Examining problems in project work executed in high schools according to student and teacher views

Güner TURAL[1,4], Nevzat YİĞİT[2] and Nedim ALEV[3]

**[1,3]Karadeniz Technical University, Fatih Faculty of Education, Department of Secondary Science and Math Education,
61335-Söğütlü- Trabzon /TURKEY**

**[2]Karadeniz Technical University, Fatih Faculty of Education, Department of Elementary Science Education,
61335-Söğütlü- Trabzon /TURKEY**

[4] Correspondence author

Email: gdincer55@gmail.com

Received 29 Dec., 2008
Revised 12 Jun., 2009

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Abstract

Project work is the primary method which enables practicing the activities that contemporary learning theories suggest. The aim of this study is to determine the issues encountered during project work in accordance with students' and teachers' views in secondary schools physics courses in the city of Trabzon, Turkey where project work has been executed. Case study strategies were adapted using semi-structured interview protocols with five teachers and five students in three different secondary schools. Findings revealed that students who designed their own projects lacked fundamental and experimental process skills such as "deciding on

the project topic", "observation", "measuring and using the numbers", "drawing conclusion" and "organizing and writing a report". Issues such as time, availability of materials required in the project and consultancy needed have an effect on the process of project-based work. This study also indicated that students have not acquired the skills and knowledge of doing project-based work during their elementary education. Finally, the study illustrated that issues such as teacher pre-service and/or in-service training, cooperation among schools, university and other parts and support from local and national level are not enough to use project-based work in secondary schools, and thus it only depends on the school and teachers to utilize this mode of teaching of physics.

Keywords: Project work, scientific process skill, issues of project work, secondary education

Introduction

Today, productivity in science and technology is an indicator of the development level of countries. As a result, countries compete with each other to improve their educational systems in order to be successful in this respect. Being productive in science and technology depends on the adoption of scientific thinking and the scientific method as a way of life. In this information era, the basic objective of education in the national curriculum is to equip students with the skills and knowledge of how to reach information instead of simply transmitting information. This new age of information and technology is mainly impacted by the rapid change in science and technology. For this reason, each passing day the importance of science education increases. The aim of science education is to improve students' scientific process skills and attitudes and make them generate scientific knowledge (Çilenti and Özçelik, 1991). The project-based work executed in schools has an important role in order to make the students acquire fundamental scientific knowledge and skills (Çepni, Ayas, Johnson and Turgut 1997) and apply it to new situations (Solomon, 2003). The project method is a mental and physical activity done in real-life like conditions. It gives students an opportunity to experience the facts in context (Özden, 1998; Raghavan, Coken-Regev and Strobel, 2001), allowing them to work independently and construct their own learning processes, and thus knowledge. The laboratory approach has been used in order to solve real life problems, and thus the project work which includes laboratory activities has gained importance (DeBoer, 1991). Project work is a sign of giving importance to students' thoughts and interests, and thus, teachers should let students develop their own projects according to their interests. When students realize that teachers value their thoughts, their personal interest and self-confidence will increase, leading to reorganization of their own potential for self learning. Students' belief that they can learn by themselves is one of the most important aims of science teaching. Executing projects lets students to develop mental correlation to create new knowledge, construct their own knowledge and promotes them to generate and finalize their own products (BIE, 2008; Howe and Jones, 1998).

Korkmaz and Kaptan (2001) considered science projects within three of the following categories:

Construction or Machinery Projects: For example, students focus on an atom model and try to explain the product.

Experimental/Research/Evaluative Projects: Based on theoretically known concepts, but in order to investigate the effects of multiple variables, these experiments or models can be done.

Investigation and Discovery Projects: Students define a problem, suggest possible solutions, try multiple solutions, reach a verdict and share it with others like a scientist.

This study is about research and discovery projects which promote scientific skills to students. Executing projects efficiently depends on the opportunity provided for students to be able to do the project work, that is, the learning setting should be carefully designed for students. The most important behavior developed by students in a suitable project setting is that they are able to decide for themselves. The theoretical knowledge which is learned in school enhances the connection information clusters, generates curiosity and improves skills, therefore, participation results in overall improvement of mental process skills (Özden, 1998). Students can be independent learners with the help of project work by partially transferring the responsibility to the learner. It is important to emphasize the necessity of project work in science especially in physics (Sezgin, Çalışkan, Çallıca and Erol, 2002).

However, literature show that project work is not common in current physics classrooms, and students do not have the expected level of skills and knowledge to execute project work (Akdeniz and Keser, 2000; Akdeniz and Devecioğlu, 2001). Teachers and students are encouraged, especially in science high schools, to design and execute high level project work by the Ministry of National Education (MEB, 1999a). Determining the problems while preparing a project or understanding how project work is conceived is vital in order to generate desired level of project work.

