Work-In-Progress- SUNRISE: Schools, University 'N' (and) Resources In the Sciences and Engineering-A NSF/GMU GK-12 Fellows Project

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***Abstract* - This WIP report is a continuation of the 1st year work presented at the previous FIE conference 2008. The WIP documents 2nd year development, implementation efforts, and results of SUNRISE, a unique graduate Fellowship program at George Mason University (GMU) that targets graduate students working in the grade 4-6 school environment. SUNRISE is a new GK-12 project aimed at partnering STEM (Science, Technology, Engineering, and Mathematics) graduate students (Fellows) with school teachers from three different school divisions in Northern Virginia. The innovative practice aspect of the project is the construction of a framework that provides training, exchange of information, and integration of scientific research from diverse disciplines with teaching to make science exciting for students. A feature of SUNRISE that makes this project different from other GK-12 projects in the nation is that the project is housed in the School of Information Technology and Engineering which is unique in the nation. One of the contributions of the project is that it is focused on infusing Information Technology (IT) rich STEM concepts into K-12 education, which is also another unique feature. This WIP presents examples of Fellows research that have been integrated with Grade 4-6 curriculum to excite the K-12 student interest in science.**

Index Terms - Elementary and middle school, Fellow research and integration into K-12.

INTRODUCTION: THE SUNRISE PROJECT

A National Research Council panel [1] report urged the need for increased cooperation between universities and K-12 schools in teacher education and professional development for teachers of science and mathematics. The National Science Foundation's Graduate Fellows in K-12 Education (GK-12) program offers a unique opportunity to address the above need. SUNRISE is one such GK-12 program whose conceptual focus is to improve outcomes for elementary and middle school students in STEM subjects as identified and driven by the science needs at the schools in the participating school divisions. The objective of this project is to build a unique model of collaboration among elementary and middle schools, school division administration, and GMU to foster systemic efforts in implementing Information Technology (IT) rich STEM content-knowledge into grades 4-6 education by graduate Fellows, with the potential to enhance the delivery of science instruction and provide long term professional development for teachers. Last year, the WIP presented at FIE 2008 focused on expected outcomes and evaluation plans of the SUNRISE project. This WIP documents samples of Fellows research that have been integrated into the Grade 4-6 curriculum. The project serves as one source of evidence that demonstrates the importance and the process of building partnerships among university's engineering/technology departments, schools of education, and the K-12 STEM education that would strengthen the nation's educational enterprise.

IMPLEMENTATION

The 2nd year implementation started with the recruitment of Fellows and teachers in April 2008. The program supported 8 Fellows from STEM disciplines who are paired one-on-one with 8 teachers, one pair per school. The schools chosen were those with high percentage of minorities from low socio-economic backgrounds. Fellows came from chemistry, computational sciences, environmental science, physics, mathematics, and biochemistry. 65% of the Fellows were women graduate students. The fellows were given a two month long training program by the project co-PI from the College of Education and Human Development. The training included an understanding of the Virginia State Science Standards of Learning (SOL) [2], preparing and delivering of sample lessons, and discussing general topics on pedagogy particular to elementary school teaching. The Fellows worked out a schedule with the teacher at the Fellow-Teacher meeting just before school reopening in September 2008. The Fellows began their visits to classroom, identified the science needs with the teacher and began contributing to the enrichment of the lessons and discussing the science behind the lessons. The Fellows were introduced to the children as Scientist, Researcher, or an Engineer. Thus, a strong foundation was laid for a long-lasting partnership between the school and the university.

PROJECT'S INNOVATIVE PRACTICE APPROACH

The salient features of the project's approach to infuse cutting edge STEM topics into K-12 curriculum are as follows.

- Regular classroom assistance in both preparation and teaching by the Fellows along with teachers
- Fellows serve as resources for the teachers and work toward improving the content of science and mathematics taught in their classes
- Fellows lead the post-experiment discussion about the science behind the experiments
- Fellows encourage the use of Technology for teaching, incorporate the use of graphics and computer based models, to increase level of perception.
- Develop new IT rich STEM modules and lessons from Fellow research areas and infuse them into elementary school environment through hands on experiments
- Engage in after school programs, Discovery clubs, School science days, Judge County Science Fair projects, answer questions dropped off in the "Question Box", and participate in field trips.

PROJECT ACTIVITIES AND OBSERVATIONS

Evidence of innovation in lesson development and the integration of graduate fellow research into the classroom presentations were found in classroom visits by the evaluator, fellow interviews and surveys and in reports and papers produced by the fellows and as verbal reports at project meetings attended by the evaluator. The highlights of the second year include the development of a number of curriculum projects, a teacher-fellow developed weather station, a fellow created inter-session project on simple machines, magnetism and electricity that included a visit to an electronics lab at the University and a series of modules on force, motion, and energy. One of the achievements by the research team at GMU is to regularize the practice of "Fellow led post-experiment discussion with the teacher" in the K-12 classroom to fully understand the science behind the experiment. This is seen as a key ingredient to the learning process at school that is enhanced through the above partnership and which has remarkably benefited the Fellows to discover their own field and has improved content knowledge for both teachers and K-12 children.

In addition to a number of new fellow created lessons, fellows reported that they were able to modify existing lessons. One fellow in a middle school observed that "the text book for 6th grade science…is a fairly good text and has some interesting labs. I try to use these whenever they are applicable because I know that my teacher will be able to duplicate them for years to come." This fellow modified a lab on physical and chemical weathering, greatly improving it. Another fellow substituted high refractive index glass prisms for plastic for a lab in the county lab kit on primary and secondary colors to better accomplish the objectives of the lab. There are numerous other examples of fellow modifications of existing labs and lessons. These modifications are significant from a sustainability perspective as the teachers will be able to use these modifications within the existing framework of their school. Every effort was made to show computer models and graphics to allow students to discover the STEM concepts. This motivated teachers to use more technology in the classroom, improved perception of concepts via simulation and graphics, and excited student's interest in STEM topics who are growing up in an IT environment.

FELLOWS RESEARCH AND INTEGRATION INTO K-12

The SUNRSIE project highlights for 2nd year also include examples of how GK-12 fellows brought their research into the K-12 setting and the training that was provided to them to effectively communicate their STEM research to a broad audience. The examples of lessons include: 1) studying properties of most superconductors in which students are shown how the fundamental, underlying properties are used in Electronic Structure calculations to help explain and predict the quantum mechanical superconducting trend, 2) learning about the kingdom "Monera", characteristics of organisms in this kingdom, and how bacteria can be used in research, 3) analyzing spectrograms of marine animal sounds, including sounds made by humpback whales, 4) interpreting real solar wind data taken from a number of different spacecraft, to learn more about their characteristics, 5) growing their own biofilms from pond water to understand the role of biofilms in the health of the water system, 6) understanding galactic evolution, which includes learning about the different types of galaxies and the effects that a black hole has on the space surrounding it, 7) Performing "Modular Arithmetic and Encryption", in which clocks with a different number of hours were shown to explain modular arithmetic, and 8) leaning "Methionine Biosynthesis", in which students were introduced to amino acids as the 20 building blocks of life, and Methionine was introduced as one of the amino acids.

REFERENCES

[1] Brunkhorst, H., and W.J. Lewis (co-Chairs), Educating Teachers of Science, Mathematics and Technology: New Practices for the New Millennium, National Research Council, in press, 2000, http://books.nap.edu/catalog/9832.html.

[2] Virginia State Science Standards of Learning (SOL) URL:http://www.pen.k12.va.us/go/Sols/home.shtml

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