THE PEER-LED TEAM LEARNING INTERNATIONAL SOCIETY
PROCEEDINGS OF THE 2013 CONFERENCE
MAY 30-JUNE 1, 2013
UNIVERSITY OF HOUSTON-DOWNTOWN
HOUSTON, TEXAS

EDUCATIONAL PARTNERSHIPS TO ENCOURAGE STEM PARTICIPATION

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Abstract: U.S. rankings in education, especially in Science, Technology, Engineering and Mathematics (STEM) fields, are below many developed countries. One third of the STEM doctoral students are international. Thus, there is an urgent need to creatively teach US students about STEM fields so that they can select these areas and pursue careers. This paper describes a Peer-Led Team Learning (PLTL) partnership between General Microbiology and Urban Education (UE) classes at the University of Houston Downtown (UHD). The students in the UE class train to become inner-city teachers. In our model, the microbiology student peer leaders assisted in science projects design and implementations. As a result, the UE students more effectively taught hands-on science to elementary school students. Preliminary conclusions from this project are (1) the microbiology students learned the subject better by becoming peer leaders, (2) the UE students were encouraged to conduct science experiments in the classroom, (3) both sets of students were happy to contribute to their community, and (4) the elementary school students became excited about working on science projects.

STEM Education

The job market is increasingly demanding a labor force with a background in STEM fields. However, undergraduates are not selecting careers related to STEM fields. Hall, Dickerson, Batts, Kauffmann, & Bosse (2011) found that school teachers are able to influence career choices of their students. However,the teachers have limited knowledge on careers in STEM fields. The authors suggested that without proper encouragement and knowledge of the STEM fields students may never consider these fields as career choices. Strayhorn (2010) and Hubbard & Stage (2010) found that the situation is even worse among underrepresented racial minorities (URMs). Strayhorn reported that in the STEM fields labor market only 6% is composed of URMs. Therefore, it is imperative that teachers are trained with strong backgrounds in STEM pedagogies to enable them to introduce children to these concepts (Epstein & Miller, 2011; Greene, DeStefano, Burgon, & Hall 2006).

Peer-Led Team Learning

The concept of PLTL originated at the City University of New York in the early 1990's. The idea is to recruit students who have performed well in a particular class and make them peer

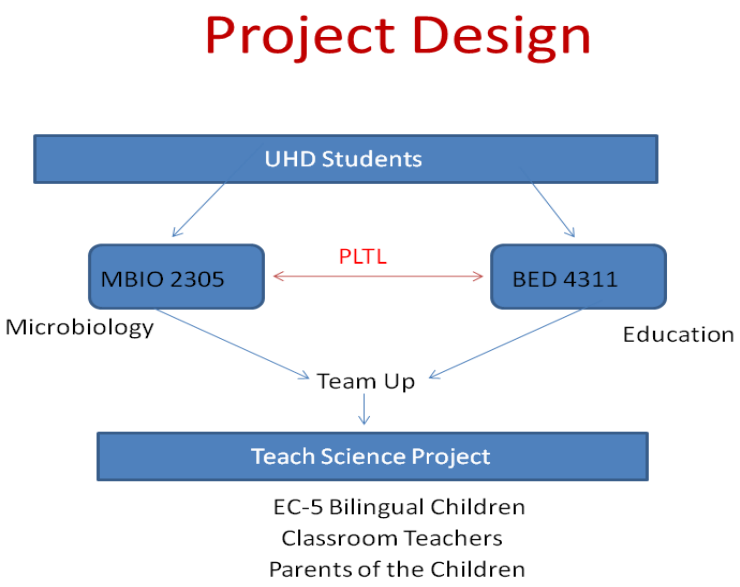
leaders in the class. The peer leaders typically meet with small groups of students from the class and discuss concepts covered in the course (Gosser, 1994). This project at the University of Houston – Downtown used a modified version of the PLTL approach. The microbiology students who were learning the science in their class led discussions with their partners in the UE class to help them understand the science concepts. The UE students in turn taught minority children in elementary schools the necessary scientific investigation skills to develop a better understanding and appreciation for science.

Project Goals

The goals of this collaboration were to (1) improve the dismal statistics in the STEM areas, (2) enhance science pedagogy in schools with better trained teachers, (3) excite young students in STEM field concepts, (4) provide service learning and civic engagement opportunities to college students, and (5) conduct experiments relevant to society such as urban gardening and microbes in society. This paper will include the project design, communication among the team members, role of the team members, assessment of their work, and participant reflections.

Project Design

The purpose of the project was to encourage minority children to learn scientific investigations skills and get exposure to careers related to the STEM fields.The following model shows the project design:



Microbiology students enrolled in General Microbiology (MBIO 2305) and Urban Education (UE) students enrolled in BED 4311 teamed up to use the knowledge being learnt in their classes to teach minority children about STEM fields. Each team was composed of 3 MBIO students and 1 BED student. MBIO students were well versed in scientific concepts and experimentation and led discussions with the UE students. The MBIO and the UE students collaborated to teach the

science state curriculum to the minority children. Forty percent of the questions on the Texas state science test (STAAR) are related to scientific investigation.

