

Project Based Learning to Promote Educational Leadership Skills Implementation in an Environmental Science Course at Zayed University

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ABSTRACT

The main idea underlying this work is that higher education students can develop educational leadership skills throughout the learning process supported by the approach of project based learning (PBL). This method has been known to point out at the challenge of increasing students' motivation, their involvement in the course, and looking for applications of their learning. This study shows the benefits of designing a project in an environmental science course to create a more effective learning medium. Using PBL, students who were enrolled in the introduction to the environment sciences' course at the general education level at Zayed University, were given the responsibility of quantifying the consumption of paper, to study qualitatively and quantitatively how this consumption would affect ecological resources as well as air pollution production. Students needed afterwards to discuss the benefit of recycling and how this can affect people lives. With the use of the PBL approach, students have shown a good improvement within the area of educational leadership skills (objective, group work, motivation). Most important of all, students showed a high level performance and course satisfaction.

Keywords: Educational leadership skills, Project based learning approach, Project design, General education courses, Introduction of environmental sciences' course.

INTRODUCTION

Over the last three decades, research has suggested that opportunities for gaining a good understanding of science could be achieved via courses that use project based learning approach (Egenrieder, 2010). In fact, PBL is a comprehensive method in which students work in groups and conduct an investigation of a real world topic. Students need to work over extended period of times to solve challenging questions or problems. Therefore students would be involved in the process by: designing and conducting investigations, gathering information, collecting data, asking questions, drawing conclusions based on their results and reporting their findings toward the end of their work (Peggy, 2009).

Today's students need a better understanding of what science is, a clear presentation of scientific concepts, activities that require analysis and interpretation of real data, and most of all a deep appreciation for the role of sciences to the well-being of humanity (Cox, 2012). Indeed, project based learning is believed by its nature, to provide the opportunity to students to accomplish all of that. Rivet and Krajcik (2004) reported that the design of project based curriculum that converges the learning of sciences from concepts based to meaningful world projects, promoted learning of important and practical science content (Rivet, 2004). In another study, project based learning environment and its impact on students have been investigated. The results indicated that PBL has been motivational and effective when it comes to development skills, students have gradually shown more interest and more confidence about different component of their project (Papastergiou, 2005). A similar study conducted for first year undergraduate students, aimed to investigate the effect of PBL on science students' achievement and their development of scientific process skills. The research findings proved that there was a significant improvement of students' learning as well as an enhancement of their attitude toward sciences and research skills (Altun, 2009).

In the education field, professors and students often speak of skills and knowledge as separate matters, while, indeed, there are intertwined. For instance, if a student has developed the ability to "think scientifically," he or she can do so within a context. In this regard, domain knowledge is mainly important as a channel to teach how to think scientifically. Furthermore, project based learning as well as problem based learning have been proved to be good

approaches in implementing business skills (Stinson & Milner, 1996) and technical skills (Littlejohn, 2002). As per leadership skills (Goal setting, group work, motivation,...), there is little evidence of research on the actual effectiveness of the academic programs offered at the higher education level to develop leadership skills. Students' successes or failures were due more to context, previous experience, and personal characteristics than to any appropriate effort to provide them with these skills within the educational context. University's students have been expected to have the necessary skills on entry into the job market, or to develop them on the job via professional development and/or special trainings. Thus the aim of this work is to attract the attention to the importance of using academic approaches as vehicles of implementing leadership skills within students' population at the higher education level.

The main goal of this study was to investigate the important effect of PBL in promoting the implementation of educational leadership skills (Objective, group work, motivation) within undergraduate students' population at Zayed University, as well as their academic performance. The performance and the acquiring of educational leadership skills have been compared with that of students in the standard curriculum over two semesters. More specifically, a lot of effort was given to the design of the project and how students could use it to discuss and find a solution for a real world problem. Three methods were used to evaluate the output of the study: Grade's comparison, class observation and students' survey. And the research results revealed that science achievement of undergraduate students significantly improved with the acquiring of educational leadership skills via project based learning.

