The STEM Club at Marietta High School

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Abstract – The Student and Teacher Enhancement Partnership (STEP) program of Georgia Tech has partnered with Marietta High School (MHS) to create a new program, the STEM Club, for students to actively engage in the design, research, and presentation of science-fair projects within an area of the student's choice. STEP Fellows and MHS faculty will provide mentorship to students, so they may compete with other schools at the local, regional and state science fairs. This represents MHS first attempt at developing a science fair program and represents a primary goal set by the system. STEP Fellows within MHS provide a wide range of skills including, the use of the scientific method, design of experiments, writing skills, and the encouragement to pursue science. This paper will describe the program details and examine the role of Georgia Tech graduate and undergraduate students in the STEM program.

Keywords: Science fair, inquiry, outreach, K-12

INTRODUCTION AND MOTIVATION

The importance of inquiry-based learning within the classroom, whether secondary education or collegiate, has gained significant attention recently. A number of educational reforms were created to address the growing need of students to gain scientific skills especially in the areas of critical thinking and scientific reasoning addressed by the American Association for the Advancement of Science (AAAS) in 1989 and the National Research Council (NRC) in 1996 [Bell, 1]. Bell, et. al. cites the notion of scientific literacy as the motivation behind the goal of providing more inquiry-based education. From the article, scientific literacy is defined as the ability to make decisions concerning science and technology using a deep understanding of scientific concepts, scientific inquiry, and the nature of science [Bell, 1]. O'Neill and Polman continue with this theme by adding that the current curriculum within American classrooms, as well as other classrooms around the world, focuses too much on the exposure of students to various areas of science, while depriving them of critical time needed to gain a deeper understanding of the topics at hand. This deeper understanding is what the authors cite as critical to the development of the student [O'Neill, 5]. These citations represent only a few of the articles addressing a key issue facing science education in today's world of how to get students to become scientists and not absorbers of facts.

One of the ways to address the need to incorporate more inquiry-based learning within the curriculum is a technique/learning tool that has been present for many decades, the science fair. Within any science fair design, students are required to employ the scientific method with current knowledge they have on the subject. Properly implementing a science fair can provide an excellent means to address the needs of increased amounts of inquiry-based learning within the secondary education environment. Many schools currently have science fairs and often produce very successful students within the sciences due to a strong program that is present within their given high

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school. On the contrary, a number of schools lack the structure of a science fair and often struggle when attempting to create a system without precedence.

Without question, the importance of science fair and the extra-curricular activities around it could provide an excellent means to educate students in science by providing hands-on learning of scientific ideas and scientific procedure. In a recent editorial by Mark T. Hoske, the editor-in-chief of Control Engineering, the central theme and title was help students in the STEM game [Hoske, 4]. Throughout this paper, this central idea will be addressed by highlighting a new partnership between the Georgia Institute of Technology and Marietta High School. This notion is supported by DeClue, et.al. who notes that one key way to enhance the science fair experience is through the creation of partnerships of colleges/ universities or industries with nearby secondary schools. This arrangement can provide valuable outcomes for both sides by offering the students enhanced resources and mentorship that in turn results in a higher level of enthusiasm creating better science fair projects overall [DeClue, 2]. Through the use of an NSF funded GK-12 program, graduate and undergraduate students from Georgia Tech, and ambitious teachers at Marietta High School (MHS), the STEM club of MHS provides high school students a means to create and execute science fair projects and hopefully begin to address a number of the issues posed in the previous paragraphs.

Details of the program

Marietta High School is a city school system located in the suburbs of Atlanta in Marietta, Georgia. The Student-Teacher Enhancement Program (STEP) is an NSF funded GK-12 program that provides support to graduate and undergraduate students of Georgia Tech and places these students within various secondary schools to offer support to both teachers and students. Additionally, this initiative provides a means for Georgia Tech students to develop their teaching skills through experience in curriculum design and classroom teaching. For the 2008 academic year, MHS and the Marietta school district adopted a major initiative to increase the involvement of students within middle grades education and secondary education to become more actively involved in the science fair process. Being a school within the International Baccalaureate (IB) program, a number of the students at MHS are required to complete projects as requirements for this program, yet there is no system in place for the students to develop these projects or an avenue to present the results. With these two issues facing the faculty of MHS, the solution was the creation of the science, technology, engineering, and mathematics (STEM) club.

