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Developing K-5 Engineering Educators through Authentic Experiences in a Research Laboratory

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Abstract

The University of Florida Multidisciplinary Research Experiences for Teachers (MRET) is a 3-year program bringing together engineering research scientists, K-5 teachers, and industry professionals with the goal to increase interest in and preparation for STEM careers through the incorporation of STEM concepts, practices, and role models into elementary classrooms. MRET includes four elements that are designed to heighten participating teachers' STEM awareness and expertise: (1) 6-weeks of immersive research experience; (2) curriculum development led by an education expert; (3) exposure to STEM careers through seminars and field trips led by industry professionals; and (4) engineering researcher involvement during curriculum development and implementation. This year-one evaluation is focused on the research question: *What elements of the research experience support the project's goals?* and involved a mixed method approach to understanding the experience of six participating elementary teachers and six engineering graduate students who worked together as protégé-mentors in each of three different laboratories.

Keywords: Research Experience for Teachers, RET, Professional Development, Elementary

Introduction and Justification of Program

In order to sustain economic growth, maintain national security, and endure as a global leader, the U.S. needs to further develop and maintain a qualified STEM workforce[1]. Within the STEM workforce pipeline, the inadequate preparation of elementary school teachers is of grave concern. Elementary educators are responsible for laying the foundation of STEM interest and skills, yet often lack the content knowledge and prior experiences necessary to confidently teach STEM concepts[2]. This indicates a clear need for professional development (PD) experiences that will build stronger science content understandings and confidence for elementary teachers.

Scientist-Teacher Partnerships (STP's) have been designed with the goal to "enhance teachers' abilities to construct materials featuring current science"[3]. Research Experience for Teachers (RET) sites are a popular form of STP PD in which practicing K-12 or community college teachers are embedded in a research laboratory for a period of time in which they participate as contributing members of the research group with the ultimate goal of translating that experience back into their classroom to enhance the STEM educational experiences of their students[4].

Program Description

Multidisciplinary Research Experiences for Teachers (MRET) is an integrated 3-year program to bring together engineering researchers, K-5 teachers, and industry professionals to address this need of elementary teacher STEM development leading to enhanced educational experiences in their classrooms with students. The project is guided by a logic model (Figure 1) and the following goals:

1. Teachers learn STEM concepts and practices as contributing members of a research laboratory, by hearing from guest speakers and visiting local industry and businesses.
2. Engineering researchers mentor teachers on STEM concepts and authentic practice.
3. Teachers translate their experience and new knowledge into a planned unit for their students that is based upon the approximation of authentic STEM practice.

