Impact of problem-based learning to students and teachers

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Abstract

The Ministry of National Education of Turkey has decided to give up traditional methods to be used in the classes and to develop a new secondary school curriculum based on Context-Based Learning (CBL) in 2007. This paper discusses integrating Problem-Based Learning (PBL) tasks into the new physics curriculum in Turkey. A brief overview of a theoretical background to CBL and PBL will be described. A design of Science Circus that based on the principles of the PBL will be provided along with sample tasks produced by the students. The final section of the paper reveals the findings from the students of PBL process, and their teachers' point of view, attitudes towards physics, and opinions on the PBL process. Interview findings demonstrate that the implementation of PBL in the physics course encourages students to take a more active role in their learning and makes the course content more interesting.

Keywords: Problem Based Learning (PBL), Context Based Learning (CBL), physics, New Physics Curriculum

Introduction

Learning occurs through the individual's own construction but it can't be realized by a teacher (Driscoll, 1994; Nieswandt, 2001). In traditional science lessons, teachers come to teach and students memorize or mimic their acts. Thus, most of students feel that science is one of the most difficult subjects to learn and one can not apply it to the everyday life (Ghani, 2006). Further, students hate learning science (Ghani, 2006). Furthermore, science is not popular among students (aged 14-16) in the world (Sjøberg & Schreiner, 2006). More often, teachers hear from students in classes questions like "why do I have to know this information and how will I ever use it in the future?"(Ipek, 2007). As a consequence, students entering primary education are often reported to have weak science background with very few students studying the physical sciences at the upper secondary levels, and are often reported to have negative attitudes toward science (Peterson & Treagust, 1997; Speedy, 1989). Based on this premise, numerous studies have been conducted to determine the factors that affect the students' attitudes in science that can be listed, including: teaching-learning approaches, the use of the presentation graphics, the type of science courses taken, methods of studying, intelligence, gender, motivation, attitudes, science teachers and their attitudes, self-adequacy, previous learning, cognitive styles of pupils, career interest, socioeconomic levels, influence of parents, social implications of science and achievement (Erdemir, 2009).

If so, what should we teach in science classes (in content) and to what extent (in details)? This is a vital question in an educational setting. In addition, how should we change students' attitudes towards science in order to engage students with science careers (Minstrell & van Zee, 2000). To overcome these problems, The Ministry of National Education of Turkey has decided to give up traditional methods and develop a new physics curriculum based on Context-Based Learning

(CBL) in 2007. The new physics curriculum in Turkey proposes a set of learning experiences that should be provided to all students. It is organized around competencies while taking into account of the individuals' differences, and adopts the vision of science and technology literacy that aims at linking physics and technology with the students' own life and their environment (TTKB, 2007).

The New physics curriculum also states that the rate of increase in production of knowledge that grows about 30% with respect to previous years. Teaching all information to students is impossible in formal education. This requires choosing some main contents among others by considering the merits of them (TTKB, 2007). For this reason, students should be provided with necessary information they will need science engagement both in school and after school in their life. When students are active in learning process, they move from being passive recipients of knowledge to being participants in activities that encompass analysis, synthesis and evaluation besides developing skills, values and attitudes (Sivan, et al., 2000). Active learning not only emphasizes the development of students' skills but also their exploration of their own attitudes and values (Sivan, et al., 2000). CBL provides science for students with opportunities to test theories with real-life problems (Overton, 2007) that take part in students' life and arouse students' interest. Therefore, the use of a meaningful and appropriate context has been shown to motivate learners (Hennessy, 1993). Further, interest-focused problems, from student's point of view, have potential to develop more interesting activities, provide more choice, and ensure optimally challenging tasks (Savin-Baden and Wilkie, 2004).

