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PROSPECTIVE SCIENCE TEACHERS' CONCEPTUALIZATIONS ABOUT PROJECT BASED LEARNING

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Project-based learning (PBL) consisting projects that integrate science, technology, society, history, mathematics, politics and even arts serves a productive discussion opportunity for students, fosters a student-directed inquiry of real world problems, gives them the excitement of learning and seen to be an effective teaching strategy. Therefore, examination of PBL from the practitioners' point of view, interpretation of the conceptualizations and experiences of them would yield valuable indicators for future PBL processes in classes both for instructors and students. This study focused on the prospective science teachers' conceptualizations about project-based learning as practitioners in this research but also as instructors of future. A group of 75 prospective science teachers took place in research for a period of ten weeks and conduct projects in groups of four to five based on science-technology-society issues. Multiple data sources were used consisted a questionnaire with open ended questions, project portfolios and presentation notes. Data collected analyzed qualitatively and some assertions generated with the help of conceptual constructs derived. Assertions generated indicated that prospective science teachers developed some varying understandings based on their experiences about conducting projects in the context of PBL.

Key Words: Project-based learning, science-technology-society

INTRODUCTION

The search of science educators for helping students to learn science more effectively is an ongoing process and the idea of more authentic contexts for presenting scientific knowledge (Roth, 1995), encouraging students to take place in discussions, argumentation and social negotiation (Newton, Driver, & Osborne, 1999) and developing problem-solving skills of students (Slack & Stewart, 1990) are all examples of that effort. The international research studies such as Trends in International Mathematics and Science Study (TIMMS) that reported the science and mathematics achievement of over 40 countries also entailed the need for search of improving science education exactly for countries lag behind others (Schmidt et al., 2001). and Turkey is such a country searching for improving its science education. That portrait and the need of scientifically literate citizens for the society forced Turkey to reform its educational system and a new program for elementary education developed. Within the context of that new program constructivism and scientific literacy became the foci.

The concepts of constructivism and scientific literacy are not new to science education researchers and a huge amount of literature is now available exactly in English but for science teachers in Turkey that is not the case. So for that new program to be successfully implemented the elementary science teachers must understand the philosophy of that program and a route must be presented to teachers for how to transform their teaching understandings consisting also learning environments perception. That means, the conception of scientific literacy exactly with emphasis decision making, moral reasoning and argumentation must be presented to teachers with a teaching strategy to be meaningful for them. That teaching strategy should develop students inquiry skills, give them central role in decision making, have authentic content and pay attention to the values and attitudes of students who will be the scientifically literate future citizens.

The description of project-based learning (PBL) consisting projects that integrate science, technology, society, history, mathematics, politics and even arts that serves productive discussion opportunity for students and gives them the excitement of learning should be seen as an answer to the search of such a teaching strategy. Within that context students have the chance of investigating rich and challenging topics of real-world issues, share their study with others and the portrait of the classroom consists students discussing on various topics in groups, searching knowledge from varied sources, take decisions and presenting their products. The context described above that students conducting their works and performing projects gives idea about how project-based learning (PBL) is not a simple teaching strategy. The examples of PBL and their striking features such as project-based science with emphasis on a driving question for guiding an investigation (Marx, Blumenfeld, Krajcik, & Soloway, 1997), disciplined inquiry with authentic and purposeful investigations which allows more flexibility for learners (Levstik & Barton, 2001) and WebQuests which would be created for just about any discipline (Dodge, 1998) should also be thought in that manner. So considering PBL as not a simple teaching strategy requires answering precisely the question "what is PBL?". For that, expressing what can not be PBL could be an illustrative starting point.

Thomas (2000) stated that the idea of assigning projects to students is not a new one and there is a longstanding tradition in schools for "doing projects," incorporating hands-on activities, developing interdisciplinary themes, conducting field trips, and implementing laboratory investigations. However discovery learning and hands-on activities are questioned for their effectiveness and found to be failed because of developers who did not base their programs on the complex nature of student motivation and knowledge required to engage in cognitively difficult work, nor did they give sufficient attention to students' point of view (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, and Palincsar 1991). Some other authors hold that view and mention authenticity, constructivism, and the importance of learning "new basic skills" in attempting to describe the difference between PBL and prior models that involved projects (Diehl et al., 1999). So projects, laboratory experiments and hands-on activities performed by students under strict direction with predetermined outcomes and processes in which students' motivation and point of view neglected could not be seen as PBL. That point of view requires examining the context of projects, skills that must be included within that context and how to conduct projects as instances of PBL.

