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INTEGRATED STEM IN MIDDLE SCHOOL:

A Purdue Service-Learning Class

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ABSTRACT

STEM is a growing buzzword in schools across the country. While the initial creation of the acronym was intended to emphasize the integration of Science, Technology, Engineering, and Math, they are still being used as separate disciplines. Traditionally, science has been viewed as the study of the natural world, math as the study of patterns and relationships of numbers, and engineering as problem solving (NAE & NRC, 2009). Moving forward, the goal is to help future generations experience math and science come together through engineering activities to produce new and innovative technologies. This is happening today in part through a partnership between Purdue's Center for Advancing the Teaching and Learning of STEM (CATALYST) and a local middle school. The partnership originated in EDCI 605, a course taught by CATALYST faculty that requires students to create an engaging, integrated STEM activity for middle school students. The middle school students, who are from low-income households and are eligible to receive the 21st Century Scholarship, visit Purdue's campus for three after-school sessions to learn STEM content, identify solutions for real-world problems, and engage with graduate students. The activities are collaboratively taught by two faculty and multiple graduate students in EDCI 605. The middle school students are introduced to global challenges requiring innovative solutions. The partnership between CATALYST and the middle school could provide an opportunity for students to explore a career suitable for solving global challenges the future STEM workforce will encounter.

KEYWORDS

STEM, integrated STEM, middle school, CATALYST

INTRODUCTION

STEM is a growing buzzword in schools across the country. While the initial creation of the acronym was intended to integrate science, technology, engineering, and math, they are still being used as separate disciplines, especially science and math (Bybee, 2010). Traditionally, science has been viewed as the study of the natural world, math as the study of patterns and relationships of numbers, and engineering as problem solving (National Academy of Engineering & National Research Council, 2009). The president's council has called for an increase in the number of students prepared to enter the STEM workforce (Alper, 2016). Therefore, middle

school students are now being introduced to global challenges requiring innovative solutions. Moving forward, the goal of STEM education is to help future generations experience the integration of math and science through real-world engineering challenges. One way this is happening today is through a partnership between Purdue's Center for Advancing the Teaching and Learning of STEM (CATALYST) and a local middle school.

COMMUNITY PARTNERSHIP DESCRIPTION

CATALYST is an interdisciplinary research-oriented center focused on building a learning community of K-12 STEM professionals, jointly sponsored by Purdue's

College of Education and College of Science. The partnership between CATALYST and the middle school provides an opportunity for students to explore a career suitable for solving global challenges the future STEM workforce will encounter. The partnership originated from the creation of an assignment in EDCI 605, a course taught by CATALYST faculty. Each student in the class created an engaging and culturally relevant, integrated STEM activity as defined by Bryan, Moore, Johnson, and Roehrig (2015) for middle school students. The middle school principal is seeking to obtain STEM certification from the state and would like to offer after-school STEM activities for students. The middle school students visit Purdue's campus for three after-school sessions to learn STEM content, identify solutions for real-world problems, and engage with graduate students. Each lesson is taught by one graduate student or faculty member with at least one other graduate student or faculty member there to help assist students in working through the activities. The middle school students invited to participate in these activities are from low-income households and are eligible to receive the 21st Century Scholarship.

COMMUNITY IMPACT

There were only nine students present for the first week. However, the following two weeks, there were 21 and 22 students, respectively. For the first week, the students were separated into two groups and participated in one of two STEM activities for one hour. The two groups then reassembled for group reflection. To keep the attention of middle school students for the second two sessions, the time of each activity was reduced to 35 minutes with rotation between three activities. The activities included designing sails, milk cartons, and musical instruments. With each activity, every student was able to create something that was unique to his or her personality. Each student learned the importance of working through the design process and improving existing designs to meet specified criteria.

For instance, one lesson we taught the first week was on Global Positioning System (GPS) devices. It was taught by a Purdue master's student and veteran of the Air Force. She was a member of the military who helped to work with the development of the military's use of GPS. The students in her class were quickly engaged in seeing the experience and application. They came out of the class reporting the speed of satellites in addition to how tall buildings and trees can block the signal between satellites and GPS devices. One of the students who attended this lesson proudly came the third week reporting that she used the knowledge about GPS on a trip to Chicago with her grandfather.

The activities exposed the students to possible STEM career paths. Some of the lessons helped to bridge the gap between student interest and real-world application of those skills. An example of this was an activity where students were given materials to create their own instruments that had to reach three different decibel levels (degrees of loudness). Almost all of the students had previously expressed interest in music. Through direct instruction on sound waves, the design of their own instruments helped bring the music they love to life.

STUDENT AUTHOR IMPACT

In looking at the implementation of STEM for these students, I felt that there was a heightened awareness in myself to relate the material to the students. As I moved through the lesson and checked for understanding, I was aware that I hadn't considered the students' situation and background. While I had used this lesson before with different demographics, the response, or lack thereof in some cases, was very different. Students care a lot more about what they're learning when they are able to see how it applies to their personal lives. Realizing that I have a strong belief in the importance for students to learn this material, I also feel that as they are able to see the personal application, they will be able to take more from the lessons. Having skills found in using the engineering design process can help the students in any field or career they choose to pursue. The only way for them to see that and to strengthen their belief in its importance is to understand them first. The principal that came with these students was exceptional at this. She understood these students and knew what they did and didn't like. The importance of understanding whom we were serving became much more vital than how we were reaching out to them.

It is important to continue to reach out and host after-school activities that allow these students to try something new in a fun and stress-free environment. The partnership formed between Purdue and local schools is vital in serving the present and future generations. With continued efforts, they can continue to work together to assist and develop the educational interests of students.

In the implementation of such a project, scheduling can always be hard. When the students arrived, it was in the late afternoon when most of them were hungry and had already attended eight hours of school. After the first week, the principal made sure that the students had sustenance before coming to participate in the activities. It was also made very apparent after the first week that we had to recognize that the students were open to learning,

but they were already exhausted from the day, so engaging, hands-on activities were vital. Because of these situations, in moving forward, it would be beneficial to schedule the after-school activity to a more fitting time for the students. Although they are all middle school students, they could also still use some sort of snack time. Being aware of what they need and about at the time could definitely change the implementation.

Each graduate student learned a lot about strengths and weaknesses. The students taught each of us as much as we were trying to teach them. As CATALYST continues to implement these activities, they are opening eyes to opportunities and possibilities. Both the graduate students and middle school students were able to look into another world and see that there are areas we don't realize exist that we can still help to change and uplift.

CONCLUSION

Moving forward, there is a continued need to expose students to STEM. It can link content application to the interest and life of the students. With the 21st Century Scholarship, these students have been given a chance at a college degree, but they are left to find the motivation and desire to pursue an education that will lead them to a career that fits their interest. As society continues to develop as a technological world, the development and implementation of new technologies and problem-solving skills will be vital. As a community, preparing future professionals to develop these products and skills can make a difference in the world being created.

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AUTHOR BIO SKETCH

Emily K. Yoshikawa is a first-year master's student in technology leadership and innovation with a focus in engineering and technology teacher education at Purdue University. She wants to teach engineering and technology in secondary education and continue to promote the interdisciplinary integration of STEM. In her undergraduate work, she spent two years on professional development with elementary educators to bring computing and engineering into the classroom.

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