UE students were assigned to classrooms where they completed an internship of sixty hours per semester. During this time they practiced teaching young children scientific investigation skills. The PLTL approach was a powerful method to assist the UE students to become effective science teachers. The project lasted 10 weeks per semester. Students from both classes met at the beginning of the semester, and got an overview of the project. Groups were formed and contact information exchanged. The groups worked together throughout the semester, and reported the results as a video presentation.

Class Projects

The two main projects conducted during the semesters were (1) composting to produce fertile soils and (2) gardening using the composted soils.These projects were designed to teach STEM areas and practice skills involved in experimenting. In the first project, the BED students and the elementary school children learned about the role of microbes in breaking down organic matter to soil. The children also discussed recycling kitchen wastes and helping the environment. The second project on gardening addressed the issue of healthy eating with 2-5 year old children who are becoming overweight or obese in the USA (Ogden, Carroll, Kit & Flegal 2012). We reasoned that if young children learn to grow their own food and discuss healthy diets, they could avoid becoming part of the obesity statistics.

Implementation of PLTL

After the first meeting of all students, the small groups of 4 - 5 students met and/or communicated weekly. Initially, the microbiology and BED students discussed the concept of composting and decided on the ingredients to use for composting. The microbiology peer leaders explained the science behind using the appropriate ratios of nitrogen and carbon needed for the microbes to thrive and break down the wastes. Thereafter, the team projects were designed using the scientific method. The peer leaders discussed how to pose questions, formulate hypotheses, and design dependent and independent variables. The groups had to decide on measurable outcomes, for example, height of plants, number of leaves, and rate of growth.

As the semester progressed, microbiology peer leaders discussed problems that arose during the experiments. These included delayed or no germination of seeds, foul smells from the compost, ant piles in the compost, etc. Although most of the time the microbiology students were the peer leaders, the roles became reversed when the microbiology students went to the class rooms. Each microbiology student visited the classroom twice in a semester. During this time, they observed and learned from the UE students. It was an eye-opening experience for the microbiology students to witness the class room setting. The UE students taught the children and carried out the experiments with them. The microbiology students learned pedagogy in elementary schools and the finesse required to manage a classroom.

Communication within the Team

An important component of this project is communication among the members of the group. Since these are two separate classes, a fixed meeting schedule was difficult to construct. Therefore, each group made its own weekly communications schedule and maintained a log. They could communicate face to face or use electronic media. Some of the teams used social media such as Facebook and Twitter. The log contained information relating to the following questions: What component of the science project was addressed in your meeting? What questions did you bring to your peer leader? What did you learn from your peer leader? What questions did your peer leader ask you? The logs were turned in at the end of the semester and were part of the evaluation.

Assessment of the Project

The efforts of microbiology and UE students were assessed and grades were assigned. The MBIO students received twenty percent (20%) of their grade in the class for becoming effective peer leaders. They had to submit written assignments on the science as well as reflection pieces from school visits. BED students received thirty-five percent (35%) of their final grade for this project. They submitted written assignments on the project as well as effective science pedagogy. All students created videos with their partners describing the project and its implementation.

Participants' Reflections

The success of this PLTL experience is evident in the student comments - a few sample comments are shown below.

In the MBIO class: One student wrote: "We had to learn the material better than we normally would because we had to teach it." "I thoroughly enjoyed every moment of the experience and our BED partner appreciated our help and expertise as well."Another one said, "Through this project, I not only learned microbiology, but I had the opportunity to apply my studies …" Another comment was: "I got to see two different sides of careers, teaching and being the scientist. It was a great way of coming together with my peers and putting our knowledge together for kids and teaching them what we have learned."

The comments from the BED class included the following. One student stated, "I learned (from the MBIO team) that bacteria grow in everything and that *plates* should be kept closed. Leaving them open can cause others to get sick." Other student wrote "I learned (from the MBIO team) that we should first research how much space the fruit or vegetable will need to grow. Some vegetables need lots of space, so planting in a pot is not a good idea in some cases." Another comment was: "My teaching is connected to the STAAR test because I am teaching them (children) how to plan and implement a simple experiment to test one variable. ... I also started to teach the scientific method and the children did really well on formulating a testable question/hypothesis." Overall the university students agreed that it was a lot of work but they also learned a lot from the experience.

Conclusions

The modified PLTL approach that we employed for this project was a useful strategy and a powerful method. The MBIO and UE students worked together to improve science pedagogy in the schools and excite young students about science. Both sets of students commented that the project was successful. Expansion and continuation of such programs can help to increase the numbers of U.S. students enteringthe STEM fields.

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Cite this paper as: Gulati, P., Bhattacharjee, M. (2014). Educational Partnerships to Encourage STEM Participation. *2013 Conference Proceedings of the Peer-Led Team Learning International Society*, May 30-June 1, 2013, University of Houston-Downtown, www.pltlis.org; ISSN 2329-2113.