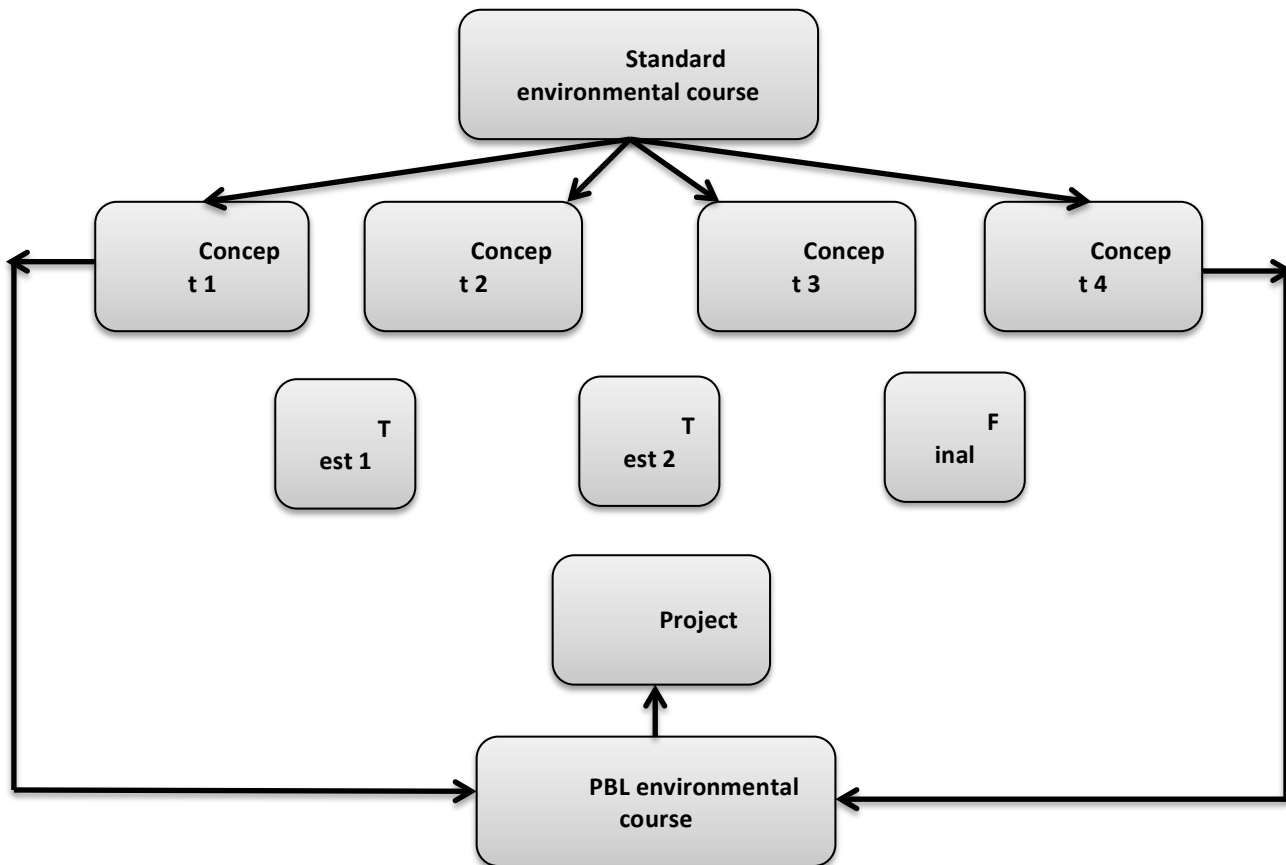


Figure1: Course map for the introduction to the environmental sciences course using the PBL approach.

METHODS

The sample of the study conducted at Zayed University, Dubai campus, UAE, consisted of a total 111 students from the general education level. The project based learning approach was developed for a non-science majors introductory environmental science course taken by all undergraduate students to fulfill the science general education requirement. The course was normally scheduled to meet three times a week for a period of 50 minutes each time. Course sections had in average 20 students. And, over three consecutive semesters (Fall, Spring and Summer) of the academic year 2012-2013, data were collected.