Grey (2004, p.272) described projects as ideal settings for developing inquiry skills that enable us to better understand our assumptions and the consequences of our actions. Thomas, Mergendoller and Michaelson (1999) described projects within PBL as based on challenging questions and making students having central role in design, problem-solving, decision making processes so giving students the opportunity to work relatively autonomously. Moursund (1999) added authentic content, authentic assessment and teacher facilitation without strict direction to that definition. Krajcik, Blumenfeld, Marx and Soloway (1994) listed the features of "project-based instruction", a model of PBL, as the use of an authentic question, a community of inquiry and the use of technological tools.

Worthy (2000) claimed that with PBL, learners have more autonomy and motivated to take more responsibility for their learning. Moursund (1999) defined more autonomy as having the opportunity of shaping projects according to own interests and abilities and stated that PBL allows the individualization of curriculum, instruction and assessment so is learner-centered. Ayas and Zeniuk (2001) pointed out another concept, reflective practices, and suggested to focus on that practices to increase the 'quality of learning' in projects for exploring how to make learning in projects more meaningful, relevant and enduring. Those reflective practices remind reflective practitioners of Dewey (1933) who are open-minded and willing to accept responsibility for their decisions and actions. They have enhanced learning capabilities; they can accommodate multiple perspectives and cope with complexity.

Although Barak and Dori (2004) presented PBL as a prominent means to enhance science curricula and Simkins (2002) described it as an old and respected educational method, Thomas (2000) reported in his review that research on PBL has taken place in the past ten years, most of it within last few years and stressed that limiting the scope of the review on PBL to research articles in which the authors describe their work as PBL, seem to leave out prior research into project-focused, experiential education or active learning. Tretten and Zachariou (1997) in their report on PBL in multiple classrooms also questioned that issue and concluded that the variety of practices under the banner of PBL makes it difficult to assess what is and what is not PBL. So the features mentioned by researchers above can be seen as giving idea about the range of PBL but that is not the only case. The similarities between models referred to as PBL and models referred to with other labels such as "intentional learning" (Scardamalia & Bereiter, 1991) and "problem-based learning' (Gallagher, Stepien, & Rosenthal, 1992) constituted another problem that if these models could be considered as a part of PBL. So defining the features of PBL and distinguishing it from other similar models are still being problems for researchers. The examination of instances of PBL and research for the answer of question that how can we determine if an instance is a part of PBL or not should be viewed also in that manner.

Grey (2004, p.274) distinguished project-based learning from learning in project-based and identified those features of project-based learning: (1) A sense of purpose and clarity of long and short-term objectives, (2) A psychologically safe project environment and a commitment to telling the truth, (3) A balance between emerging and formal structures, (4) Communities of practice that cross project boundaries, (5) Leaders setting the tone for learning and modelling the reflective behaviour, (6) A systemic and collective reflection. Thomas (2000) also had aimed to answer the question of "what must a project have in order to be considered as an instance of PBL?" by establishing five criteria: (1) Centrality, (2) Driving question, (3) Constructive investigation, (4) Autonomy and (5) Realism.

Simkins (2002) merged the project-based learning and multimedia to represent a powerful teaching strategy called "project-based multimedia learning" and defined that as a method of teaching in which students acquire new knowledge, skills in the course of designing, planning, and producing a multimedia product. Simkins (2002) thought seven key dimensions for project-based multimedia learning method which can be evaluated as distinguishing features of PBL: (1) Core curriculum, (2) Real-world connection, (3) Extended time frame, (4) Student decision making, (5) Collaboration, (6) Assessment and (7) Multimedia. Blumenfeld et al. (2000) thought four essential components for project-based science which could be seen as PBL: (1) A driving question, (2) A tangible and meaningful end product, (3) Collaboration with community, (4) The use of cognitive tool. The features listed by different researchers above should not be seen as implying a definition or boundary for PBL rather a guide to understand, design PBL and viewed in that manner in this research.