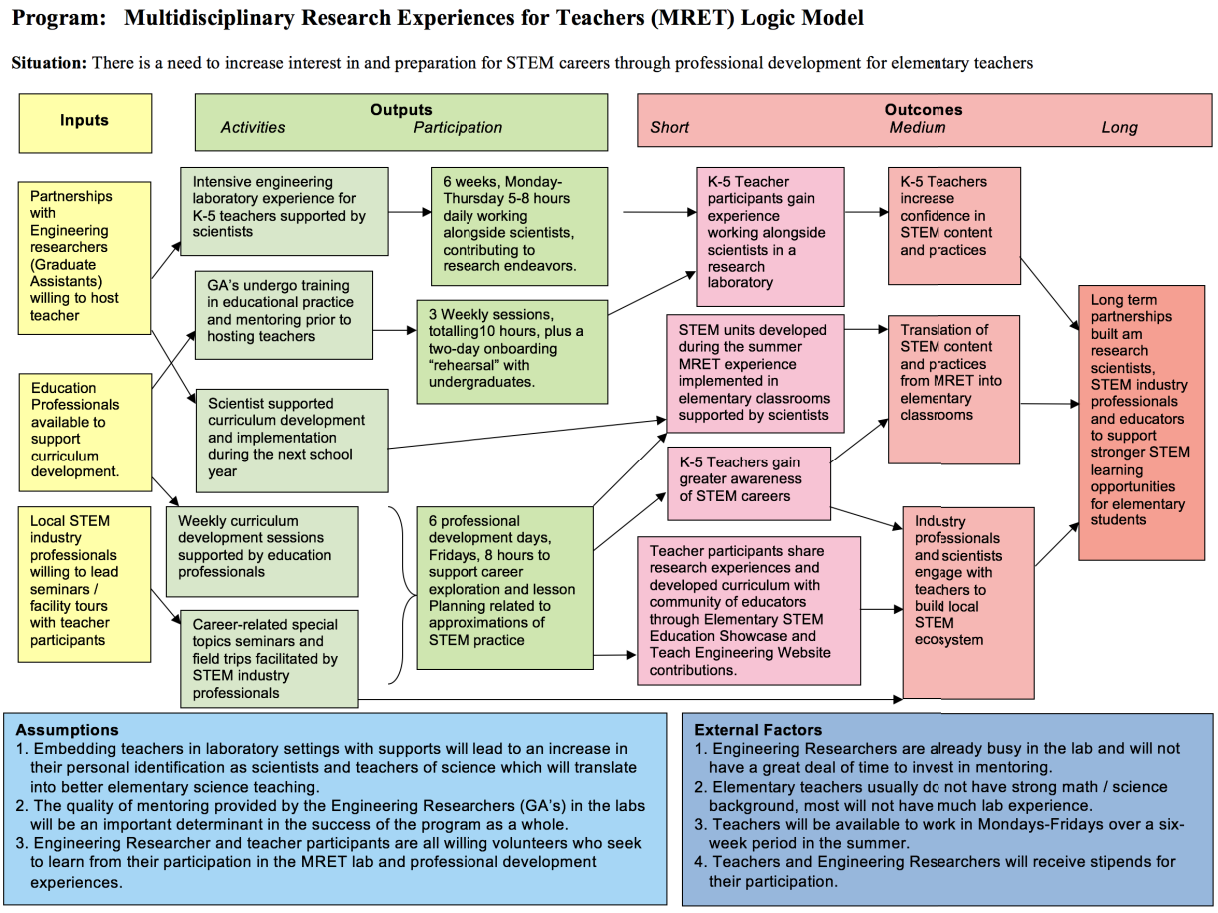

Figure 1: MRET Logic Model outlining the program inputs, outputs, outcomes, assumptions and external factors.

Methodology

This year-one evaluation report is focused on the question: *What elements of the research experience support the project's goals?* and involved a mixed method approach to understanding the experience of six participating elementary teachers and six engineering research graduate students who worked together as protégé-mentors in each of three different research laboratories. The evaluation strategy involves a two-tiered approach based upon the five levels of PD efficacy[5]. For year one, this emphasized participant's reactions and learning (Table 1). Survey instruments were adapted from the Scientific Work Experience Programs for Teachers (SWEPT) study. Other instruments were developed by the project team.

Results from Initial Program Cycle, 2017

The elements of the research experience included: training of engineering graduate students, immersive mentored laboratory work for teachers, engagement with local STEM professionals and weekly curriculum development support.

Graduate Student Training

In their first week in the lab, teachers participated in a series of four, morning "onboarding" sessions led by their engineering researcher collaborators (GA's) to orient them to the knowledge and skills they needed to engage in laboratory protocols and procedures. Training sessions included background information on biomedical engineering, aseptic technique, microscopy, basic cell biology, and laboratory safety. GA's engaged in training sessions to prepare their lessons prior to teacher onboarding, led by a science education professional. Based on feedback surveys from training sessions, GA's valued the training sessions to plan onboarding lessons (28% of coded responses). Graduate students expressed that they found training in basic educational pedagogy was helpful to them in determining how to design lessons to prepare elementary teachers for their laboratory experience. It was also found that GA's struggled to identify which skills / content teachers would need to know (22% of coded responses). Responses indicated that GA's lacked an understanding of what background content knowledge and skills teachers would have, and also were unsure of which skills to focus on for the trainings.

Partnerships with Scientists

K-5 elementary teachers, working in pairs spent four days a week (Monday – Thursday) for six weeks during the summer working alongside engineering research scientists (defined here as university research faculty, post-doctoral fellows and Ph.D. students) engaged in activities designed to incorporate them as contributing members of the research team. Once the six-week lab experience was completed, the partnerships formed between the scientists and the teachers were sustained via shared participation in an educational showcase presented by a local museum. Teacher perceptions of the laboratory experience, based on responses to the SWEPT Post-Program Survey, indicated that teachers related their learning about STEM professionals and approximations of STEM practice to their translation of the MRET to their classroom practices (24% of coded responses). For example, teachers found their experiences working in the laboratory and interacting with STEM industry professionals as giving them knowledge and skills relevant and impactful to their teaching practices. It was also seen that Teachers felt that

the time in the laboratory could be better organized (19% of coded responses); for example, teachers suggested modifications in the structure of the program to consider for future iterations including length of workday, clear expectations for assignment of lab duties and lab participation, and also allocating more time to visit STEM facilities other than those assigned.