Lack of materials, the university entrance exam, and teachers' insufficient level of skills were found as the factors that have an effect on the process of project-based work (Akdeniz and Devecioğlu, 2001). Research show that students mainly encounter problems with data analysis, making conclusions, peer cooperation, peer discussion and time management in project basis learning activities (Edelson, Gordon and Pea, 1999; Krajcik et al., 1998; Thomas, 2000). BEST (Board of European Students of Technology) states (2006) the handicaps as:

- Projects require suitable space for cooperative work ;
- Sufficient funds can be needed;
- Evaluation can be a vital problem;
- Group members need to be at the same level and accomplishing this situation can be difficult;
- Communicative problems;
- Length of time;
- Group members can be excluded;
- Disappointment;
- And extra effort should be given by teachers.

An experimental study conducted by Kaptan, Aslan and Atmaca (2002) about primary school students' problem solving abilities in science showed that the problem solving method was successful, particularly from the perspective of real and permanent learning. Kaptan and Korkmaz (2002) carry out similar research with science student teachers. Their study

illustrated that lessons problem solving methods used increased the student teachers' problem solving skills.

It is important to do research about how schools, teachers and students manage project work and which issues arise from the practice in order to take precautions for the possible disadvantages of project-based learning. Continually encountering similar problems could eventually can make students reluctant to do project work, which could pose a serious threat to science education. It is well-known from the literature that project-based learning is rare in secondary physics classrooms. Therefore, the importance of this study is to find out why the project work cannot be done as desired, which issues need to be tackled and how to solve the encountered problems during the project-based work. It is believed that finding answers to these basic questions might help teachers, and thus students, to find ways to accomplish their tasks in practicing this valuable learning approach.

The aim of this study is to understand the issues that arise from project-based learning and the problems encountered during the project work from the participating teachers' and students' point of view. The study seeks to find answers to the following questions: who decides the project topics and problems?; do the schools have enough materials and suitable environment to execute the project work?; do the participants have the knowledge and skills to execute project work?; what are the problems they faced and at which stage(s) of project work did they have difficulties?; what are their suggestions to make a real improvement in doing project work as desired?

Method

Research Design

A case study strategy was used to better understand the phenomenon holistically and in-depth. As Merriam (1998) puts it, a case study is suitable research design if the study is about the process. In this current study the researcher tries to understand and discover how the project-based work proceeds in physics lessons and how participants (teachers and students) define their practices and problems encountered. The identified cases are three different types of secondary schools in the city of Trabzon, Turkey in which project-based work has been executed.These schools were chosen since they were schools that participated in a physics project competition at the national level from the city of Trabzon.

The Participants

The participants of the study are five volunteer physics teachers and five volunteer secondary students who had some experience of doing project-based work at the national level in their respectives schools that are the cases of this multiple case study. Table 1 summarizes the participating students' and teachers' backgrounds. All participating teachers and students have had some experience of doing project-based work in physics lessons.

Table 1. *Background information about the participating students and teachers*

Students	Information about students	Teachers	Information about teachers
A	Anatolian High School student, age 16, grade average 4.65.	**A**	Working in an Anatolian High School, female, with 13 years of experience and first year in her current school
B	Private High School student, age 16, grade average 4.70.	**B**	Working in a Private High School, female, 5 years of experience and fifth year in her current school
C	Private High School student, age 16, grade average 4.00.	**C**	Working in a Private High School, male, 7 years of experience and first year in his current school
D	Science High School student, age 17, grade average 5.00.	**D**	Working in a Science High School, male, 19 years of experience and twelfth year in his current school
E	Science High School student, age 16, grade average 5.00.	**E**	Working in a Science High School, male, 11 years of experience and second year in his current school and doctorate student

Data were collected through semi-structured interviews with the participating teachers and students. It is worth noting again that the participating students and teachers were purposefully chosen as the sample of this study since they all had experience in project work during physics lessons.

As Stake (1995) asserts, for transferability, the researcher provided input into the reader's naturalistic generalisations. So, warranting generalisation is the job of the others interested in this study. It is believed that enough information about the research process and raw data as quotes or data in the tables were presented for the reader to judge the adequacy of the process and assess whether the findings flow from the data to enhance confirmability (Miles & Huberman, 1994).

The researcher ensured the participants that no harm would come to the participants because of the nature and results of the study. The participants also informed that the information they provided might be in the final report, but their identities will not be revealed in any stage.