Although all the arguments viewed above present a detailed portrait for PBL, it should be accepted that some common features must be drawn to design the process of projects at the core of instruction. A challenging driving question, an investigation process, resources for search, student autonomy, student centered design, teacher or expert guidance, collaborative work and presentation of products should be listed in that manner and had taken as guiding features in this research for design of process. Within such a context it was aimed to interpret the conceptualizations of prospective science teachers about PBL from driving questions to presentations of products. The prospective science teachers' experiences with PBL were thought as the core of this study because they will be the teachers of elementary science students and will guide them for their projects. So in this study by searching the conceptualizations of prospective science teachers about PBL, it was expected both to give a chance them to experience a real PBL context and present information for educators of teachers to design more effective PBL contexts.

Design Issues

The present study made use of an interpretative research design that it was attempted to interpret the conceptualizations of prospective science teachers about PBL. For that a qualitative data analysis technique was used through a process of open coding (Strauss & Corbin, 1990) in order to identify important conceptual constructs and categories.

Participants and Course Context

The prospective science teachers participated in this study were enrolled in Science-Technology-Society (STS) course within two groups in a university, in Istanbul, Turkey. Those prospective science teachers took all physics, chemistry and biology courses up to STS course in seventh semester in university and accepted to have the basic science knowledge. The prospective science teachers enrolled in two groups and were taught by the researcher, three hours a week for a period of fourteen weeks. The distribution of participants into groups was randomly made. Although the research did not involve a control-experimental group, prospective science teachers were distributed into groups to guide them within the course more effectively and to make presentation of products possible. So in group A 35 prospective science teachers and in group B 40 prospective science teachers took place and within group A and group B prospective science teachers established small project groups of four to five.

It must be noted that most science courses in this university are taught in a lecture-oriented traditional fashion. The prospective science teachers in general experienced science exactly in physics, chemistry and biology courses as a subject in which knowledge transmitted from teacher and textbook to themselves. However the learning environment and teacher-student, student-student interaction was exactly different in this STS course. The prospective science teachers had conducted projects based on science-technology and society relations for 10 weeks and presented their work in class to their friends. The STS course was chosen for that research because it has been an important component of the science education program at university consisting the conception scientific literacy as the central theme with emphasis on science-technology and society relations. That course is traditionally thought as three hours in a class per week but in this research with those three hours, an out of class work was also asked from prospective science teachers. Since in this research PBL was the teaching strategy accepted that out of class work like searching information, group work, interviewing people and etc. was a great portion of prospective science teachers' study. Within that process prospective science teachers were free to organize their group work and had a real autonomy to conduct their projects from defining the problem to presentation of products. Taking science-technology and society relations as central to projects also required the student autonomy to be held more accurately because prospective science teachers as project conductors were seen as cultural and moral agents.

The projects were assigned to prospective science teachers after a presentation of two weeks about scientific literacy with sub dimensions nature of science, science-technology and society relations and a study of two weeks on basic research methodologies. After that four weeks of introduction prospective science teachers were asked to start their projects by establishing a guiding or driving question based on science-technology and society relations. The researcher also listed some topics that should be taken as driving questions and presented it to prospective science teachers, exactly for the ones who could not establish their own driving questions. After that phase completed those steps were fallowed:

(i) Planning an investigation process according to driving question.

What kind of research will be conducted?

What will be the methodology?

What kind of resources will be searched?

What kind of data will be collected and how will they be evaluated?

(ii) Searching for the theoretical background of the driving question.

(iii) Presenting that theoretical background to class and discussion about the issue.

(iv) Deciding the study group, the way of collecting data and data analysis.

(v) Evaluating data, arriving a conclusion, presenting the project in class as preferred and discussion.

Prospective science teachers were asked to present their projects within class for each step given above and negotiate projects with peers. That activity also forced prospective science teachers to conduct their projects more critically and gave the instructor the chance of guiding more effectively.

Data Sources and Analysis

In this research three data sources were used. The primary data source consisted a set of open ended questions; Process Evaluation Questionnaire (PEQ) developed by the researcher. PEQ was administered to prospective science teachers after the projects performed and presented to explore prospective science teachers' experiences and perceptions about PBL. It was also designed to have the prospective science teachers to perform a self evaluation for project process with totally six open ended questions. A sample question from PEQ is given below:

- Which skills and attitudes one should have to conduct a project effectively do you think? Please explain your answer in detail.

