Innovative Pathways in STEM Teacher Preparation: Bridging the Gap between University Expectations & Secondary School Needs

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Abstract

Innovative teacher preparation programs for STEM education are essential for meeting the goal of ensuring that secondary school students receive instruction from a certified teacher. This exploratory workshop examines the role that interdisciplinary STEM and mathematics programs can have to increase the number of certified teachers prepared to teach STEM classes from an interdisciplinary approach.

Introduction

The focus on integrated STEM education continues to increase dramatically in both research and practice. As secondary schools push toward integrating mathematics and science education, it is essential for teacher preparation programs to also design programs that prepare teachers for these changing STEM teaching and learning environments (Nadelson & Seifert, 2017). At Dordt University, we have engaged our stakeholders and utilized data on mathematics and science teacher preparation to design innovative teacher preparation pathways that give pre-service teachers the foundation needed for being interdisciplinary STEM teachers.

Statement of the Problem

There is tension between the expectations of university teacher preparation programs and the needs of secondary schools. University professors, deeply passionate about their subject area, push for more and deeper content knowledge in specific STEM disciplines. This is an important goal to retain; however, many secondary school leaders desire to hire teachers who have more breadth in their preparation across multiple STEM disciplines. Our experiences in secondary schools both as teachers and as an administrator, in addition to our experience training mathematics teachers at the university level, have helped us see the dire need for well-trained STEM teachers who can teach in an interdisciplinary manner. While change is difficult, Norman (2010) states that “teaching is about nothing if it is not about change. If as teachers, principals or professors we do not believe we are capable of affecting change, then so much of what we do becomes meaningless” (p. 4).

Schools across the United States feel the pressure created by a shortage of highly-qualified STEM teachers. In 2017-2018, the United States Department of Education reported that 48 of 50 states had a shortage of mathematics teachers and 43 of 50 states had a shortage of science teachers. The National Science Foundation (2014) reported that 27% of mathematics teachers and 18% of science teachers at the high school level did not possess a degree in mathematics or science. In 2003, Iowa specifically designated mathematics, biology, chemistry, earth science, physics, industrial technology and agriculture

as teacher shortage areas at the middle and high school levels, with some STEM disciplines identified as areas of shortage even earlier (United States Department of Education Office of Post Secondary Education, 2015).

The acute shortage of STEM teachers nationally is of no less concern in rural schools, with some arguing that the challenges in hiring and retaining STEM teachers are even greater in rural schools (Monk, 2007). Despite the necessity for high-quality STEM education for all, rural schools have high proportions of unfilled positions (23% to 36%) across STEM fields (NCES, 2013), a number that ranges up to 43% when schools with enrollments less than 199 students are considered. Rural schools which face difficulty retaining highly-qualified STEM teachers (Goodpaster, Adedokun, & Weaver, 2012) often resort to provisional certification.

Proposed Solutions

To meet this need for more STEM teachers, Dordt University has designed new and revised interdisciplinary STEM programs for teacher preparation including a joint mathematics/physics major and a joint mathematics/engineering major. The joint mathematics/physics major certifies educators to teach both mathematics and physics in grades 5-12. Given the amount of overlap in the courses required for mathematics and physics majors, it makes it possible to become certified in both fields. Many smaller high schools only offer one or two physics courses, so producing graduates who are certified in both mathematics and physics meets multiple needs for these schools. A similar, but stronger argument can be made for the joint mathematics/engineering certification since even fewer schools offer engineering or robotics classes. We are also working with our state accreditation agency to offer a joint mathematics/computer science major as well as an *all science* (biology/chemistry/earth science) major.

These joint majors are helping university professors reshape their approaches to mathematics and science in a more interdisciplinary manner. There is a renewed focus on the most important content knowledge needed for broader, more integrated, teacher preparation for emerging STEM classrooms. Additionally, we have designed an innovative pedagogy course, *Methods of Teaching STEM*, which builds a foundation of knowledge for STEM teaching, differentiates by pre-service teacher area of study, and applies knowledge in lab-based teaching settings. The addition of the STEM-specific pedagogy course, in conjunction with interdisciplinary STEM majors, addresses the call from many in the United States to reform STEM education (Weaver, et al., 2016).

This interdisciplinary approach to STEM education mirrors a similar shift in STEM research as the National Science Foundation has recently shared its strategic plan for 2018-2022 (National Science Foundation, 2018). An emphasis of strategic goal number one includes a call for more convergence research since “there is growing consensus that some of the most intractable problems in the scientific, technological, and social arenas require perspectives and approaches from multiple disciplines (National Science Foundation, 2018, p. 18). This increased emphasis on convergence can also be seen in the growth of interdisciplinary institutes in both the public and private sector as well as a rise

in joint appointments and interdisciplinary departments in academia (National Science Foundation, 2018).

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Conclusion

We are optimistic about the outcomes for these interdisciplinary STEM programs. Since implementing these programs, there has been an increase in the number of pre-service teachers seeking certification in one or more STEM fields. Exploring and examining approaches to improve STEM teacher preparation will help all attendees consider how to better meet the STEM education needs of secondary schools.

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