Typical introductory to the environmental sciences course often is presented as a sequence of topics-based lectures and various assignments. These assignments are most of the time directed by a series of questions and instructions to introduce students to general environmental knowledge. Although, undergraduate students may enjoy

learning about environmental problems and discussing possible solutions, it has been noticed that most of the time, they fall short in understanding the relationship between the knowledge they have learned and its application to their real lives.

The basic idea behind this work is to incorporate the approach of project based learning within the traditional course. The course was redesigned to provide students with a project at the beginning of the semester. Students of the introduction to the environmental sciences' course were offered a good opportunity to work on a meaningful project in class through project based learning and under the course same outlines.

Procedure: In a typical introductory course to environmental sciences conducted at Zayed University, students usually are presented with the contents of four units that discussed different environmental aspects. And each unit is followed by a test. Students' focus is directed toward getting the unit done quickly and the whole main objective of the course could easily be lost. In the redesigned form of the course, and to truly understand the course content and successfully engage in the project based learning method, students need to understand that if the first step of their project is not performed properly, they will fall the following steps. Achieving success in each part of the project provided students with self-confidence and brought motivation and enthusiasm for the course.

Figure 1 illustrates the course map and how different components of the course are related. Students earn the necessary course knowledge throughout class discussion and activities in addition to a project that is embedded along the semester.

Different units of the course included the social aspect which covered population and how it affects the environment. This was followed by discussing the ecological aspect by learning different component of an ecosystem and how does losing one component may affect the whole system leading to dangerous environmental problems. The third unit of the course focused on learning about biodiversity and therefore understanding why each ecological unit of an ecosystem is valuable from an instrumental and from an intrinsic point of view. In the last unit of the course, students needed to learn about air pollution and how this may affect biodiversity. While the classroom discussions include the basic knowledge of the course followed by a unit test, there were designed with the goal of completing the course project that all of the students were involved in during the whole semester.

During the first week of the semester, students were introduced to the PBL approach, its goals and procedures. At the start of each class meeting the basic unit concepts were discussed and once a week, students were provided with time to work on their project in class, to discuss problems and challenges they were confronted with.

Project based design of PBL: The students of the introduction to the environmental sciences' course needed to work on a project that reflects the UAE ecological foot print. Early in the semester various discussions were held concerning this issue and the decision came up to work on paper consumption. The project was then divided on different sections related to different units of the course. At the first phase of the project, students with their groups needed to quantify their paper consumption (A4 paper) during a period of two weeks. After that, the social aspect of the course was taken into account by using population numbers. The following phase concentrated on quantifying how much trees are used to make paper that was consumed in the first phase, as well as discussing the impact of losing trees on the ecosystem and the biodiversity therein. In the last phase of the project, students and their groups needed to quantify chemical pollutants produced (carbon emission) as per their individual paper consumption. Overall, students of the introduction to the environmental sciences' course needed to present, in a report, their data collections, calculations, predictions, analysis and problem's solution.

Study evaluation: At the end of the semester, an online survey was given to the students of the introduction to the environmental sciences' course which contain ten questions. However, in this paper, only few questions are discussed and analyzed. Also, student's academic performances were measured based on their tests' grades, and overall course grades. Different semesters' results are presented in this paper for the reason of comparison. Furthermore, and to better assess student attitude toward the course and the PBL approach, an evaluation based on observation was conducted in a weekly basis. The observation was launched at the beginning of the semester and number of students who were involved in their work, were asking questions and paying attention during course discussions or project work, was recorded.

RESULTS AND DISCUSSION

In this work, the main objective behind using project based learning in a science subject, is that designing projects that are relevant and interesting are known to give students good opportunities to become independent learners and be more involved with the course material. All of that can be achieved by acquiring educational leadership skills as well as scientific skills. (Bolotin & Svinicki, 2000) The students' population involved in this study is non-science majors, that implies that students had various levels at sciences and quantitative background. Therefore, teaching this heterogeneous group of students is known to be a very challenging task. However, if the PBL approach is

used, every one of these students will be given a chance to contribute, and to develop the project work and therefore have a very valuable impact on students acquiring many educational and scientific skills. Students are developing the skill of working with a clear objective (Knowledge in action) as well as developing the skill of working within groups.