In addition to the faculty of MHS, graduate and undergraduate students involved in the STEP program at MHS have become an active part of the STEM Club. Besides the specific knowledge that each Georgia Tech student brings from his or her given discipline, the MHS students can access the advanced materials, instruments, and machinery located at Georgia Tech. Each Georgia Tech student will serve as a mentor to a group of students who are pursuing projects within the mentor's field of expertise. Combining the knowledge of the faculty of MHS and the current students from Georgia Tech, the areas of biology, chemistry, physics, behavioral science, mathematics, and engineering are all offered to the MHS students with the promise that a mentor within the field will be available to help with the multiple facets of the process. According to French and Russell, this process of mentorship can have retroactive effects by benefiting the mentors who are involved in the implementation of the inquiry-based learning. In a recent paper the authors highlight a study that shows the perception of teaching assistants (TA) who are involved in activity-based laboratories and how this approach to teaching enhances the skills and knowledge of the TA [French, 3].

Implementation of a new program always poses a challenge with respect to program design and implementation. For the first year, students enrolled in the conceptual physics class at MHS were required to complete, from start to finish, a science fair project of their own design. With this, a number of projects whose design and experimentation could not be carried out without the use of laboratory equipment or special materials added for increased motivation to create the STEM Club. Membership into the STEM Club was not required of the students but was highly encouraged to those who felt their projects could not be done outside of school. The STEM Club's sole purpose is to allow any student at MHS access to the scientific facilities as well as access to a venue that allows for the student to develop and enhance his or her scientific thinking as well as enhance his or her scientific knowledge. This is done through discussion sessions with mentors and fellow students to help create new ideas of science as well as ways to design experiments testing these ideas. To keep the theme inquiry-based, the students are given minimal direction and are required to create hypotheses, experiments, and presentations with only guidance rather than instruction from the mentors and faculty. The exception to this is anything involving safety.

The STEM Club boasted a significant number of students actively involved in researching their designed projects. The system is designed to have students propose an experimental design within the first two weeks of classes, begin work on gathering data through the first part of the fall semester, and compose the results in a comprehensive lab report. Each student presents his/her findings at the MHS Science Fair held in late January. The science faculty of MHS, as well as representatives from Georgia Tech, serve as judges to this event with the winners advancing to the regional competition. At the time of press, qualification to the state competition was unknown. In the inaugural year, approximately 70 students completed in the school wide science fair with four students advancing to the Cobb-Paulding regional competition held in February. Students advancing to regional and state levels had full use of STEM Club mentors to help them develop presentation skills as well as enhance the design of the tri-fold display. It is the hopes of the mentors that these students, all of whom are in 9th grade, will continue to develop their winning projects through their high school careers. Following this, the program will restart with a new set of students in the conceptual physics course. By repeating the process new students should be gained and through time the club is designed to strengthen in numbers. Additionally, the IB program mentioned earlier provides a number of students who are actively pursuing required projects. While these students did not actively participate in the process this year as intended, it is proposed that next year these students be incorporated into this design increasing the numbers and age range of the students even more. Of additional note, any student at MHS is encouraged to join and all students within science courses will be encouraged to complete a science fair project.