The project portfolios prospective science teachers prepared before their final presentation in class constituted the secondary data source. After PEQ responses analysed the project portfolios of prospective science teachers for their driving questions, planning, organization, data sources, data analysis, conclusions driven and sources used were examined in parallel with PEQ and prospective science teachers responses were questioned for their accuracy per project group. The third data source was the notes taken by the instructor while project presentations in each step and used to interpret the responses given to PEQ more accurately.

Data from PEQ were analysed qualitatively through a process of open coding (Strauss & Corbin, 1998) in order to identify important concepts and categories. Open coding process is established on labelling and categorizing of phenomena as indicated by data and the products are concepts and categories. Concepts are the basic constructs and grouped under higher, more abstract levels termed as categories. Within that process open coding requires asking questions such as what, where, how, when etc. and making comparisons. The categories and conceptual constructs derived by the analysis of data in this study were as fallows:

Table 1. Categories and Conceptual Constructs

Categories	*Conceptual Constructs*
Driving question	Explanatory but simple Related with daily life Interesting Enable available sources Focused on common misunderstandings
Planning	An exact plan An elastic plan Without a plan
Conducting skills	Being objective Being Systematic Effective communication Creativity Critical thinking Multiple views Proficiency in research techniques Group harmony
Objectivity	Satisfied that criteria Did not satisfy that criteria Anyone else should evaluate

After the open coding process of PEQ completed and examination of project portfolios and presentation notes were performed, some assertions were generated by the help of the categories and conceptual construct given above in Table 1.

FINDINGS

Findings of this research were presented as assertions generated by the help of the conceptual constructs and categories derived through open coding of data collected. Four assertions were generated some of which may appear obvious but it must be noted that the intention was to clarify and interpret the conceptualizations of prospective science teachers about components of PBL based on STS issues from their point of view.

Assertion 1: Prospective science teachers who experienced the process of conducting and presenting projects on STS issues indicated that driving questions of projects should be explanatory but simple, related with daily life directly, interesting, enable available sources and focused on common misunderstandings.

In this research most of the project groups had assigned their driving questions after a period of research and only four groups had chosen from the topics given to them. So prospective science teachers' conceptualizations about assigning driving questions were mainly established on their preferences. Analyses of responses to PEQ, and parallel examination of project portfolios indicated that prospective science teachers stressed being explanatory but simple, related with daily life directly, interesting, enable available sources and focused on common misunderstandings as striking features that a driving question should have. Those features of being explanatory but simple and enable available sources were mentioned in the context of conducting projects effectively by prospective science teachers. Some sample statements from prospective science teachers' response to PEQ were as fallows:

> "A driving question must be simple to understand but also give enough information about what is being searched. This is really necessary to conduct project easily. Because the guidance of such a driving question will always make you remember on what you should focus and what action to take. It must be simple because it must be researchable and give chance to easily determine what are the variables (PST 6)."

> "You must establish a driving question that you should find information about its focus concepts in internet or library. Because some questions developed are seen to be exciting at first sight but you can not develop a related literature review so can not establish a theoretical background. For example we changed our question for that reason (PST 23)."

Those statements of prospective science teachers given above indicated that they thought being explanatory but simple and enable available sources as striking features of a driving question to conduct projects effectively. "Enable available resources" was seen important to establish a theoretical framework and "explanatory but simple" to conduct project with less confusion about what and how to do. The value and importance of those statements should be evaluated by considering that all reflects the experience of prospective science teachers with difficulties they faced.

The features of being related with daily life directly, interesting and focused on common misunderstandings were seen to be mentioned with a different motivation by prospective science teachers. Although being explanatory but simple and enable available sources were stressed mainly for the process of conducting projects, being related with daily life directly, interesting and focused on common misunderstandings were thought mainly for attracting attention of peers to projects exactly while presentations. A sample statement from a prospective science teacher's response to PEQ was as fallows:

> "As I see in presentations of our friends projects about issues related with our lives directly or about some failures that we have in mind, the attention in class was attracted successfully and those projects were followed with more interest. That makes conductors more satisfied with their projects. So I think that a good project must have an interesting issue (PST 13)."

The statement of the prospective science teacher with code number 13 given above indicated that she values taking attention to projects and with that motivation asserts that a good project must have a driving question which should be related with daily life, interesting or focused on some misunderstandings. All those features indicated above should be viewed by considering that all reflects the experience of prospective science teachers with difficulties they faced while conducting projects or determined while presenting them.