Engagement with Local STEM Professionals

During the Friday PD's, teachers also had opportunities to participate in seminars and field trips led by local STEM professionals including topics in Wetland and Aquatic Research, Smell and Taste, and Biotechnology. The goal of this component of MRET was to broaden teachers' perspectives about career possibilities in STEM through experiences with industry professionals. Teacher perceptions of engagement with local STEM professionals as measured by the SWEPT Post-Program and Feedback on Lab Work surveys indicated that Teachers enjoyed and appreciated the seminars and field trips led by STEM Professionals (13% of coded responses) and found the opportunity to interact with and visit local STEM professionals to be a valuable component of the MRET, especially as it related to translating the experience to their classroom practices.

Curriculum Development Activities

Each Friday teachers spent the full day in PD led by an expert in elementary education. Primary goals of these sessions were to share and make meaning of their laboratory experiences, and work to design curricular units appropriate to their school-based teaching context that would transfer their MRET experience into the classroom via approximations of practice[6]. Teacher perceptions of curriculum development activities and support, as measured by the Feedback on Lab Work survey, indicated that teachers valued the support received during weekly PD (25% of coded responses), and expressed appreciation for the guidance from the curriculum professional and the dedicated curriculum planning time. We also saw that teachers would prefer shorter workdays (13% of coded responses) through several comments related to the time commitment being greater than a typical workday.

Discussion

With a goal of determining what defines an appropriate engineering research experience for elementary teachers, this year-one evaluation found that providing engineering researchers (GA's) with training prior to the lab experience helped them to conceptualize their work with teachers and to provide mentoring related to laboratory practice. As such, the training made a positive contribution to the satisfaction of both the GA's and their teacher partners. Teachers expressed satisfaction in all three major aspects of the MRET program: the embedded laboratory experience, curriculum focused PD, and seminars and field trips led by local STEM professionals. Suggested improvements for future iterations of MRET included refining the logistics of the experience through better communication of expectations among lab researchers, teachers and education professionals; adjustment of time commitments in terms of hours spent in the lab and PD sessions; and additional communication and paperwork related to stipends. As the project plans for the year two iteration, these data are already influencing the communications regarding recruitment for the next round of both teachers and researchers.

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Biographical Information

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Gayle Evans is a Lecturer and Doctoral Student in Science Education in the School of Teaching and Learning at the University of Florida. She is science coordinator for the UFTeach undergraduate secondary STEM teacher preparation program and supervises and teaches in the M.Ed. secondary science teacher certification program. She previously worked as a high school science teacher. Her research interests include mentoring relationships and program development in STEM teacher preparation and professional development.

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Kent Crippen is a Professor of STEM education in the School of Teaching and Learning at the University of Florida and a Fellow of the American Association for the Advancement of Science. His research involves the design, development, and evaluation of STEM cyberlearning environments as well as scientist-teacher forms of professional development. Operating from a design-based research perspective, this work focuses on using innovative, iterative and theoretically grounded design for the dual purpose of addressing contemporary, complex, in situ learning problems while concurrently generating new theoretical insight related to the process of learning and the relationships among the people, tools and context of the problem space.

Chelsey Simmons, University of Florida

Chelsey S. Simmons, Ph.D., is an Assistant Professor in Mechanical and Aerospace Engineering at the University of Florida. Her research lab investigates the relationship between cell biology and tissue mechanics, and their projects are funded by the National Science Foundation, National Institutes of Health, and American Heart Association. Prof. Simmons received her B.S. *cum laude* from Harvard University and her M.S. and Ph.D. from Stanford University. In addition to her engineering research and coursework, Prof. Simmons received a Ph.D. Minor in Education

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Renee Simmons, University of Florida

Renee Simmons is an Adjunct Professor in the College of Education at the University of Florida and University School Assistant Professor at PK Yonge Developmental Research School. Dr. Simmons earned her B.A. in Early Childhood and Elementary Curriculum, M.Ed. in Early Childhood Education and Ph.D. in Curriculum and Instruction from the University of Florida. She has twenty years of elementary classroom teaching experience and she earned National Board Certification during her tenure as a classroom teacher. As a University Supervisor, she supervised graduate students and undergraduate pre-service teachers during their internships in local schools. She currently works as a Certified Instructional Coach with graduate interns where she supports, models, instructs and assesses them on pedagogy and best practice.