Furthermore, it has been proven that the success of using the approach of PBL (and therefore educational leadership skills implementation) within the instructing process in higher education is based on its special characteristics, and that is that of the practice nature of knowledge and learning, on the nature of the project, and finally on the knowledge integration. All of that has proved to overcome challenges of the learning process in higher education. (Scarborough, et al., 2004)

The main goal of this study is to focus on the project design and help students put their knowledge gained in the introduction to the environmental science course into action. For example, in this project-based learning course, instead of just learning and discussing about the social aspect of the course, the ecology and biodiversity aspect, and the chemistry and physics aspects, students take on the role of discussing and quantifying an environmental problem that concerns them and their country and that is that of the very high ecological footprint. Classroom discussions had come up with the decision on working on paper consumption as being one of the most contributors to the ecological footprint in the UAE. In these roles, students think about how different concepts they have studied could apply to the cases they are working on. Using projects as the spine of the course, in which students take on authentic roles and participate in simulations of real-world scenarios, allows students to engage with the content in context as well as to apply what they learn throughout the semester, not just on one test. In the first part of the project, students needed to collect their paper consumption data (A4 paper) for a period of two weeks. That will give students a good idea about how much they can consume paper for longer period of time such as a month and a year. After that, students needed to come up with predictions of yearly paper consumption from within their own families, cities and then the UAE. The table below shows an example of the sample data collected and processed by one of students' groups that took the introduction to the environmental science course during summer 2013 at Zayed University in Dubai.

Quantification of A4 paper consumption					
	Week/ Number	Month/ Number	Year/ Number	Yearly consumption/grams	Yearly consumption/Tones
Individual students	41	164	1,968	10,017	0.010017
Student's family	287	1,148	13,776	70,119	0.070119
Student's city population	82,129,970	328,519,880	3,942,238,560	20,065,994,270	20,065.99
UAE population	338,826,870	1,355,307,480	16,263,689,760	82,782,180,880	82,782.18
UAE active population	279,532,137	1,118,128,548	13,417,542,576	68,295,291,712	68,295.29

Table1: A summary of an average A4 paper consumption of a students' group that was part of the PBL project. (Summer 2013)

The above data was collected by each group of students. Students have worked out their average daily A4 paper consumption and their weekly consumption. The monthly and the yearly consumption were predictive calculations based on the actual average daily consumption. After that students needed to move further and try to quantify how much A4 paper their families consume in a daily, a weekly, a monthly and a yearly basis. The family data was predictive calculation based on the actual average individual student's consumption (Seven family members were used to predict how much the above family consumes of A4 paper). These calculations were followed by a trial to

estimate how much A4 paper a city can consume. Dubai was the city used in the above example, and a recent population number of Dubai was used (2,003,170). (Total Population of the UAE, 2013). Then, a trial to estimate how much A4 paper the UAE population can consume in a daily, weekly, monthly and yearly basis. The estimation was based on the individual student consumption and using a recent UAE population number (8,264,070). (Total Population of the UAE, 2013) This last estimation on how much A4 paper the UAE population can consume is not quite accurate, as the calculation assumes that all population is consuming A4 paper in a similar way. Therefore, the use of a better estimation of population that are effectively using paper and that is what is called "Active population". This latter is known to be a group of population that includes ages from 15- 64 years old. Using a recent estimate, it has been reported that only 6,817,857 (82.5% of the 2010 UAE population) is categorized under the active population group. (The Demographic Profile of the United Arab Emirates, 2013)

To better quantify the number of A4 paper consumption in the UAE, students needed to conduct a unit conversion (from numbers to grams). An international conversion rate was used and the students' yearly consumption data was converted from number of paper to the weight in grams and tonnes. The conversion rate used in this phase of the project is that 1 A4 paper weights around 5 grams. (Paper density, 2013) In addition to the litterature rate conversion, students have used an electronic balance inside the classroom, and the rate found was around 5.09 g.