One of the student-centered instructional approaches used for effective instruction in science education is Problem-based learning (PBL). Through the use of PBL instruction that is organized and driven by real life contexts as in CBL (Overton, 2007), students can solve problems encountered in any area of everyday life by using scientific method (TTKB, 2007). Overton (2007) describes PBL as a subcategory of CBL. CBL and PBL provides students with guided experience in learning through solving complex, real-world problems (Hmelo-Silver; 2004), which is presented as a scenario to intrigue students' curiosity in small groups (Barrows & Kelson, 1995; Sahin, 2007). PBL is a learning method that uses problems as a basis for students to improve their problem-solving skills and to obtain knowledge (Inel and Balim, 2010). An important point of PBL is that the learning resulting from a resolution of the problem is often more important than the solution (Peterson & Treagust, 1997). Thus, PBL allows students become active learners and makes students responsible for their learning (Hmelo & Ferrari, 1997; Kolodner et al., 1996; Serin, 2009), develops more positive attitudes to physics lesson (e.g., Alper, 2008; Akinoglu & Tandogan, 2007; Dolmans et al., 2001; van Kampen et al., 2004; Prince, 2004; Selçuk & Tarakçi, 2007) and allow higher conceptual learning gains (Alper; 2008; Sahin, 2010). In conclusion, PBL is designed to help students to construct an extensive and flexible knowledge, develops as individuals apply their knowledge in a variety of problem situations, develop effective problem-solving skills includes the ability to apply appropriate meta-cognitive and reasoning strategies and it develops self-directed, lifelong learning skills; becomes effective collaborator who knows how to function well as part of a team (Barrows & Kelson, 1995; Kolodner, 1993; Torp & Sage, 1998; Wilkerson & Gijselaers, 1996; Serin, 2009).

When students engage in a PBL, also known as the PBL tutorial process, several steps are followed. At first, students are presented with a well-structured problem scenario. It is noticed that well-structured problems should provide the information, the compass, and a clear destination for the problem solver, tapping only the lower-level thinking skills of knowledge, comprehension, and application. Afterwards, students formulate and analyze the problem by identifying the relevant facts from the scenario. This fact-identification step helps them represent the problem. As students understand the problem better, they generate hypotheses about possible solutions and research solutions to the problem. Later, students apply their findings and evaluate their hypotheses in light of what they have learned. Then, at the completion of each problem, students reflect on the abstract knowledge gained. At the end, they present their solution (Akçay, 2009; Chin and Chia, 2006; Fogarty, 1997; Hmelo-Silver, 2004; Sahin, 2007; Serin, 2009).

Since PBL applied widely as an instructional model, several studies have paid more attention to PBL in different perspectives in Turkey: Newtonian mechanics (Sahin, 2010), motion and energy (Tandogan, 2006), Electromagnetism (Saglam, 2010), Pressure (Serin, 2009), Medicine (Alper, 2008), Biology (Akinoglu and Tandogan, 2007; Inel and Balim, 2010), Mathematic (Boran and Aslaner, 2008).

For instance, Sahin (2010) investigated the effects of problem based learning on students' beliefs about physics learning and conceptual understanding of Newtonian mechanics. In result of this study, PBL group gained higher conceptual learning than the traditional group. However, there was no difference between their attitudes. Inel and Balim (2010) found a significant difference in favor of the PBL students' for the concepts concerning the "Systems in Our Body" unit in the science and technology course. Tandogan (2006) concluded that PBL is effective on conceptual development and re-mediating misconceptions in the unit of "meeting of force and motion-energy". Another study in electromagnetism course Saglam (2010) revealed that providing students with some formative assessments during the PBL process confidence could help them to better judge their understanding. According to Serin (2009) PBL students mostly engaged with doing research, designing and making experiments and in general students are enthusiastic about the PBL instruction. Akinoglu and Tandogan (2007) determined that the implementation of PBL had positively affected students' academic achievement and their attitudes towards the science course and it also affects students' conceptual development positively and keeps their misconceptions at the lowest level. However, Alper (2008) concluded that although students have positive attitudes toward PBL applications, more than half of the students do not want to be in PBL study in future.