Data Analysis

Descriptive analysis was adopted for the qualitative data derived from semi-structured interviews. Transcripted interviews were coded as first level code (inductive codes), then the related first level codes were grouped as themes and coded again regarding the research questions (deductive codes) (Miles & Huberman, 1994). Using these thematic codes, the data is presented in the tables, allowing the reader for comparison between cases. Then, the

findings drawn from the tables are supported by presenting enough excerpts from the participants.

Findings

In this section findings about who decides and plans the project are presented first. Then findings about the infrastructure of the schools are presented. Next, the participants' ability to do project work is covered, followed by the stages of project work at which they encountered problems. Finally, the participants' suggestions to better project-based work in physics lessons are presented.

Deciding on the project topics

Table 2 illustrates who decides the topic or the problem of the project work to be studied. As seen from the data, teachers in all types of schools generally let students decide which topic or problem to study.

Table 2. *Deciding on the project topic*

Schools	Students	Teachers
Private High School	Student's decision Teacher's decision	Collaboration between teacher, student and postgraduates, Teacher's decision
Science High School	Student's decision (2)	Student's decision Collaboration between teacher, student and academician
Anatolia High School	Student's decision	Student's decision
(n): the number of the participants that emphasized the idea		

The data also revealed that during decision making process, students can gain help from their teacher, a post-graduate student or an academician. In state schools such as the Science and Anatolia High Schools, students are in control over the decision of the topic under the guidance of the teacher. In the private school, however, a hybrid approach is in action; that is, both the teacher and students themselves can decide on the topic of the project work. Following excerpts illustrate the decision process of the topic.

Teacher B, for instance, commented that, "In general students' opinions and teacher's opinions together shape the final decision. We don't get any support from university, but sometimes we asked for help from a post-graduate student". Teacher C, on the other hand, declared that, "I decide myself. We decide the feasibility of the project in teacher meeting". Student A emphasizes that his teacher helps him to find a topic and said, "Our teacher gives options and we chose among them. While I chose, I chose the one I like and the one that I would learn the most about". Teacher E commented that, "Mostly an academician or we determine the topic, but lately students have started to think for themselves and take the responsibility, too."

Schools' Facilities to Execute Project Work in Physics Lesson

Table 3 illustrates whether the schools' facilities are sufficient to execute project work in physics lessons from the participants' point of view and experiences. Teachers and students from state schools declared that their schools' facilities are insufficient to perform the project work in physics lessons.

Table 3. *Sufficiency of schools' facilities for physics projects*

Schools	Students	Teachers
Private High School	Sufficient (2)	Sufficient (2)
Science High School	Insufficient (2)	Insufficient (2)
Anatolia High School	Insufficient	Insufficient
(n): the number of the participants that emphasized the idea		

The private school, however, has sufficient facilities to perform the project work as both participating groups stressed. Following excerpts illustrate the participants' views on this issue.

Teacher B from the private school, for instance, stressed that, "All materials we need are provided by school administration". Teacher E from Science High School, on the other hand, commented that, "We encounter problems about materials. The university doesn't help us enough. And we have a budget problem." Student D from Science High School stressed that, "We get the materials we need for the Project work from university and from other shop, our laboratory is not sufficient." Student A from Anatolia High School also mentioned that, "I think laboratory is not sufficient enough for project work." The data from both participating groups indicate that state schools have not have a sufficient laboratory and facilities to perform project work mainly because the budget of the state schools is not enough to cover expenses of the laboratories.

Issues with Project Work in Physics Lesson

Table 4 illustrates at which stage(s) the participants faced some problems, taking their experiences into consideration. As can be seen from the Table 4, doing experiments, gathering data and doing the analysis (i.e. calculating, interpretation, reporting as the participants declared) are the most problematic part of doing project work in physics.

Table 4. *The stages that the participants faced with some problems*

Schools	Students	Teachers
Private High School	Making a decision on the project topic Data gathering Doing experiment Calculating	Planning Data gathering Reporting

	Interpreting the data	
Science High School	Calculating (2) Time (2) Doing experiment	Doing experiment (2) Time Data gathering
Anatolia High School	Making a report Doing experiment	Data analysis
(n): the number of the participants that emphasized the idea		

Especially from the participating teachers' point of view, preparing and doing experiments is the most difficult part of project work. Teacher E from Science High School, for instance, stressed that,

"They experience problems during doing experiment and gathering data. The reason for this is that our school has not had some apparatus required for their experiments, we do not have a close relationship with the university to use their facilities."

Student C from the private school commented that, "There are some experiments which I can't do...[that] require more information. I have some difficulties of doing the calculations and interpreting the data." Student A from Anatolia High School, on the other hand, declared that, "I have difficulties in converting the experiment into a report. I also need professional support, for instance, from an electrician, to set up difficult experiment settings."

