MRET Badges: Using Micro Certifications to Scaffold an Engineering Laboratory Research Experience for Elementary Teachers

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Program Abstract: 350 Characters

Join us to learn about our development and use of a micro-certification framework based on NGSS science & engineering practices, MRET Badges, to scaffold a research experience for elementary teachers embedded in engineering research laboratories and aid in the translation of these experiences into classroom STEM teaching.

Proceedings Abstract: 2100 Characters

Research Experiences for Teachers (RET) as teacher professional development strive to increase teachers' identity as science educators through authentic experiences in scientific research teams (EEC-1711543). MRET is a NSF-funded RET in its third year of embedding K-5 teachers in engineering laboratory research teams. Historically, most RET sites focus on secondary (6-12) teachers as participants, leveraging their content knowledge as they must have significant college level coursework and often a degree in the subject taught. Elementary teacher preparation has a broader scope; primary teachers require basic proficiency in all subject areas, creating a unique challenge for MRET in finding common ground among participating researchers and teachers. This paper presents our process of developing and employing badges to ensure the time elementary teachers and university scientists spend together in the laboratory is productive in both accomplishing the work of the lab and in contributing to the desired professional growth outcomes for the teachers. A key component in finding this balance has been the construction of a micro-certification framework based upon the Next Generation Science Standards (NGSS) science and engineering practices, and specific skills and proficiencies teachers are expected to demonstrate as laboratory researchers. This framework has been translated into MRET badges, loosely based on the structures of Boy Scout badges and digital micro certifications, that teachers may earn through a process of learning about a topic or skill, practicing it, then demonstrating their learning to a member of the MRET team. MRET badges have been enthusiastically received by both teachers and scientists as a valuable form of scaffolding of the research experience and as an aid to direct teacher activities within the lab in circumstances where they may otherwise have unstructured time. Because badges are tied to the NGSS science and engineering practices, they serve as a bridge uniting the work of the research labs and teacher's elementary curriculum.

MRET Badges: Using Micro Certifications to Scaffold an Engineering Laboratory Research Experience for Elementary Teachers

Research Experiences for Teachers (RET) programs have been a popular type of professional development, focused on increasing teacher identity as science educators by giving them access to authentic experiences embedded in a university based scientific research team (Russell & Hancock, 2007). MRET is a NSF-funded RET currently in its third year of offering elementary school teachers from grades K-5 an opportunity to spend six weeks during the summer embedded as contributing members of an engineering laboratory research team. Historically, the majority of RET sites focus their recruitment on secondary teachers (grades 6-12) as participants, leveraging their content knowledge since middle and high school teachers are required to have significant college level coursework and often a degree in the subject they teach (Miranda & Damico, 2015; Ragusa & Juarez, 2017; Schwartz et al., 2010; Silverstein et al., 2009; Simmons et al., 2009; Westerlund et al., 2002). Elementary teacher preparation has a much broader scope, as primary teachers are expected to have a basic proficiency in all of the subject areas especially as they relate specifically to elementary standards and pedagogical practices. This creates a unique challenge for MRET in finding common ground among the researchers and teachers participating in this experience. This paper will present the process we have undertaken to ensure that the time elementary teachers and university scientists spend together in the laboratory is productive in both accomplishing the work of the research laboratory and in contributing to the desired professional growth outcomes for the teachers. One key component in finding this balance has been the construction of a micro-certification framework based upon the Next Generation Science Standards (NGSS) science and engineering practices as well as the types of skills and proficiencies teachers are expected to demonstrate as researchers in the labs. This framework has been translated into MRET badges, loosely based on the structure of both Boy Scout badges and digital micro certifications, that teachers may earn by working through a process of learning about a topic or skill, practicing it and then demonstrating their learning to a member of the MRET team. MRET badges have been enthusiastically received by the teachers and researchers as a valuable form of scaffolding of the research experience and as an aid to direct teacher activities within the lab in circumstances where they would otherwise have unstructured time.

Badging / Micro-Certification as Framework

Badges have been used across the centuries by social, religions and educational communities as a sign of trust, membership and achievement (Halavais, 2012). Since 1910, the Boy Scouts of America (BSA) have offered opportunities for scouts to earn merit badges as a way to demonstrate achievement of specific educational objectives for the program (Henning, 2017; Vick & Garvey, 2011). Across the hundreds of BSA badges available, some common characteristics are shared. (1) Each badge is centered around a single aptitude, concept or area of study and allows a person to demonstrate knowledge or a skill related to that topic. (2) Badge attainment is wholly voluntary, and scouts select the badges they are interested in pursuing without an expectation that every badge must be achieved or an order in which badges must be completed; allowing participants' learning to be self-directed. (3) Badges are intended as a motivator to increase scouts' learning and impetus to try and master things they may not otherwise do. (4) Physical badges are displayed as a formalized recognition of the knowledge, skills and experience scouts have accumulated during their participation in the organization (Abramovich, Schunn, & Hagashi, 2013; Halavais, 2012; Merit Badges, 2019; Vick & Garvey, 2011).