With respect to improvement of education in the secondary school and enhancement of the students' engagement, it is important to know how good PBL classroom practices can be enhanced and what are the views of students about effective PBL discussion and working together. Consequently, the present study aims to investigate the effects of PBL on high school students' attitudes towards physics and physics learning, scientific process skills and their physics conceptual understanding when compared with traditional instruction.

Research Methods

Research Design

A case study strategy was used to better understand the phenomenon holistically and in-depth. Case study is a research design that explores the case under scrutiny within its borders and which is used where the borderlines between the case and its environment are not clear and where more than one source of proof or data exist (Yildirim and Simsek, 2006). PBL work has been executed in Zonguldak Anatolian Girls Vocational High School in Turkey, with the participation of 22 students at 9th grade at the beginning of Education Year 2008-2009. All of students were girls. It is worth noting that the participating students were purposefully chosen as the sample of this study since they all had experience in problem based learning during physics lessons.

Data Analysis

The survey data was collected through semi-structured interviews, a qualitative method, in order to gain insights into students' and teachers' opinions. As such, the aim was not necessarily to produce data that can be generalized to larger populations, but rather to explore the range of attitudes and beliefs that were held. The interview was a "purposeful conversation" between two people (or more) with the explicit purpose of gaining information from the other (Bogdan & Biklen, 2003).

Nine teachers and thirteen students in PBL process were also interviewed during the study to find out their experiences of working on their projects in a PBL context. Interview questions that asked to students included "What are some problems that you have encountered?," "How do you find this PBL process?," and "What have you learned?". Besides, one question was only directed to teachers individually. The question asked them was 'What are your opinions and views about our science circus?' Interview was a method, which was qualitative, in order to gain insights into teachers' and students' opinions. The data was analyzed by the descriptive statistics, and then the findings were digitalized and presented.

In this section, meeting the problem for PBL process is presented first. Then, findings about the two samples of PBL teaching design are presented. Finally, in findings, the participants' and teachers' views about PBL process are presented.

Developing PBL process

When I came into 9B class every time, I have often heard that physics is one of the most difficult subjects to understand and they couldn't apply it to the everyday life. That was a problem, and PBL begins with a problem, or a scenario, presented in the same context, as it would be encountered in real life (Woods, 1994; Savery, 2009). As this was a PBL approach, the main purpose was for students to identify their learning needs, and then proceed to investigate these needs through subsequent research (Peterson & Treagust, 1997; Savery, 2009).

I wanted my student to solve this problem and I asked them "If you were a science teacher how could you motivate primary or secondary schools' students to become more interested in science topics?" Following this, students were divided into groups of 5 or 6 and work together throughout the process, design, implement, and report their projects. Before the students embarked on their projects, I briefed them on the aims and objectives of the project. They defined the problem, and produced hypotheses, then discussed them and eliminated false hypotheses, thus forming a true hypothesis toward a solution of the problem. After they wanted help from some other science teachers, their parents and enlisted their helps (e.g., teaching ideas, suggest experiments, and help to provide books and develop materials), they came to the next process prepared, studied and learned the necessary concepts required to solve the problem. In the light of their friends' comments, they researched some science experiments that were just for fun, some were "tricks," and some would allow students to obtain useful scientific concept and also applied a number of additional criteria: low cost, simplicity of design, feasibility, safety, compactness, less time to set up.

The aim of all students in PBL process was to provide their friends with some science experiments that a child of any age can perform to help demonstrate principles of physics. The teaching materials prepared by the students included their overall plan for teaching the subject in classroom, and the activities and resources that would form the basis of this teaching. They knew that that transferring knowledge from an instructor to a passive learner will never success . Thus it has become inevitable for the learner to take an active role in and shoulder the greatest part of the responsibility in teaching learning activity.

To be realized the aims of the new physics curriculum, in this study, students placed at the center of the activity so that the whole activities proceeded under their control, based on their specific needs and preferences. Since the learner neither can nor does to be loaded with all sorts of knowledge available, they should determine the limits of the knowledge they needed. They decided on the learning objectives and also on the way to access those objectives. They corrected and improved their learnings through practicing the mechanism of self-appraisal. In other words, the study tried students to get actively take part in learning activities and eventually become a life-longer learner. My role was as an instructor in this activity confining to act as an efficient facilitator rather than a knowledge-conveyor.