Students' Competence of Doing Project Work in Physics

Table 5 illustrates the participants' views on students' knowledge and capability of doing project work in physics. Data show that both participating groups were negative on students' ability of doing project work.

Table 5. *Students' ability of doing project work*

Schools	Students	Teachers
Private High School	Had previous experience of doing project work (2) Feel confident on doing project work (2)	Incapable (2) Gaining skills by doing project work (2)
Science High School	Not have previous experience Not feel confident on doing project work	Incapable (2) Gaining skills by doing project work (2)
Anatolia High School	No previous experience Lack of laboratory experience	Partially have
(n): the number of the participants that emphasized the idea		

Only students from private schools had executed project work in elementary school felt confident executing project work. However, both teachers from the private school commented

that their students are not capable of doing project work in physics, stressing that they are learning and acquiring required skills by doing a project. Science high school students from both Anatolia and the Science High School claim that they have lack of laboratory experience and did not have any experience of doing project work in their elementary education. Teachers B, C and D share the same opinions about their students, stressing that, for instance, "At the beginning they were not capable of doing project work. In the course of time we guide and teach them the information and skills they need throughout the project work" (Teacher C). Teacher D from the Science High School, on the other hand, commented that, "Generally our students don't have any experience of doing project work earlier, but we show some exemplary already finished project work to new comers and explain to them haw a project work can be planned and executed." Student A from Anatolia High School stressed that "We did not do any project work so I don't have enough laboratory experience." Student D from the Science High school made similar points stressing that he doesn't have the skills of doing project work. It is clear from the data that students are learning by doing project work in all secondary schools.

The Participants' Suggestions for Project Work in Physics

Table 6 illustrates the participants' suggestions about doing project work especially about the solutions of the encountered problems during project work.

Table 6. *Participants' suggestions*

Schools	Students	Teachers
Private High School	Reaching more information (2)	Curriculum reformation Elective lessons Exams
Science High School	Science club Collaboration with university Reaching more information (2)	Science club Collaboration with university
Anatolia High School	Professional help	Ways to reach the source of information
(n): the number of the participants that emphasized the idea		

As the data shows, to overcome the difficulties the ideas for improvement, such as collaboration with university and forming a science club in schools, are shared by teachers and students. Teacher E from the Science High School, for instance, claimed that "In order to overcome this difficulty we try to cooperate with the university and established a science club at school, but that wasn't enough." Student D from the same school stressed that, "In my opinion there should be science clubs and they should cooperate with universities." Teacher C from private school mentioned that, "For project work there should be elective lessons. It is important to get rid of laziness that university entrance exams promote." Both student B and C declared that they want access to more information when needed during the project work. Student C stressed that, "There are experiments that I can't do I need more information."

Conclusions and Suggestions

Findings revealed that teachers who work in private schools are able to form suitable environments for project work. State schools, on the other hand, suffer from lack of materials required for project work in physics. This shows that schools with their own budgets can support students' project work. State schools do not have a budget, except for the money coming from the Ministry of National Education, which clearly is not enough to support students' work. As a consequence, the reason for insufficient project work is due to the insufficient arrangement of the administration.

Findings also revealed that teachers in all types of schools generally let students decide which topic or problem to study on. In private schools, however, the teachers are more in control of deciding on the project topic. One of the reasons for this, as one of the teachers from the private school stressed, is that the private schools take the feasibility of the project into consideration during their teachers' meeting.

At all stages and at all schools, teachers and students experience difficulties during project execution. In process of project work, science high school students experience difficulties in data gathering; they claim that their experimental skills are insufficient and they do not have the habit of doing research, planning a project and documenting the results. These results correspond the findings of Akdeniz and Devecioğlu (2001)'s study. The majority of the problems encountered during project work is a result of lack of students' basic process skills, as they have not learned the skills required to do project work earlier in their education.

Findings from the participants' suggestions about the appropriate use of project-based learning in secondary physics lessons revealed that in order to overcome the difficulties encountered "elective lessons aiming to teach executing a project work", "collaboration with universities" and "forming science clubs at schools" are required.

In summary, project-based work is not generally used in secondary schools and so there are very few relevant studies. Thus, there is still a need to do more studies examining how project work is executed and barriers to doing project work in secondary school physics lessons. Since project-based work is crucial in physics lessons, students' ability to execute project work needs to be improved. An elective course for this purpose might be very useful in this aspect in secondary schools. For the policy makers and school administrators, they need to arrange a close relationship and collaboration between schools and universities, especially to use laboratory facilities of local universities.

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