

Board 19: The Impact of a Research Experiences for Teachers Program in Precision Agriculture and Sustainability for Rural STEM Educators

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Abstract

North Dakota State University (NDSU) has conducted a National Science Foundation sponsored “Research Experiences for Teachers” (RET) grant over the past three years. Focused on Precision Agriculture and Sustainability, the six week summer experience engages middle and high school mathematics, science, and technology education teachers in authentic projects through the mechanical engineering and the electrical and computer engineering departments. By participating in the program, teachers develop a practical understanding of the engineering design process as it relates to research principles and authentic applications. Teachers build capacity to increase student engagement by also participating in professional learning sessions on effective pedagogy, active classroom environments, and student-centered learning strategies. A unique aspect of this program is the focus on the rural teacher, selecting participants who were the only math, science, or technology education teacher in their school building. In addition, pre-service teachers were paired with an in-service teacher in NDSU’s mathematics education or science education program. This provides a valuable collaborative experience for both the in-service and pre-service teachers. Having completed the third summer of the program, results of data analysis show the program has been highly effective in transforming the teachers’ approach to classroom practices that increase student engagement. Results also demonstrate a positive impact on the pre- and in-service teacher’s shift in attitude towards general classroom practices and teaching pedagogy. This paper describes the program goals and outcomes, specifics of the summer experience, data collection, results, and the next steps for research and practice.

Introduction

Referred to as “solitary STEM teachers”, the participants in this RET are the only mathematics, science, or technology education teacher in their middle or high school grades (referred to in this paper as STEM teachers). These teachers are from the upper Midwest region where it is common for schools to be separated 30 miles or more [1]. Teachers in this region are typically the only teacher in their content area, and their schools and districts lack the support, resources, and professional opportunities to help them further develop effective teaching strategies. And taking into consideration that these teachers may be the only STEM teacher their students have while in that school building, these teachers have significant influence over the educational development of their students. Many of these teachers have 5-7 different class preparations a day with only one planning period. Teachers may struggle to implement and sustain effective teaching practices when policies and assessment methods need to be modified due to the adoption of new standards, such as with Common Core State Standards for Mathematics and Next Generation Science Standards [2] – [4]. During the RET program, teachers focused on the agricultural aspects of STEM education in order to connect to a strength of the local region. The primary goal of the program is to enhance STEM education for rural students and their teachers, while using an engineering context through an agricultural framework. The RET program consists of a 6-week summer research experience as well as follow-up activities and support for

each cohort as they translate the research experience into their STEM courses throughout their academic year.

Program Description

The primary activity of the RET program is a six-week summer experience that engages five in-service and five-pre-service teachers. Each in-service teacher is paired with a pre-service teacher while conducting research on an established faculty project in the Mechanical Engineering Department or Electrical and Computer Engineering Department on the campus of NDSU. The research team, graduate student mentor, and other faculty members provide support to teachers to enhance the knowledge and skills gained throughout the program. This support is provided in a variety of ways, including refresher courses in math and science content, pedagogical workshops, engineering design activities, lab work, and curriculum writing. Four follow-up workshops are conducted through the year to provide sustained support throughout the school year. By participating in the program, the teachers gain a personal insight to research-based classroom instruction that follow best practices in K-12 engineering education, STEM learning, active learning instruction, and project-based learning [5] – [12]. The cohort-style program design allows participants to develop relationships, support networks, and a professional learning community they would not otherwise be a part of.

Methodology

The qualitative methodology used Kirkpatrick and Kirkpatrick's four-level model for evaluating training programs, with measures collected to address key features of participants' training experience and learning [13]. Data was collected at various times throughout the program to address key aspects of the participants' training experience, learning, and overall satisfaction. More specifically, the data was used to assess: (Level 1) participants' reaction to the training and its content (reaction); (Level 2) the extent of participants' learning of the intended skills, knowledge, and dispositions from the training (learning); (Level 3) the extent of participants' transfer of these new skills, knowledge, and dispositions into their own course design and classroom practices (behavior); and (Level 4) the extent of their students' achievement of desired educational results stemming from these enhanced educational practices (results). Data was collected and analyzed during the three years of the program to assess the outcomes of Levels 1-3. Level 4 outcomes are currently being evaluated to determine the impact of the program in regards to the level of engagement of the participants' students during classroom learning activities. During the three years of the RET program, eleven in-service and ten pre-service teachers participated in the program, with eight of the participants completing two years of the program. Data collection included the following measures:

- Pre- and post-program classroom observations and lesson plan evaluation [14], [15]
- Pre- and post-program individual interview [16], [17]
- Mid-academic year interview

An external evaluator conducted individual interviews with each participant during the final week of the summer program. Semi-structured interviews, lasting approximately 30 minutes, allowed coverage of the essential topics while providing flexibility to probe unique and personalized experiences of the program. In-service teachers were interviewed again during the

academic year to document self-reported changes in teaching philosophy and classroom practices since participating in the summer program.

Results

The follow sections describe the results of the data analysis.

Pedagogical Shifts

From the pre- and post-program observations and lesson plan analysis, it was evident the in-service teachers had a shift in teaching philosophy and approached classroom teaching with a greater purpose for engaging their students. Through recorded classes and lesson plan analysis, teachers demonstrated an increased use of the engineering design process and integrative learning strategies. The classroom environment promoted more student communication, collaboration, design thinking, and inquiry-based instruction.

Interview results demonstrated pedagogical shifts in teaching philosophies towards a more design thinking approach to teaching. Teachers reported an increase in classroom learning activities that require students to take more control over the learning process. The teachers reported an increased level in student engagement during these learning activities. Some of the comments from the interviews are, “I now have new ideas about how to teach lessons. I learned a better way to engage students with research and design activities”, “I need to give my students more chances to think through a design process”, and “I learned to ask my students much broader questions. This will allow my students to work through the different steps of the engineering design process without me giving them the answer.” These comments demonstrate how the RET program is fundamentally shifting their approach to teaching.

Benefits of Pairing

Another major theme that emerged from the data was how pairing an in-service teacher with a pre-service was mutually beneficial for all participants. The pre-service teachers appreciated being able to work with and develop a relationship with a practicing teacher. This allowed the pre-service teacher to learn much more about the practical aspect of being a classroom teacher than they learn in their teacher preparation coursework. One pre-service teacher said, “It was really nice just being able to talk to someone who has been a classroom teacher for a while.” Another one said, “I was able to compare what I’m learning in my classes to what might actually go on in the classroom.”

The in-service teachers also appreciated being paired with a pre-service teacher because the pre-service teachers brought fresh insights, new theories, and up-to-date pedagogical research to the pairing. One in-service teacher said, “It has been a while since I got my degree, so it was eye-opening to hear what they are learning about in their classes these days.” Another one said, “It sounds like they look at a lot of research about pedagogy, so I liked hearing about some of the new techniques to engage students in the classroom.”

Pre-Service Teachers

Interviews conducted specifically with the pre-service teachers produced quality information about how the RET program is directly affecting their career path. Several of them mentioned how this program has impacted their approach to student teaching. One pre-service teacher said, “Participating in this program will help me with my student teaching. It allowed me to get ahead on some of my lesson plans where I can incorporate active learning strategies for the students.” The RET program also helped the pre-service teachers connect with leaders in the local educational community. Two of the pre-service participants connected with a local middle school to offer weekly engineering design challenges for several classrooms.

Conclusions

The RET program is very impactful to both in-service and pre-service teachers in many ways. All participants are gaining personal knowledge and skills about the research process and how to use this process to engage middle and high school students in the classroom. They are also learning how the practical applications of engineering and design can help them more effectively deliver their existing course content. It is apparent the participants enjoyed the program and the collaborative learning environment it provided. Being a solitary STEM teacher, building a network of resources along with a professional learning community, is vital to these teacher’s ability to continually provide effective learning experiences for their students. Pairing an in-service teacher with a pre-service teacher proved to be an extremely valuable aspect of the program. Each group was able to both share ideas and learn from the other, which increased their knowledge about teaching. Overall, the researchers were pleased with the results of the program and the outcomes produced from the data. The data will continue to be analyzed to determine other emerging themes from the RET program. The researchers believe the lessons learned from this program will greatly benefit other teachers in similar teaching environments.

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