The process had taken about a month up, and an agreement upon the solution of the problem was reached. I evaluated them on the basis of their participation and effort in solving the problem in the PBL process. During this time, I provided feedback, asked guiding questions, and encouraged them to share and discuss their ideas. In carrying out their project work, the students went through five consecutive phases (Chin and Chia, 2006): (1) identifying the problem to be investigated, (2) exploring the problem space, (3) carrying out the scientific inquiry, (4) putting the information together, and (5) presenting the findings, teacher evaluation, and self-reflection. The following models developed in PBL lessons to explain a real-world phenomenon, which can also be considered a physics subject.

Table 1. *A sample process of PBL teaching design for incandescent bulb model*

Phase	Teacher	Group 1
The Problem	Imagine that you are a physics teacher. You always hear "we don't like physics and we don't understand it". What will you do? in your class. Can you teach some physics that you and your students like	We familiarized ourselves with some issues related to "electric" by discussing and reading books, asking our parents on topics such as electric current, Edison's life, differences between bulb (incandescent light) and fluorescent lamps. We then decided to make "electric bulb" that we wanted to investigate.
Learning Objectives	What do you know about electric? What do you need to know? How can you find out what you need to know?	We tried to find various possible sources of data and information. For example, We did some laboratory experiments and interviews with our parents and science teachers. Our two friends researched included books, articles, videos, website links.
Resources	You should use our laboratory and library, You want help from other science teachers or your parents	We collected data to answer how would teach electric. We decided to make "a model of bulb". We used the science laboratory to carry out our investigations. One of our father was electric engineer. He helped us.
Product Specifications	Can you describe your process by giving examples of the sequence of activities that you used to implement your study?	We made our own electric bulb (model) and get a bright, though brief, glow. We used two nails, a short length of thin iron wire, a bottle, a cork to fit the bottle, and cell batteries with a length of covered copper wire. My father helped us for idea and making this lamb. We sticked the two nails through the cork and we attached the iron wire to the nail points. After that, we fitted the

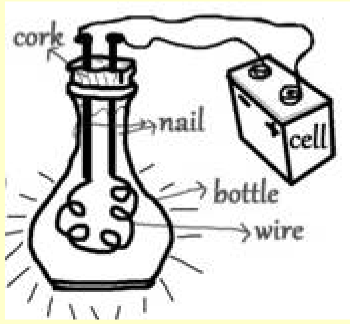
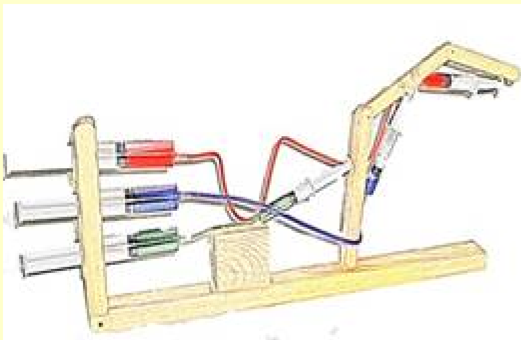
		cork into the neck of the bottle, allowing the nail heads to remain outside and the iron wire to go inside. With the covered wire, we connected the dry cells to the heads of the nails, as shown in the illustration  **Figure 1** . Electric bulb model
Presentation	How did you produce light? What is resistant? What do you know about electric current?	Although we used iron wire in our model, the real incandescent light bulb contains tungsten wire called a filament. This wire has a very high resistance to electricity. When electric current flows through it, it produces heat. In our bulb model, When the iron wire becomes hot, it combines with the oxygen and burns up. To prevent this, all of the air is removed from the light bulb and is replaced with an inert gas such as argon.