With the advent of online learning environments, communities, and video games, the idea of badges has moved beyond physical representations of achievement through beautiful embroidered patches to use as a novel form of assessment and micro certification (Abramovich, et al., 2013; Dickey, 2005). Digital badges as micro certifications are used to scaffold learning experiences while providing motivation for learning (Devedžić & Jovanović, 2015). Currently in the accountability driven arena of

teacher professional development, use of badges and digital micro certifications have proliferated to demonstrate teacher learning, and competence and as a means of clearly articulating the performance objectives of a professional development offering (Berry, Airhart & Byrd, 2016). In a manner similar to scout badges, digital badging often uses pictorial representations for the skills or competencies attained, and users are encouraged to display their earned badges as a form of acknowledgement of achievement within a virtual community (Ferdig & Pytash, 2014).

Methodology: Development and Implementation of MRET Badges

In an effort to leverage the affordances of both physical badges as used by BSA and the digital badges designed for use in online communities, we have developed a set of MRET badges which may be earned by participating elementary teachers in our NSF- funded RET Site. Now in its third year, MRET annually places six to twelve elementary teachers in pairs as contributing researchers in university engineering research laboratories for six weeks during the summer. During their RET, participating teachers work in their assigned laboratory approximately six hours per day, Monday through Thursday, with a full day of professional development activities each Friday intended to support the translation of the research experience into lesson planning and other activities related to improved STEM education and self- identification for the teachers. Based on feedback from teachers and the graduate research assistants (GAs) who mentored teachers in the labs in our first year, collected through daily self report surveys, we decided to develop a set of badges as a way to scaffold the research experience by outlining a specific set of competencies and knowledge bases teachers could reasonably expect to attain during the RET. This came about as we realized that some of the GAs were struggling to identify appropriate tasks to engage teachers within their labs. While teachers in some labs were reporting a greater variety of activities and satisfaction with their opportunities, others were expressing frustration at being limited to a narrow array of tasks, or feeling as if they could benefit from more challenging assignments.

In our second iteration, we worked with the GAs prior to teachers' arrival to generate a list of lab competencies, activities and skills they would expect a participating member of their team to attain. Using this list and the NGSS science and engineering practices as a guide, a set criteria for eleven badges was developed and given to the teachers as they began their research experience. Teachers were informed that the badges were voluntary, could be achieved in any order, and at the end of the RET they would be awarded a physical badge depicting an icon representing that competency. The eight science and engineering practices practices identified within the NGSS (National Research Council 2012) as essential to K-12 education include (p. 382):

1. Asking questions (science) and defining problems (engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (science) and designing solutions (engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Badges we developed to align with these practices were: (1) Defining a problem that may be improved through investigation and testing. (3a) Keeping a Lab Notebook (3b) Laboratory Measurements (3c) Design & Conduct an Investigation or Experiment (4a) Reading Journal Articles for Comprehension (5) Using Software to Organize & Analyze Data (8a) Preparing to Present Your Work at a Group Lab Meeting (8b) Communicating Your Work to Others and Asking for Constructive Feedback. Three additional badges related to work in the lab as provided by the GAs that didn't clearly align to one of the

SEPs included (0a) Staying Safe in the Lab, (0b) Keeping a Tidy and Organized Lab, and (0c) Microscopy.

Results

In the first year of badge implementation, summer of 2018, ten of the twelve MRET teachers attained one or more badges, eight of whom attained more than 50 percent of available badges and four of these reaching 100% completion. Five of the eleven badges were completed by all ten participating teachers; these were 3a, 3b, 5, 0a and 0b, indicating that the categories related to planning and carrying out investigations, computational thinking and specific lab competencies were well represented in the documented activities of the teachers. The least attained badge was 8b. Overall, of the teachers attempting badges, 76 percent of possible badges were completed. Taking into account all twelve of the MRET teachers from that year, 64% of all possible badges were completed. A selection of teachers were interviewed in the school year following the RET experience and teacher impressions regarding the badges were discussed. Preliminary analysis of the interviews indicates that teachers held the badging process in high regard, and appreciated the opportunity to use the activities outlined in the badges to stimulate conversations with their GA mentors about activities and skills they would like to experience and learn. This allowed teachers who were feeling less challenged by the assignments from their GA mentors to ask for opportunities to conduct activities required for badge completion. Teachers also reported turning to working on the badges when they found themselves with free time in the lab that may have otherwise been wasted. Our presentation will include more specific results from the completed qualitative analysis of these interviews.

Conclusions

The data we collected from the badge attainment of teachers in the summer of 2018 indicates that teachers embraced the idea of the badges to scaffold their laboratory activities, make productive use of free time and motivation to learn new skills in which they may not have otherwise engaged. In our third iteration of MRET, in the summer of 2019, we added two additional badges specific to defining engineering careers and using the engineering design loop process. This addition arose from data we collected in observations of teachers working in the lab, daily activity and engagement surveys self reported by GA's and teachers as well as post RET interviews which indicated that more emphasis should be placed on highlighting the unique nature of the various fields of engineering and the engineering specific research processes.

Elementary teachers are the first contact that most students have for learning about Science, Technology, Engineering and Mathematics (STEM) subjects. Assisting practicing elementary teachers in expanding their knowledge and experience in STEM through offering them opportunities to collaborate with scientists and engineers on the cutting edge of current research has the potential to positively impact their ability to communicate the work of STEM professionals as accessible to their students. Merely placing teachers in laboratories is no guarantee that they will leave with an accurate or even positive mindset related to STEM research. Scaffolding the research experience through making concrete connections to the K-12 NGSS science and engineering is one way to empower teachers to translate their research experiences into changes in their approach to STEM in their classroom teaching. Our experience with MRET badges suggests that this can be a valuable tool for use within RET sites to facilitate the accomplishment of these goals.

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