Future Plans

The STEM Club will continue to provide a means for students interested in developing a science fair project. The needs of the student body within secondary education are constantly changing, but what is not changing is the need to use more inquiry-based learning within high schools to develop students to their full potential. The creation of the STEM club helps to address this deficiency within the secondary curriculum. Being in the inaugural year, it is difficult to measure the effect the STEM Club has on the student participants. If the club remains successful into the next academic year, a longitudinal study is proposed comparing and contrasting students who participate and elect to not participate within the STEM Club and how this participation affects performance within the scientific classroom. This can be assessed in a number of ways including course grades, performance on standardized tests, and surveys to teachers assessing non-grading student performance. The scope of this study is very broad, but with additional time could easily be narrowed into a focused study addressing the key point of the significance and impact of the STEM Club on MHS students. Additionally, the partnership between Georgia Tech and Marietta High School will persist into the future and hopefully these efforts of the faculty of MHS as well as the STEP Fellows of Georgia Tech will work to develop the future scientists of tomorrow.

REFERENCES

[1] Bell, Randy L., Blair, Lesley M., Crawford, Barbara A., and Lederman, Norman G., "Just Do It? Impact of a Science Apprenticeship Program on High School Students' Understanding of the Nature of Science and Scientific Inquiry," *Journal of Research in Science Teaching*, Wiley Periodicals, Inc., 2003, 40(5), 487-509.

[2] DeClue, Mary Ellen., Johnson, Kevin, Hendrickson, Howard, and Keck, Pamela. "Stimulate High School Science Fair participation by Connecting with a Nearby College" *Journal of Chemical Education*, May 2000, 77(5), 608-609.

[3] French, Donald and Russell, Connie, "Do Graduate Teaching Assistants Benefits from Teaching Inquiry-Based Laboratories?" *BioScience*, November 2002, 51(11), 1036-1041.

[4] Hoske, Mark T., "Help students in the STEM game," *Control Engineering*, April 2008, 39.

[5] O'Neill, D. Kevin, Plman, Joseph, L., "Why Educate 'Little Scientists?' Examining the Potential of Practice-Based Scientific Literacy," Journal of Research in Science Teaching, Wiley Periodicals, Inc., 2004, 41(3), 234-266.

Anthony Baldridge

Anthony obtained his B.S. in Chemistry and Mathematics from Piedmont College in Demorest, GA and is currently as Ph.D. candidate studying organic chemistry in the Laren Tolbert group at the Georgia Institute of Technology, where he synthesizes and researches novel green fluorescent protein analogs. At Georgia Tech, Anthony is a Presidential Fellow, a TA Fellow and a STEP Fellow for the 2008-2009 academic year. In addition to fellowships, he was awarded most outstanding teaching assistant in chemistry for 2008 at Georgia Tech and is actively involved in student government at Georgia Tech.

Ashley Nutt

Ashley is a fourth year Psychology major at the Georgia Institute of Technology. She is currently a STEP intern where she works with a regular and special education class. She has also been a research assistant in the Adult Development Lab in the School of Psychology at Georgia Tech for a year where she instructs adults ranging from ages 20 to 80 on how to complete studies of the lab. She likes working with high school students and plans o attend graduate school for school counseling.

Mary Vaughn

Mary will graduate from Georgia Tech in May with a Bachelor of Science in Science, Technology, and Culture in May 2009. After graduation, she will pursue a Masters of Education. Mary is currently working at Marietta High School as a STEP Fellow. She works in the English and Literature classes for freshmen, sophomores, and seniors.

Celis Hartley-Lewis

Celis received her B.S. in Biology from Spelman College and a Masters in Education from Walden University. She has 14 years of experience teaching science for 7^{th} through 12^{th} grade. Celis has worked for the Fred Hutchinson Cancer Research Center and at the University of Washington conducting research on how to implement advances in science to K-12 curriculum. Celis is currently the PLC Chair at Marietta High School and the assistant to the department chair.

Amanda Amos

Dr. Amanda Amos received her B.S. in Chemical Engineering from Auburn University and her Ph.D. in Chemical Engineering from the Georgia Institute of Technology. Currently, she is a chemistry teacher at Marietta High School teaching college preparatory chemistry, chemistry II, and International Baccalaureate chemistry I. She also serves as the STEP coordinator for Marietta High School, where she was a STEP fellow during her tenure at Georgia Tech.