Table 2. *A sample process of PBL teaching design for simple crane model*

Phase	Teacher	Group 2
The Problem	Imagine that you are a physics teacher. You always hear “we don’t like physics and we don’t understand it”. What will you do? in your class. Can you teach some physics that you and your students like	We discussed ourselves with some issues related to “Pascal's Principle” by reading books, asking our parents and teachers on topics such as Pascal, Pressure, Force, Physics of Fluids and Hydraulic Engineering. We then decided to make “simple crane model” that we want to investigate.
Learning Objectives	What do you know about energy? What do you need to know? How can you find out what you need to	We knew about energy a little. We tried to find various possible sources of data and information about energy. For example, by doing laboratory experiments and interviews with our teachers and parents. We investigated related books, articles, videos, website links

	know?	
Resources	You should use our laboratory and library, want help from other science teachers or your parents when you want	We collected data from web to answer how would teach “Pascal's Principle”. We saw a simple Crane model in www.arvindguptatoys.com. We used the science laboratory to carry out our investigations. We made a simple crane by taking professional support from an carpenter.
Product Specifications	Can you describe your process by giving examples of the sequence of activities that you used to implement your study?	We used several old plastic syringes, old plastic drip tubes, pieces of wood, screws and ordinary hand tools from carpenter. The movements of this crane are based on the principle of hydraulics. It can be understood by filling two plastic syringes with water and attaching them with a plastic drip tube. When you push the plunger of the first syringe, the plunger of the second syringe will move out. Thus the motion is transmitted through water pressure from the first to the second syringe. The motion of the second plunger is transformed into the swivel, or up-down movement of the crane.  **Figure 2** . A simple Crane model
Presentation	How did you do it? Why did you use water? What do you know about pressure?	Pascal's principle states that a pressure applied to an enclosed liquid is transmitted everywhere in the liquid. Hence, if a pressure is applied to one side of an enclosed liquid, all the other walls containing the liquid feel the same pressure. The pressure is transmitted without being diminished. For Pascal's principle to be useful to hydraulics, the fluid should be an incompressible liquid, which will transmit the applied pressure without changing its volume.

As a result of the process, “science teams” that were called “science circus” were occurred spontaneously. At the end of the first semester, students present their experiment for not only students but also their teachers to participate in their exhibits in and to introduce cutaways and working models to encourage the students and their teachers to learn about how things work rather than what they look like. After finishing implementing activity, students and teachers were asked to give some written feedback on the "science circus" project.

Findings

The feedbacks of the students and teachers were analyzed and summarized. The reported feedbacks of the students and teachers on science "circus" can be classified into three groups. They are (1) direct feelings towards the activities, (2) perceived learning outcomes in Physics learning, (3) their puzzle and worries in the activities.

Concerning direct feelings towards these activities, nearly all of the students feel that taking part in the "science circus" based on the principles of the PBL, was a real challenge, helping them acquire a new identity; an identity of a science teacher, as illustrated in the following extract:

"While working on this science show, we felt ourselves like a science teacher. Really, identifying a problem, investigating ways of solving a problem and teaching those to primary school's students and our teachers have been very enjoyable and exciting for us".

"I think this science activities have been of a great benefit for us. In fact, teaching is to encourage us to do research for learning some physics concepts. It is very logical that this objective is aimed at in this process because I really do not think that anyone in our science team would take an interest in science, especially physics lessons".

"It is my first opportunity to be creative in physics and thus I was very happy to get more involved in the science subject."

Concerning perceived learning outcomes in Physics learning, most of students indicate that PBL process developed around the feelings of challenge, self-confidence and satisfaction and was pleased about being offered with this opportunity. Their feedbacks are:

"When we begin the process, I though, these activities are unnecessary for physics. But now, I think that physics is everywhere and we enjoyed these science toys.

Furthermore, all students and teachers who came our science circus played with them."

"I really honor for teaching some physics to my teacher"

"I am not good at in physics, but I enjoyed teaching something"

On the other hand, some students had mixed feelings. They felt that the physics is quite difficult and yet still like doing them.