Assertion 2: Prospective science teachers who experienced the process of conducting projects on STS issues had divided into three groups for their views about the necessity and process of planning; (a) a detailed exact plan, (b) an elastic plan and (c) no predetermined plan.

Within the process of presentations of groups to class it was determined that project groups were three types for their planning. First type of groups were that ones who planned their projects in detail before starting work and tried to conduct their projects according to their plan strictly. The second type of groups were that ones who planned their projects broadly before starting work and made some changes easily while conducting their projects according to problems they faced with. The third type of groups was the ones who did not develop a whole plan for projects exactly or broadly before starting their work. Analyses of responses to PEQ and parallel examination of project portfolios also indicated that portrait. A group of prospective science teachers had stressed that they had an exact plan and conduct their projects according to that plan. They mentioned that having a predetermined exact plan behave them acting confidently and knowing what to do so must be a necessity for projects. They stated that they did not make considerable changes in their projects and tried to solve problems faced with while reaching institutions, collecting data and etc. A sample statement from a prospective science teacher's response to PEQ was as fallows:

> "After we determined our driving question we talked with group members and decided to develop a detailed plan before starting our project. We wanted to know what to do in all stages and to feel comfortable. I think this planning phase is the most important stage in projects. If you really brainstorm as a group and plan what to do, everything come by themselves next. Of course some problems related with our plan occurred but we tried to solve them and solve most (PST 28)."

The phrases of feeling comfortable and knowing what to do placed in above statement indicated why that group of conductors stressed a predetermined exact plan developed with group members necessary for a project. But as seen in presentations those groups who strictly tried to follow an exact plan sometimes faced with important problems and the motivation of following their plan strictly blocked them to see possible solutions.

A second group of prospective science teachers had mentioned that they also had a plan before but develop that plan elastically with some alternatives in each stage. The reasons for that were indicated as the possible problems with study group and collecting data. A sample statement from a prospective science teacher's response to PEQ was as fallows:

> "We as group members talked with each other and decided to develop a plan. All the group members concluded that a plan must be. But while group discuss some alternatives for some of the stages occurred and we concluded on a plan not exact but just like a skeleton. We had some alternatives and problems faced shaped our choices (PST 41)."

That group of conductors were also seen to be decided the necessity for a plan but hold that view with a more elastic perspective and developed a plan with alternatives in each stage. Since they studied on STS topics and mostly searched individuals' views about various topics that elasticity gave them the chance of moving more freely and being welcomed to unexpected developments.

A third group of prospective science teachers had stated that they did not develop a predetermined plan before work, had only a driving question and did not decide the study group, data collection instrument, data analysis etc and shape their plan by step by step while conducting their projects. They stressed that within each step a possibility of facing with some unpredicted situations was their acceptance and for that reason they behave in that manner. A sample statement from a prospective science teacher's response to PEQ was as fallows:

> "In fact we did not develop a plan before our study. We assign our driving question firstly and tried to perform project step by step as announced in calendar. After assigning driving question, in second step we started to search for theoretical background and then determined the study group and etc. Sometimes we thought that if we had a predetermined plan we should move more comfortable but we finished our project and I think it was enough (PST 53)."

That groups without predetermined plans were warned about possible problems exactly related with motivation at first step within the process but that was their choice and conduct their projects as they wish. Since they did not have a predetermined plan they asked for more guidance compared with other groups but in spite of this their logic was established on "do and look for next step".

Assertion 3: Prospective science teachers who experienced the process of conducting and presenting projects on STS issues indicated that being objective, carrying out systematic and planned process, having effective communication skills, creativity, critical thinking, openness to multiple views, proficiency in research techniques and establishing group harmony were the most striking skills they need for conducting projects.

The presentations of groups to class were mainly based on the process not only the product for each stage. So groups talked about what they do and how they do. Within such an atmosphere the discourses were mostly about the problems faced, solutions offered and consisted some indicators for the perceptions about project conducting skills. Those indicators were also taken into consideration while analysing responses to PEQ. The analysis of responses to PEQ indicated that being objective, carrying out systematic and planned process, having effective communication skills, creativity, critical thinking, openness to multiple views, proficiency in research techniques and establishing group harmony were seen as most striking skills for conducting projects. The belief for the necessity of most of those skills was shaped by the difficulties faced with while conducting projects as manifested within discourses. Group harmony, proficiency in research techniques and having effective communication skills were mentioned to be exactly that type of. A sample statement from a prospective science teacher's response to PEQ was as fallows:

> "The most concrete problem we faced was getting together as a group. We could not study effectively as a group out of class sometimes and that harmed our motivation. So establishing a good group harmony is important I think. Also as I experienced with my group, performing effective communication with people and institutions was so important. While collecting data or looking for views communicating effectively, talking about what we are doing for what and try to persuade people to talk were important (PST 8)."