The data that students have collected, calculated, projected and converted is by no mean 100% accurate, due to a number of assumptions that were made in this stage of the project. However, the numbers presented in Table 1 can give students a good quantification as per the use of paper either at an individual level or at the country level. And therefore, can put their knowledge (Population and footprint) earned in the first part of the introduction to the environmental science course into action. This important step of the project presents with no doubt a chance for students to earn educational leadership skills such as objective and group work.

The second phase of the PBL experience, in the introduction to the environmental science course at Zayed University, focused on the ecological and biodiversity aspect of the course. After discussing the concept of ecosystem and the importance of each biodiversity component in various ecosystems. Students needed to find out which ecological resource is used to make paper. And therefore, quantify their previous data as per the ecological resource's consumption. The following table illustrates how much of a tree, Zayed University students, their families, their cities and the UAE are consuming:

Quantification of trees' consumption		
	Yearly paper consumption/Tones	Yearly tree consumption
Individual students	0.010017	0.170289
Student's family	0.070119	1.192023
Student's city population	20,065.99	341,121
UAE population	82,782.18	1,407,297
UAE active population	68,295.29	1,161,019

Table2: A summary of a yearly average tree consumption of a students' group that was part of the PBL project. (Summer 2013)

In this phase of the project based learning course, students needed to focus on quantifying the yearly tree consumption from an individual level to the country level. The introduction to the environmental science course students developed further their skills in understanding scientific concepts. Calculations and number projections were mainly made based on previous data for yearly paper consumption as well as on a known international conversion rate. Research in the field of paper manufacture has shown that in order to make 1 tone of paper, in average around 17 trees should be used. This conversion rate was published by Concervatree (a non-profit organization) based on a

report to Congress in the USA in the 1970s. The rate was used to estimate the number of trees needed to make virgin paper, without taking into consideration the type of tree, its height nor its diameter. Although other estimations were made after that, there will be always a need to more trees' specification. For the quasi quantitative nature of this work, the first rate was used keeping in mind that the data presented in this work provides environmental students course and researchers with only a good estimate of the number of trees as per their A4 paper consumption.

During the last phase of the project of the PBL introduction to the environmental science course, students needed to find out the main pollutant as per paper manufacture. Then, students had to quantify how much pollutant they were contributing with upon their average A4 paper yearly consumption. Table 3 presents a summary of data as per pollutant production.

Quantification of CO ₂ production		
	Yearly paper consumption/Tones	Yearly CO ₂ production/Tones
Individual students	0.010017	0.013623
Student's family	0.070119	0.095361
Student's city population	20,065.99	27,290
UAE population	82,782	112,584
UAE active population	68,295	92,882

Table 3: A summary of a yearly average CO₂ production as per paper consumption of a students' group that was part of the PBL project. (Summer 2013)

In a similar way to the previous phases of the PBL project, students needed to quantify their yearly contribution to the chemical production (mainly CO₂). Calculations have been performed starting from an individual level to the country level. And were mainly based on previous data for yearly paper consumption as well as on a known international conversion rate. In fact, data about how much pollutants are produced in the paper manufacture has been published and a rate of 1/1.36 tones of paper to tones of CO₂ has been used. (Learn more about paper, 2013) Other rates of pollutants' production as per paper production have been published and there were mostly close. Similarly and for the quasi quantitative nature of this work, the 1/1.36 rate was used keeping in mind that the data presented in the above table provides environmental students course and researchers with a good estimate of how much CO₂ is produced as per paper consumption.

At the end of their project, the introduction to the environmental course students have to look at their data and think about how they can avoid destroying trees and therefore saving ecosystems. In addition to minimizing the pollutants production. All of that goes under finding solutions to environmental problems. Students have been convinced upon their findings on the importance of using less paper in their everyday lives. They were encouraged to recycle, to avoid printing and to reuse paper.