"I didn't think I would be so good at this, but I found out that I actually was quite good."

"I am not good at physics but I like to teach."

Most students used to describe them the activities an "enjoyable experience" as seen below:

"Teacher, I can take a duty in other project, I enjoyed it"

"You know teacher, I don't like physics but I learnt that physics can be enjoyable with interesting science activities"

A few students did express some worries and puzzles on preparing the activities, including preparing and doing experiments is the most difficult part of project time for thinking and stressed that,

"I need professional support from an electrician, to set up difficult experiment settings."

"I am not capable of doing project work in physics,"

"Before beginning the project, we thought these activities as low cost, simplicity of design, less time to set up., altough we used some low cost material, we spent some money for professional support in the session of project"

"I don't want do anything because I don't have enough laboratory experience"

"I don't have the skills of doing project"

"I learnt differences between teaching and knowing. To be a teacher is not only knowledge, it is also good presentation."

Concerning direct feelings towards these activities, most of their teachers indicated that they enjoyed watching the science circus more than traditional science lesson. Teachers' views about "the science circus" developed around the feelings of interesting, easy and related to every-day life. Some teachers stated in the following extract.

"The experiments are too realistic to remember later. Science Circus team has given the students a good insight into the world of science."

"Students thought us real world phenomena and their physical background"

Concerning perceived learning outcomes in physics learning, most of teachers stated that it was very good idea for encouraging students to delve more thoroughly into specific aspects of a topic and to carry out their own research supporting students in their own projects teaching students the skills to transfer information and knowledge.

"The method is a great way of engaging students in science lessons because you learn a lot when you teach others."

"The experiments that were made with low cost materials are easy to organize. I will get my students/children to trial some of these activities later. I think he/she/they will enjoy doing it."

Moreover, the majority of teachers stated that some experiments were very different, interesting and they learnt as much as their students.

"Some experiments were very different, we learnt as much as students as teachers"

"I wish I had had you as a science teacher when I was a student"

"Although I have been a science teacher for many years, I confession that I have never seen before"

Some science teachers enjoyed our science circus. However, they indicated these activities didn' allow for deep understanding. They also stated that youngsters couldn’t possibly learn everything about physics course. Two examples of these views are:

“I am a science teacher for many years; I didn’t see some of these experiments before. However, I asked them about their performance; I noticed that, the Science Circus team explained their experiments with current concepts without physics symbols and formulas. When I asked them formulas and symbols of subject, they didn’t answer.”

“I am very enjoyed from your “science circus” project. But I think that it is not enough for learning science. Though your students can implement some concept, they have some difficulties of doing the calculations and interpreting the data.”

Discussion and Conclusion

This study demonstrates the impact of PBL to students’ and teachers’ beliefs about physics and physics activities. It is worth noting again that the participating students were purposefully chosen as the sample of this study since they all had experience in PBL during physics lessons. In the student evaluation of implementing PBL themselves, consistent with the nature of creative activities, Science Circus activity was their first opportunity to make physics working models or conducting experiment for exhibition. Students’ attitudes toward the PBL instruction seem usually positive with respect to the qualitative data obtained from the interviews. Because, at the beginning of the PBL process, our impression of the Science Circus team did not seem very motivated or interested in science. However, during the rehearsals and process, they emerged as science teachers and displayed a great will for perfection in performing their experiments. After performing their experiments their emotions were largely changed more under low compared to high incentive and thus they were very happy to get more involved in the project: “We are so glad that we took part. Let’s do it again!”. The results from the interviews indicate that PBL should change the beliefs and attitudes of the individual regarding the difficulty of physics skills knowledge and skills by. This finding is similar to the results obtained from a variety of PBL research which state that PBL students mostly engaged with doing research, designing and making experiments (Araz, 2007; Campbell, 2000; Cheng; 2004; Erdemir, 2009; Serin, 2009; Tandogan, 2006).

