"Pre-service Teachers STEMing at Fort Belvoir Elementary School, VA"

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Abstract

Service Learning, STEM, Pre-Service Teachers, Collaboration, Integrated Curriculum

This project was based on the importance of learning and teaching Science Technology Engineering and Math (STEM) through an integrated approach. According to Barber's article (2011) over the last three years, 85 percent of the teachers did not receive any professional development in the teaching of science. This is an important point to consider. Pre-service teachers should complete math and science methodology courses through a constructivist approach, linking concepts and skills to common everyday experiences and integrate technology effectively. Of course this is a challenge when a first year teacher enters the classroom. Thus the support of the leadership of the schools is vital to make STEM a success.

A pilot program, Phase I, at Fort Belvoir Elementary School (FBES), serving the children of the military families was just completed. This was approved by FBES principal, Marymount University's (MU) provost, the department chair, and the dean. Math/science methodology were taught and aligned with the Virginia Standards of Learning. MU students completed the STEM integrated units with 25 activities per week, and wrote lesson plans as part of their assignment. STEM related activities were conducted through a hands-on approach by FBES STEM focus teacher. They conducted activities related to Earth using Projects Learning Tree and WILD, Agriculture in the Classroom, and activities from NASA's Digital Learning Network. Through collaborative planning; lesson plans will be incorporated during an afterschool program in fall of 2014. These plans and the project model can be replicated in any state using their required standards of learning.

Barber D.A. (2011) Educators Look for Resources, New Programs Amid STEM Push retrieved April 2012 from http://thejournal.com/articles/2011/12/13/educators-look-for-resources-new-programs-amid-stem-push.aspx

Pre-service teachers STEMing at Fort Belvoir Elementary School, VA

The word STEM in Education is based on the teaching of science, technology, engineering and mathematics curriculum through an integrated approach. This method "offers students one of the best opportunities to make sense of the world holistically, rather than in bits and pieces" (Lantz, 2009, P.1). It is important to make STEM education a priority in the US schools from early ages. To compete with the global economy and the fast moving technology we need to stop compartmentalizing by disciplines, but instead teach through an integrated approach where we meet the supply and demand of science, technology, engineering and mathematics. Due to lack of confidence and training teachers often shy away from teaching through STEM. In the report *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future* (National Academics Press, 2005) it became apparent that for the United States to remain in the forefront of research, innovation, and technology there is a need to have enough scientists, engineers, and mathematicians.

> "In a world where advanced knowledge is widespread and low-cost labor is readily available, the advantages of the United States in the marketplace and in science and technology have begun to erode. A comprehensive and coordinated federal effort is urgently needed to bolster competitiveness and pre-eminence of the United States in these areas." (National Academics Press, 2005)

One of the four recommendations made by the report was to increase the students' expectations within K-12 by improving their learning and teaching in mathematics and science education (National Academics Press, 2005). Adding technology and engineering across the curriculum can definitely enhance the learning of the students and strengthen their chances of competing in the global economy.

For the United States to play a leading role globally, the focus on STEM education will have to be strengthened. According to the President's Council of Advisors on Science and Technology, "STEM education will determine whether the United States will remain a leader among nations and whether we will be able to solve immense challenges in such areas as energy, health, environmental protection, and national security" (2010, P.9). The report continues to state that STEM learning in America has become a growing concern. For example, according to Schmidt (2001), 75 percent of the 8th graders in the U.S. are not proficient in mathematics by the time they enter high school (P.2). This means high school starts for some with already a disadvantage in mathematics. However, in *Globally Challenged: Are U.S. Students Ready To Compete*? There is a more recent PISA result stating, "U.S. students in the Class of 2011, with a 32 percent proficiency rate in mathematics, came in 32nd among the nations that participated in PISA" (P.7). Thus, there is an overall consensus that U.S. schools have an important challenge in improving teaching and learning in STEM Education among students from kindergarten through high school (The National Science Foundation, (NSF), 2011). Furthermore, Merrill and Daugherty (2010) reported that "the issue of attracting more young people to choose careers in science, technology, engineering, and mathematics (STEM) has become critical for the United States" (P.2). Additionally, the report continued to state that the stake holders: businesses, associations, and education in the United States found that the learning disciplines in STEM Education are at 'a risk'. Of course this only makes the competitiveness for the U.S. students more challenging especially across the global market (e.g., Rising Above the Gathering Storm, 2007)". With the U.S. students lagging behind in mathematics and with the challenges posed in

improving STEM Education from K-12, educators must do all they can to emphasize the importance of attracting young people to select STEM careers and compete globally. As educators we need to reach out and implement a variety of teaching styles to captivate the students' interest and provide them with the means to accelerate their learning.