One of the main problems prospective science teachers faced with was collecting data through interviews and questionnaires. So communicating and persuading people to talk with was really an important skill for project conductors. Working as a group in harmony was another important problem and sometimes group members were asked to disintegrate from group. Some groups also faced problems with their research design and asked for guidance many times and members of those groups stated proficiency in research techniques as an important skill to conduct a project. Although before projects started a study of two weeks on basic research methodologies were conducted with prospective science teachers, it was seen that a continuous guidance should be necessary at least for some groups.

Other skills such as creativity, critical thinking and openness to multiple views were mostly pronounced in association with the process of presentations by prospective science teachers. A sample statement from a prospective science teacher's response to PEQ was as fallows:

> "In some presentations our friends who presenting their projects did not behave welcome to critics and did not took in to attention the value of multiple views. In fact by doing that they lost the chance of developing their projects more I think. So I think listening others without the aim of being right is important for conducting projects. Another think I want to mention is we all see how being creative is so important (PST 61)."

While presentations, some discourses of prospective science teachers with their peers had showed to all class that critical thinking and openness to multiple views were very important to comprehend what had been critised for what reason. Sometimes dialogues between peers performed only for trying to be right and it was seen that any new perspective for the project that had been critised could not be established which was not an expected situation for groups.

Assertion 4: Prospective science teachers who experienced the process of conducting projects on STS issues had divided into three groups for their views about being objective; (a) believe to be objective, (b) believe they could not be objective and (c) believe anyone else should evaluate.

Objectivity is one of the most popular concepts in scientific research and seen as a criterion that must be satisfied by researchers. In this research this criterion was held as being welcome to all point of views related with theme of projects and neglecting some views or data that are contradictory with conductors' views about an issue was defined as being subjective. So objectivity was not taken as being value free as in positivism. That definition was shared with prospective science teachers before study and a common understanding was tried to be established. So analysis of responses to PEQ and project portfolios for the concept of objectivity was performed according to that common understanding. Prospective science teachers self evaluations for being objective had yielded three groups of views. A group of prospective science teachers asserted that they satisfied the criteria of being objective. They mentioned that all available views for them were placed and discussed in their projects. That was the really case as determined by the examination of some project portfolios from this group with themes such as generating nuclear power plants, global warming etc. But by the examination of some project portfolios again from this group it was determined that some views held more strongly and discussed whereas some others superficially. Exactly the projects with themes consisting cultural and religious aspects in the area of STS were that type. A sample statement from a prospective science teacher's response to PEQ was as fallows:

> "While searching our question we find lots of information in the internet and examine most of them. We exactly tried to place the contradictory ones with our views and thus tried to be objective. Since we did not neglect any point of view I believe we were objective. Also that can be seen in our project I think (PST 17)."

The phrase of "contradictory ones with or views" given above indicated that this prospective science teacher was aware about how their point of views could shape their work while collecting information, data and etc. With that claim she was sure about being objective that she addressed their projects to be controlled. Their projects had examined and it was seen that contradictory views had really placed. Since the term being objective was defined as openness and welcome to all point of views in this research they were thought as being objective.

Another group of prospective science teachers asserted that they could not satisfy the criteria of objectivity in an absolute manner because as cultural agents with some values and beliefs they could not be welcome to all views. They stated that willingly or unwillingly they refused some views and acted with that posture. A sample statement from a prospective science teacher's response to PEQ was as fallows:

> "Our project was focused on the views of prospective science teachers about evolution. That was really a controversial issue that also related with some religious beliefs. So I do not think we exactly behave objectively while examining evolution in our literature review. That does not mean we distorted something but I mean unwillingly we should be stressed some views more. I want to say that being objective exactly for the issues just like ours is really difficult. And if a person claim to be objective in such an issue the work of him must be examined critically (PST 33)."

