Technology in Education, 38*(3), 309-327.

Kahle, J. B., Meece, J., & Scantlebury, K. (2000). Urban African American middle school science students: Does standards-based teaching make a difference? *Journal of Research in Science Teaching*, 9, 1019-1041.

Karaçallı, S. & Korur, F. (2012) Yaşamımızdaki elektrik ünitesinde öğrencilerin akademik başarısına ve kalıcılığına proje tabanlı öğrenme yönteminin etkisi. *X. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi.* 25-27 Haziran, Niğde Üniversitesi. Niğde.

Koballa, T. R., & Crawley, F. E. (1985). The influence of attitude on science teaching and learning. *School Science and Mathematics*, 85(3), 222-232.

Koballa, T. R. (1992). Persuasion and attitude change in science education. *Journal of Research in Science Teaching*, 29, 63-80.

Korkmaz, H. & Kaptan, F. (2002). The effects of project-based learning on elementary school students' academic achievement, academic self concepts and study time in science education. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 22, 91-97.

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). Acollaborative model for helping middle grade science teachers learn project-based instruction. *The Elementary School Journal*, 94, 483–497.

Kurzel, F. & Rath, M. (2007). Project based learning and learning environments. *Issues in Informing Science and Information Technology*, 4, 503-510.

Ladewski, B. G., Krajcik, J. S., & Harvey, C. L. (1994). Amiddle grade science teacher's emerging understanding of project-based instruction. *The Elementary School Journal*, 94, 499–515.

Moje, E. B., Collazo, T., Carrillo, R., & Marx, R. W. (2001). "Maestro, what is `quality'?": Language, literacy, and discourse in project-based science. *Journal of Research in Science Teaching,* 38(4), 469-498.

Oliver, J. S., & Simpson, R. D. (1988). Influences of attitude toward science, achievement motivation, and science self concept on achievement in science: a longitudinal study. *Science Education*, 72, 143–155.

Papanastasiou, E. C., & Zembylas, M. (2004). Differential effects of science attitudes and science achievement in Australia, Cyprus, and the USA. *International Journal of Science Education*, 26(3), 259-280.

Papastergiou, M. (2005). Learning to design and implement educational web sites within pre-service training: A project-based learning environment and its impact on student teachers. *Learning, Media and Technology*, 30(3), 263–279.

Rivet, A. E. & Krajcik, J. S. (2004). Achieving standards in urban systemic reform: An example of a sixth grade project-based science curriculum. *Journal of Research in Science Teaching*, 41(7), 669–692.

Salgut, B. (2007). *İlköğretim 5. Sınıf Fen ve Teknoloji Dersi Işık ve Ses Ünitesinde İnternetinde Kullanıldığı Bilgisayar Destekli Öğretimin Öğrenci Başarısına Etkisi*. [The Effects of Computer Assisted Instruction along with Internet for 5th Grade Primary School Students Acquisition in Science and Tecnology Lessons Light and Voice Unit]. Unpublished Doctoral Thesis, Çukurova Üniversitesi Eğitim Bilimleri Enstitüsü, Adana.

Schibeci, R.A., and J.P. Riley. (1986). Influence of students' background and perceptions on science attitudes and achievement. *Journal of Research in Science Teaching,* 23, 177-187.

Schibeci, R.A. (1989). Home, school, and peer group influences on student attitudes and achievement in science. *Science Education,* 73, 13-24.

Schneider, R. M., Krajcik, J., Marx, R. W., & Soloway, E. (2002). Performance of students in project-based science classrooms on a national measurement of science achievement. *Journal of Research in Science Teaching*, 39(5), 410-422.

Sert Çıbık (2009). The effect of the project based learning approach to the attitudes of students towards science lesson. *Elementary Education Online*, 8(1), 36-47.

Solomon, G. (2003). Project-based learning: a primer. *Technology & Learning*, 23(6), 20-26.

Şahin, F. & Benzer, E. (2012). The effect of the project practices improved with four question strategy to science process skills. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, 6(1), 306-337.

Tal, T., Krajcik, J. S., Blumenfeld, P. C. (2006). Urban schools' teachers enacting project-based science. *Journal of Research in Science teaching*, 43(7), 722-745.

Trumper, R. (2006). Factors affecting junior high school students' interest in biology. *Science Education International*, 17(1), 31-48.

Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching*, 32, 387–398.

Weinburgh, M. (1998). *Gender, ethnicity, and grade level as predictors of middle school students' attitudes toward science.* Georgia State University. Retrieved December 8 2012 from www.ed.psu.edu/CI/ Journals/1998AETS/s5_1_weinburgh.rtf