In 2012, the STEM Education Coalition made recommendations for K-12, Higher Education and the workforce. In these recommendations the support was extended for student performance in science with mathematics and reading as a required component for K-12; also for the effective STEM professional development and preparation for teachers, and the retention of effective STEM educators as well as undergraduates interested in STEM. Professional development should be the main focus in overcoming the challenges in falling behind and competing across the world. A creative and innovative teacher cannot only motivate students but also inspire them to get involved in STEM Education.

However, teaching STEM is challenging and this is the rationale for seeking innovative strategies and approaches to support teachers, conduct professional development, and provide resources to apply the skills learned. STEM education is a critical component to the curriculum. It embraces the subjects that influence and impact students in their everyday lives.

Another report, *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics* (2011, P.12) called upon policymakers and states nationally to give equal importance to science as they do with reading and mathematics from K-12. The recommendation goes further into suggesting that as reading and math are frequently assessed so should science in all areas. It emphasizes the importance of hands-on learning and a focus on a project-based learning rather maintaining traditional teaching methods. It is important to develop critical thinking by having students draw their own conclusions. This will not only teach the children holistically but also allow problem solving. Students must be given a project where they use a given topic from the unit learned to do their research design and develop scientific inquiry presentation. This will enable them to use critical thinking and connect technology (research), mathematics (measuring science hands-on), science (content on the topic) designing (preparing a presentation by using models) art (crafting the project), perhaps a rap/song to add to the music component. They can write their own lyrics using the content learned (reading and writing). This is a complete integrated curriculum approach which also can be assessed by using the objectives of the unit learned.

However, at the elementary school level it is vital that teachers incorporate the teaching of science curriculum through an integrated approach (STEM). Thus all core subjects' standards of learning can be met and by the same token, students are prepared for testing. Rather than teaching to the test; teach through the integrated curriculum approach (STEM) to meet the standards of learning. Currently a pilot program is being conducted to meet these recommendations and develop model lesson plans planned by pre-service teachers and tested by teachers within the classrooms. This model can be replicated in any school setting with the support of university pre-service teachers.

The Pilot Program Overview:

This pilot program, in progress since January 2014, is held at Fort Belvoir Elementary School (FBES), serving mostly the children of military families. This entire program from Phase I to Phase III had been approved by FBES principal and the Education Department at Marymount University (MU). Students were and will be (in the future phases of the pilot

program) provided with transportation to FBES from the MU campus on Wednesdays from the STEM grant money received by FBES. The program also received an approval from the MU Provost and Dean of the School of Education and Human Services.

The overall goal for this pilot program is to have the undergraduate students from ED 358 (mathematics and science methodology in Education) to spend the entire spring semester from 9:00am - 3:30 pm on Wednesdays at FBES, (except on any FBES or MU holidays). Math/science methodology will be taught and aligned, not only to the Virginia Standards of Learning (SOLs), but also to FBES content taught during each unit at the different stages in each phase of the pilot program. Two hours on each Wednesday MU students will practice mathematics and science skills learned in their classrooms with the children at FBES. This portion of the program will be subject to modification and alignment depending on the FBES teachers and content to be taught in their own classrooms. There will also be some team collaborative planning held by FBES teachers in which MU students will participate with their mentors. Pre-service teachers, during the pilot program, will be required to complete their Integrated Unit on Space and Earth. Each unit will have 25 activities over the five days in mathematics, science, language arts and a selection of two from the following: technology, art, music, social studies, and PE. Each activity will have to meet the standards of learning in VA.

Objectives of the Program:

The objectives are based on a project that is three-fold. Pilot program Phase 1, held at FBES in VA, just came to a close at the end of the semester. In this phase the pre-service teachers prepared the integrated curriculum framework for selected grades. Twenty-five activities were planned for each of the five days of the week through an integrated approach. For example, a typical day's activities for a space week could range from Phases of the moon background knowledge (science), to using fractions for the various phases (mathematics), reading a literature book and having the students write the ending (Language Arts – creative writing), creating a rap using the vocabulary from the phases of the moon and parts of a fraction (Music), and finally learning about the history of the moon landing and Apollo 11(social studies/history). They used I-Pads and relevant applications for designing and engineering. Activities related to Earth were conducted using Projects Learning Tree, Aquatics, and WILD. These activities were facilitated by the instructor of the course and the students developed hands-on demonstrations using materials provided by the stated agencies. They presented the activities to their peers, thus strengthening the application process of their own knowledge. Agriculture in the Classroom (AIC) workshop was taught by AIC staff for three hours. This earned the pre-service teachers certification, and the activities learned from here were implemented in their teaching. NASA's Digital Learning Network (virtual online workshop also for three hours) had been planned, but instead an in-person workshop was held by an Education Specialist from NASA's Goddard Center.