In summary, this study supports the fact that project based learning is an effective and motivating approach for higher education students. The work has proved that students of the introduction to environmental science course in Zayed University have had the chance to earn various skills (Critical thinking, problem solving, science's inquiry) that are in accordance with the science requirement of general education courses in the university. Furthermore, students have had the opportunity to acquire few educational leadership skills (Objective, group work and motivation).

Study evaluation: To explore the impact of the project based learning approach on students' attitude toward acquiring various skills and educational leadership skills in specific, different instruments have been used during the time of the study (2012 Fall, 2013 Spring, 2013 Summer). Mainly an observation exercise, students' performance

comparison and students' survey were used.

First, an observation exercise was carried out to investigate the in-class atmosphere and number of students who have shown involvement with the project work has been recorded in a weekly basis throughout the semester. The observation data obtained from the introduction to the environmental science course was analyzed and it has been shown that after few sessions, students have begun to take the initiative to start working, to ask questions and to discuss. Figure 2 shows the number in percent of students who have shown involvement in the project inside the classroom throughout the semester.

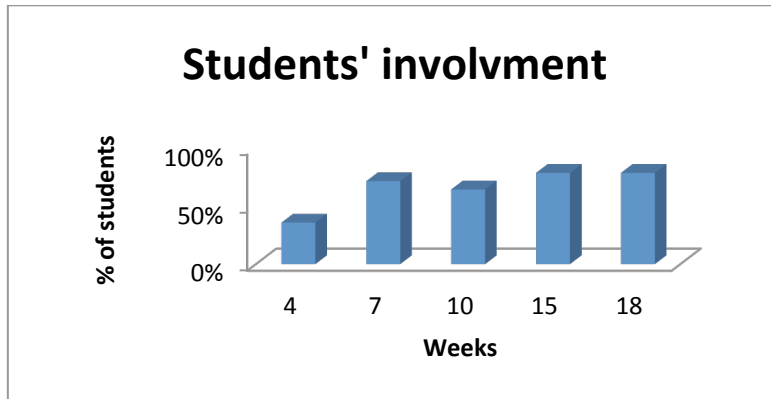


Figure 2: Example of a sample of data based on students' involmment inside the classroom.(Spring 2013)

In the first week of the semester, the approach of PBL was introduced to the students of the introduction to environmental sciences' course. The project's goal and procedures were explained. After that students were engaged on data collection as per their daily and weekly paper consumption (A4). Each week a discussion time and project work period was given to the students. Data of the number of students who were involved in the project work versus time is presented in the above chart (Week 4, 7, 10, 15 and 18).

The results of the observation exercise conducted along the semester has shown that after few sessions, students have started to show their involvement by discussing within their groups or with their instructor. The rate of involvement has shown a positive increase with time as it goes from 40% of the students during week 4 to 80% toward the end of the semester. This observation part of the study has demonstrated that not only the PBL project provided students with opportunities to see the relevance of their earned knowledge, and make the connection between the subject content, the project and their own experiences. But also, it helped them earn educational leadership skills such as appreciating the objective behind their learning as well as working within groups and all of that can explain the higher percent of involved students at the end of the project compared to that at beginning of the semester.

Second, and in order to gather adequate data about the change of student's attitudes toward their learning as well as toward their level of knowledge and skills, another data source was used. The overall students' performance was analyzed in comparing a PBL introduction to environmental sciences' course and a traditional introduction to environmental sciences' course. The table below summaries letter grade numbers (A, B, C, D, F) within sections of the environmental courses taught in a traditional way, and those within sections of the same course taught using PBL.