This prospective science teacher's statement on being objective in controversial issues with exactly religious and cultural dimensions should be examined as being aware of some complex psychological processes that shape the act of individuals willingly or unwillingly. It must be noted that this prospective science teacher's group project was also examined by the instructor for being objective and it was determined that views against the theory of evolution had held with more emphasis.

A third group of prospective science teachers asserted that they tried to be objective but anyone else out of the project group should evaluate if they were objective. That group of prospective science teachers stressed the need of peer examination or review for their projects. A sample statement from a prospective science teacher's response to PEQ was as fallows:

> "We tried to be objective but I think we can not say yes we were objective or no we were not objective. Anyone else and maybe exactly you can evaluate this. Saying we were objective is not realistic I think (PST 54)."

That group of prospective science teachers was seen to be more aware about the complex process of being objective that they mentioned anyone else out of project group should evaluate their work. That was an important point of view because stressed a peer or expert examination which is also a core idea for scientists work.

CONCLUSION AND DISCUSSION

Many researchers mentioned varying benefits of PBL including attitudes towards learning, work habits, problem-solving capabilities, self esteem (Tretten and Zachariou, 1995), increased motivation, interest in topics involved (Bartscher, Gould and Nutter, 1995) and there is a frequently voiced claim that PBL is an effective method for prompting heretofore reluctant and disengaged students (e.g., low-achieving students) to become motivated and engaged learners (Jones, Rasmussen and Moffitt, 1997). But as Barak and Dori (2005) claimed, introducing PBL into higher education is likely met with reluctance and sometimes opposition to adapt varying teaching strategies and technologically reach learning environments. That claim should not be underestimated for exactly the teacher education programs in which most of the preferences of prospective teachers about learning environments and processes are shaped. So prospective teachers' experiences and conceptualizations about their experiences should be examined more widely. With this point of view the focus of this research was the prospective science teachers' conceptualizations about PBL. The prospective science teachers' conceptualizations were tried to be interpreted by analysis of data from multiple sources and some assertions generated to present them. Assertions mentioned and examples given from the responses with notes about project portfolios and presentations indicated that prospective science teachers developed some varying understandings based on their experiences about conducting projects in the context of PBL.

It must be noted that the findings of this study presented in the form of assertions are about the conceptualizations based on experiences and also related with the difficulties faced in the process. They should be viewed with the findings from previous studies and be taken into consideration for the future instructional design processes. For example some conceptual constructs generated in this study such as group harmony, proficiency in research techniques and effective communication were generally based on problems participants faced with and implies a need for developing multiple supports for students while conducting their inquiry as claimed by Krajcik, Blumenfeld, Marx, Bass, Fredricks, and Soloway (1998). The difficulty in working together well especially in small groups which was attributed to students' lack of social skills by Achilles and Hoover (1996) should be also viewed in that way. So the conceptual constructs and assertions generated in this study should be hold as indicators for possible problems practitioners should be faced in any instruction process based on PBL and by taking into consideration those constructs instructors should give practitioners the chance of performing PBL more effectively from the first step of assigning driving question to last step of presenting products.

REFERENCES

Achilles, C. M., Hoover, S. P. (1996). Exploring Problem-Based Learning (PBL) in Grades 6-12. Paper presented at the Annual Meeting of the Mid-South Educational Research Association, Tuscaloosa, AL.

Ayas, K. & Zeniuk, N. (2001). Project-based learning: Building communities of reflective practitioners. *Management Learning*, 32(1): 61-76.

Barak, M. & Dori, Y. J. (2005). Enhancing Undergraduate Students' Chemistry Understanding through Project-Based Learning in an IT Environment. *Science Education*, 89(1), 117-139.

Bartscher, K., Gould, B., & Nutter, S. (1995). Increasing Student Motivation Through Project-Based Learning. Master's Research Project, Saint Xavier and IRI Skylight.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palinscar, A. (1991). Motivating project-based learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist*, 26(3 & 4), 369-398.

Blumenfeld, P., Fishman, B. J., Krajcik, J., Marx, R. W., & Soloway, E. (2000). Creating Usable Innovations in Systemic Reform: Scaling-up Technology-Embedded Project-Based Science in Urban Schools. *Educational Psychologist*, 35(3), 149-164.