Phase II will be conducted in two parts. In the first part activities will be implemented in the fall of 2014 during an afterschool program held at FBES, and will be based on the projects and activities developed in the framework from Phase I. Modifications and adjustments will be noted when actually conducting the activities from the framework by the after-school teachers. The second part of Phase II will be detailed written lesson plans using the framework by the spring 2015 semester students, from the science and math methodology class. The input for modifications from fall 2014 will be taken on board. These plans will include the use of the 5E's

learning cycle (Bybee, 1989) and will be aligned using the constructivists teaching approach. Lesson plans will be written with clear objectives, and evaluation of these objectives will be completed in a tabulated rubric (Evaluation) for easy reading. They will be based on the standards of learning intended in the framework to meet VA requirements for testing. The lesson plans will be written through integrating all the activities set out for the day using the framework. They will be detailed in procedural steps under the headings of before (Engagement), during (Exploration) and after (Elaboration). There will be content knowledge of the topic(s) (Explaining) to reassure the teachers implementing the plan that they have the information and background knowledge of the topic(s) to be taught.

Phase III, also in two parts, will be conducted in the fall of 2015 (research based on strategies for errors and misconceptions) and the final application process in the spring of 2016. In 2016 the entire program will be culminating as one. In Phase III implementing the Phase I framework and lesson plans from Phase II will take place in their entirety. However, prior to this final stage in fall 2015, a sabbatical semester, there will be observations and interactions with teachers in England. The focus will be on how effective strategies are conducted in responding to students' errors and misconceptions. England is using the early intervention of remedial activities for errors and misconceptions in mathematics and science, and attention to incorporate similar strategies in Phase III will strengthen the teaching of the lessons from Phase II in my spring 2015.

This program will be evaluated, modified, and revisited for clarity, specificity, and relevancy to the SOLs before the end of Phase III. To conduct this program efficiently and effectively, visits will need to be made to FBES during regular school hours. Also in Phase III, days will be allocated for modification and adjustments and preparation of the documents for publication with the input from teachers and administrators.

MU students will actually witness the collaboration and the process required to implement a successful lesson. The final product will be submitted for publication for classrooms in Virginia to replicate the lesson plans and activities. Students will be recognized for any of their lesson plans included in the publication under MU/FBES partnership.

In 2005-2007 the experience in handling teaching and learning at the University of Winchester, England, made it apparent that using different strategies, implemented during remediation for errors and misconceptions in mathematics and science, was an important step in helping students to succeed. In 2007 -2008 an attempt was made to implement these strategies while teaching at Worcester State University, but due to time issues major changes in the curriculum were not possible.

From 2008 onwards efforts were made to replicate the program using errors and misconceptions strategies and embedding them in the students' assignments in the methodology classes in mathematics and science. However, due to lack of mechanism it was difficult to determine whether students actually implemented them as they completed their field experiences in various schools. Another factor is that, to date, the work on errors and misconceptions did not get linked to the new STEM initiatives.

Once the modifications are made and lessons are successfully implemented by the classroom teachers (with MU students' assistance and FBES collaborators), the plan is to use the results of the project towards publication of STEM integrated lesson plans. These lesson plans, incorporating errors and misconceptions in mathematics and science, can be used not only in Virginia, but also internationally for teachers to replicate, modify, and apply. At all times the

purpose is to write effective and integrated lesson plans that are user-friendly, address errors and misconceptions, and use effective STEM strategies in teaching.

The focus will be to modify the courses from spring 2015 and discover how much a partnership enhances the professional development of everyone involved. This will also be useful in the application of other aspects of the elementary teacher preparation curriculum, especially in the area of classroom management. The fully developed lesson plans will then be shared with future Marymount University students to use during their student teaching, helping them implement a STEM integrated teaching unit.

Fort Belvoir Elementary School has been awarded a grant of $1.6m in for over three years from the Department of Defense Education Activity (DoDEA). Within that grant just under $30,000 per year is 'in kind service' for this project per year. Several STEM events will also be held during the school year. Marymount students will conduct STEM activities for military families and their children. Additionally, a shuttle bus service from Marymount to FBES will be provided for the spring semesters to transport students every Wednesday.

Furthermore, the plan is to have MU students and FBES teachers make presentations at the national level at the Kappa Delta Pi Honor Society, NSTA and the NCTM conferences with MU students and FBES teachers. The highlight would be the collaborative effort in the implementation of an effective STEM project and lesson plans prepared by MU students and tested by FBES teachers, and how to help future teachers best integrate errors and misconceptions remedial strategies through STEM Education.

The intention is also to present at an international level this 'collaborative effort in the implementation of effective STEM lesson plans prepared by MU students and tested by FBES teachers incorporating strategies of remediating errors and misconceptions'. This will be a beneficial project for university and school partnership, and it will result in some scholarly publications and presentations.

Currently this program (although in its very early stages) is the recipient of two awards:

- Association of Teacher Educators-Virginia (ATE-VA)
- International Association for STEM Leaders

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