Nearly all the results in the teachers' evaluation of PBL process echoed with that in the student evaluation. According to teachers, PBL process has given to students a good insight into the world of science and connects the science with everyday life. Furthermore, these modes of learning were more different and valuable not for only students but also for teachers than traditional lectures. In addition, according to teachers, it was very good idea for encouraging students to delve more thoroughly into specific aspects of a topic and to carry out their own research; supporting students in their own projects teaching students the skills to transfer information and knowledge similar to findings reported in the literature (Serin, 2009; Cheng, 2004). According to students, teachers and previous literature, physics education goals cannot be achieved by conventional science teaching that has a negative effect on most students' learning than compared to student-centred instructional approaches. If a science teacher selects appropriate, effective methods and putting their students into practice, s/he will allow them to develop a more positive attitude toward science by fixing the mistake outright (Erdemir, 2009). These results also imply that not only should science teachers apply PBL tutorials effectively but also s/he should develop new application techniques to improve and enhance science teaching in contextual areas.

Taking responsibility is one of the main important things that students have to do in PBL courses, for example; they researched various possible sources of data and information, discussed and eliminated the hypothesis, and wrote the findings together. However, some students had some hesitations and concerns during the PBL process. It is noticed that, the PBL process was their first opportunity to make physics working models or conducting experiment, they were in difficulty in designing and making experiments. For this reason, this negative situation would be limited the success of the PBL students. Similar to findings from several research-based instructional approaches reported in the literature that, despite its positive influence in students' conceptual learning, active learning teaching methods have no significant effect on attitudes and beliefs about physics (Cheng 2004; Sahin, 2010). Further, Alper (2008) concluded that some students do not want to be in PBL study, although they have positive attitudes toward PBL applications in future.

On the other hand, based on the interview findings, teachers believe that active learning techniques are useful for permanent learning. Teachers' attitudes towards creative PBL activities were actually positive; they found the PBL process as "well teaching experience" and "a good example of conceptual learning", but with hesitation. Some of them added that, this kind of learning style only develop an understanding of grasping essential concepts, not much solving problems requiring mathematical operations. It was noted from interview with these teachers that some of them didn't have more idea about active learning techniques. Morevever, they prefer traditional teaching techniques in their science lessons such as solving problems, explaining and question-answer. This finding is in agreement with the findings of related studies (Cheng, 2004; Karamustafaoglu et al., 2001; Karamustafaoglu et al, 2006; Demircioglu, 2002). Further, considering the interest, skill, capacity of the children and their features of school, these teachers wievs can't be adopted. Because, the aim of new physics curriculum goals to provide the learners with certain proper knowledge and desired skills and profound attitudes.

To sum up, most of the students felt that PBL activities are useful to their Physics learning and creativity development. Using PBL activities helps the students grasp more than just a concept; they will gain an understanding of how, and why, to use that concept. It appears from these initial data that, while youngsters can't possibly learn everything about physics, they do need and will want to learn many facts. However, the best way to help them learn to think scientifically is to introduce them to just a few topics in depth (Paulu & Martin, 1991). They enjoy physics and demonstrate their enthusiasm to their audiences with each performance. Indeed, research findings stated that, "students are likely to begin to understand the natural world if they work directly with natural phenomena, using their senses to observe and using instruments to extend the power of their senses" (National Science Board, 1991).

The benefits of the project go way beyond learning science because students not only learned some physics concept, but also learned to become more familiar with the library, organize themselves as a team, and to get public speaking practice. I believe that brief experiences may serve to prove to students the value of peer teaching and teamwork, as well as provide the skills for doing so altruistically, similar to findings reported in the literature (Barrows & Kelson, 1995; Kolodner, 1993; Torp & Sage, 1998; Wilkerson & Gijselaers, 1996).

This is that, we should include learners into learning process and thus, students can be an integral part of it. In order to include them into the learning process in appropriate ways, we can encourage them to become independent learners who can take responsibility for their own learning.

Through all of their effort and dedication, this had become their show: they were very enthusiastic and this enthusiasm carried over to their fellow high-school students in the audience.

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