Dewey, J. (1933) How We Think. A Restatement of the Relation of Reflective Thinking to the Educative Process (Revised edn.), Boston: DC.

Diehl, W., Grobe, T., Lopez, H., & Cabral, C. (1999). Project-Based Learning: A Strategy for Teaching and Learning. Boston, MA: Center for Youth Development and Education, Corporation for Business, Work, and Learning.

Dodge, B. (1998). WebQuests: A Strategy for Scoffolding Higher Level Learning. Paper Presented at the National Educational Computing Conference, San Diego, CA.

Gallagher, S. A., Stepien, W. J., & Rosenthal, H. (1992). The Effects of Problem-Based Learning on Problem Solving. *Gifted Child Quarterly*, 36, 195-200.

Grey, C. (2004). Essential Readings in Management Learning. London, GBR: Sage Publications Ltd. http://site.ebrary.com/lib/marmara/Doc?id=10076759&ppg=280

Jones, B. F., Rasmussen, C. M., & Moffitt, M. C. (1997). Real-Life Problem Solving: A Collaborative Approach to Interdisciplinary Learning. Washington, DC: American Psychological Association.

Krajcik, J., Blumenfeld, P.,Marx,, R.W.,&Soloway, E. (1994). A Collaborative Model for Helping Science Teachers Learn Project-Based Instruction. *The Elementary School Journal*, 94(5), 483– 497.

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., Bass, K. M., Fredricks, J., & Soloway, E. (1998). Inquiry in Project-Based Science Classrooms: Initial Attempts by Middle School Students. *The Journal of the Learning Sciences*, 7, 313-350.

Levstik, L. S., & Barton, K. C. (2001). Doing History. Mahwah, NJ: Lawrence Erlbaum.

Marx, R. W., Blumenfeld, P. C., Krajcik, J. S.,& Soloway, E. (1997). Enacting Project-Based Science. *The Elementary School Journal*, 97(4), 341-358.

Moursund, D. (1999). Project-Based Learning Using Information Technology. Eugene, OR: International Society for Technology in Education.

Newton, P., Driver, R., & Osborne, J. (1999). The place of argumentation in the pedagogy of school science. *International Journal of Science Education*, 21(5), 553 –576.

Roth, W. M. (1995). Authentic School Science: Knowing and Learning in Open-Inquiry Laboratories. Dordrecht, Netherlands: Kluwer Academic Publishing.

Scardamalia, M., & Bereiter, C. (1991). Higher Levels of Agency for Children in Knowledge Building: A Challenge for the Design of New Knowledge Media, *Journal of the Learning Sciences*, 1, 37-68.

Schmidt, W. H., McKnight, C. C., Houang, R. T., Wang, H. C., Wiley, D. E., Cogan, L. S., & Wolfe, R. G. (2001). Why Schools Matter: A Cross-National Comparison of Curriculum and Learning. San Francisco; Jossey-Bass.

Simkins, M. (2002). Increasing Student Learning Through Multimedia Projects. Alexandria, VA, USA: Association for Supervision & Curriculum Development. http://site.ebrary.com/lib/marmara/Doc?id=10044791&ppg=23

Slack, S.J. & Stewart, J. (1990). High School Students' Problem-Solving Performance on Realistic Genetics Problems. *Journal of Research in Science Teaching*, 27(1), 55-67.

Strauss, A., & Corbin, J. (1990). Basics of Qualitative Research: Grounded Theory Procedures and Techniques. Newbury Park, CA: Sage Publications, Inc.

Thomas, J. W. (2000). A Review of Research on Project-Based Learning Executive Summary. San Rafael, CA: The Autodesk Foundation. http://www.k12reform.org/foundation/pbl/research.

Thomas, J. W., Mergendoller, J. R., and Michaelson, A. (1999). Project-Based Learning: A Handbook for Middle and High School Teachers. Novato, CA: The Buck Institute for Education.

Tretten, R. & Zachariou, P. (1995). Learning about Project-Based Learning: Self-Assessment Preliminary Report of Results. San Rafael, CA: The Autodesk Foundation.

Tretten, R. & Zachariou, P. (1997). Learning about Project-Based Learning: Assessment of Project-Based Learning in Tinkertech Schools. San Rafael, CA: The Autodesk Foundation.

Worthy, J. (2000). Conducting Research on Topics of Student Interest. *Reading Teacher*, 54(3), 298-299.