Letter grades	Section 523 (Traditional)	Section 582 (Traditional)	Section 501 (PBL)	Section 511 (PBL)	Section 503 (PBL)
A	4.35%	0.00%	17.39%	28.57%	31.82%
B	30.43%	18.75%	43.48%	28.57%	45.45%
C	47.83%	62.50%	21.74%	42.86%	22.73%
D	13.04%	18.75%	17.39%	0.00%	0.00%
F	4.35%	0.00%	0.00%	0.00%	0.00%

Table 4: A summary of students’ performance. A, B, C, D, E are letter grades converted from the overall course grades. A section is a class of students taking the same course. Sections 523 and 582 were taught traditionally during 2012 Fall semester. Sections 501 and 511 were taught using PBL during 2013 spring semester. Section 503 was taught using PBL during 2013 summer semester.

According to Table 4, there was a considerable difference in terms of achievement between the traditional group and the PBL group. Project based learning and the trial of implementing educational leadership skills seemed to improve the performance of students in the environmental course. Most of Zayed University students who enregistered in this course seem to find learning more meaningful by being motivated to take responsibility, to investigate and to bring their own input for their project. The data collected as per students’ performance showed a general positive increase when comparing percents of A and B in traditional classes and PBL classes of the environmental course. (31.82% versus 4.34% for letter grade A. And 45.45% versus 30.43% for letter grade B respectively for sections 503 and 523). The opposite trend was observed for the percents of C and D. The data collected as per students’ performance showed a general negative increase when comparing percents of C and D in traditional classes and PBL classes of the environmental course. (22.73% versus 47.83% for letter grade C. And 0.00% versus 13.04% for letter grade D respectively for sections 503 and 523).

At the end of the semester, an online survey was given to students of the enviromental course. The questionnaire contained ten questions, however , only 5 questions that are directly related to the study are presented here.

The project has helped me understand better the objective of the environmental course.	
Strongly Agree	35%
Agree	40%
Neutral	20%
Disagree	5%
Strongly Disagree	0%
While working on the project, I have liked working in groups.	
Strongly Agree	35%
Agree	35%
Neutral	8%
Disagree	18%
Strongly Disagree	8%

I believe that the project has helped me learn better in this environmental course.	
Strongly Agree	35%
Agree	38%
Neutral	22%
Disagree	2%

Strongly Disagree	0%
I believe that the project has helped me be motivated in this environmental course.	
Strongly Agree	40%
Agree	32%
Neutral	25%
Disagree	5%
Strongly Disagree	0%
I believe that the project has helped me perform better in my tests.	
Strongly Agree	30%
Agree	25%
Neutral	30%
Disagree	10%
Strongly Disagree	2%

Table 5: Survey results and students’ feedback on the project used in the PBL environmental course. (2013 Summer 2013)

Survey results showed that more than 70% of students indicated that the project helped them to understand the objective of the course and therefore to better understand the course concepts and keep them motivated. In addition around 70% of the students have shown positive feedback on group work. Table 5 shows that 55% of students believed that the project conducted in the introduction to the environmental sciences course has helped them to perform better in their tests. This relative low percentage can be explained by the fact that many students did not make yet the link between working on the project and learning. These students still think that the project is an assessment component of the course rather than a channel of learning.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study supports the view that project based learning is an effective pedagogical approach in which students engage in intellectually challenging work that allow them to gain knowledge and educational leadership skills. At Zayed University, PBL enabled students of the introduction to the environmental sciences course to use real data, to quantify their funding and to comprehend the process of working on a project.

The project was designed to provide students enjoyable and effective environmental concepts learning. Students have put their knowledge in action. They have quantified paper consumption, ecological resource consumption and pollutant production. They have come up with real figures as per their individual, family, cities and the nation consumption. All of that has shown that well designed projects within the approach of PBL can be a real catalyst for students to gain quantitative reasoning, critical thinking and problem solving from the knowledge point of view. And to help them acquire skills such as the objective, group work and motivation. Indeed, in all phases of the study, it was rewarding to see the students interested during their PBL learning experience. It seemed obvious that students were more motivated, more focused, enjoying working in groups and performing better, compared with the students in the traditional course.

Finally, Zayed University can create an autonomous life-long learning environment by: Identifying learning objectives, employing learning approaches, using appropriate resources, training its faculties and spreading the awareness of the importance of the learning opportunities that exist inside classrooms.

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