How might we effectively prepare and support elementary teachers to teach STEM?

MANY ELEMENTARY TEACHERS HAVE ANXIETY ABOUT TEACHING STEM SUBJECTS.

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01 CONTEXT AND TRENDS

Research literature—not just in the United States, but in nations across the world—broadly shows that elementary teachers lack confidence in teaching science, technology, engineering, and mathematics (STEM; Avery & Meyer, 2012; Flores, 2012; Nadelson et al., 2013). Across the STEM subjects, elementary teachers' lack of confidence appears to result from insufficient content knowledge (knowledge of STEM) and pedagogical content knowledge (knowledge of how to teach STEM), which makes it a challenge for them to move beyond teacher-directed, rote teaching and learning of STEM content (Bencze, 2010; Walker, 2007). This may not be such a surprise when one considers that elementary teachers are often generalists and therefore (perhaps unrealistically) expected to be experts in all of their assigned subjects (Nelson & Landel, 2007).

02 DISCUSSION

Many elementary teachers not only lack confidence to teach STEM, but also experience anxiety related to STEM education. This anxiety, at least in mathematics, appears to be associated with their previous negative experiences in which they feared getting a wrong answer, were anxious about completing timed assessments, and lacked confidence to solve word problems (Harper & Daane, 1998). Research also shows that elementary-grade girls are more likely to think they're not good at math when they are being taught by a female teacher who has math anxiety (Beilock, Gunderson, Ramirez, Levine, & Smith, 2010). Given that approximately 90 percent of elementary school teachers are women, the unfortunate likelihood is that many girls are developing attitudes toward math that can derail their long-term engagement and participation in STEM (Beilock et al., 2010). In other

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words, teachers' STEM anxiety has an impact on their students' perceptions of their own STEM abilities, which interestingly appears to align with traditional gendered stereotypes. Because of the persistent and cyclical impacts teacher anxiety can have on students, this is a problem worth unpacking.

A prevailing perception of elementary teachers is that they are disinterested in STEM subjects (Abdul-Razzaq & Bushey, 2009; McGarvey, Sterenberg, & Long, 2013). This perception is perpetuated by the fact that only 4 percent of elementary teachers have a college degree in mathematics or math education (Malzahn, 2013), and only 5 percent have a degree in science, engineering, or science education (Trygstad, 2013). One interpretation of these data is that elementary teachers just aren't interested in these subjects—either as learners themselves or as educators. This interpretation, however, is problematic and may be missing the true root cause of the challenges associated with enhancing elementary teachers' STEM instruction in the classroom.

For example, in an attempt to understand why so few elementary teachers pursued degrees in STEM subjects, Bulunuz and Jarrett (2010) found that preservice elementary teachers generally noted a lack of positive experiences with these subjects, both in and out of school, that affected their interest in STEM. Other research shows that many elementary teachers regularly report poor and/or negative STEM experiences in school (Hodgen & Askew, 2007; Welder & Champion, 2011). These data suggest that identifying the challenge as developing out of negative past experiences, rather than as an inherent disinterest in STEM, may do more to advance effective solutions to the problem.

According to data from a national survey, 77 percent of elementary teachers feel very well prepared to teach math overall, as compared to 81 percent for reading and language arts. While the difference between those percentages is relatively small, the problem is more apparent when reviewing the teachers' responses to their level of preparation to teach specific topics and core concepts in mathematics: The percentages decreased notably for concepts that are more difficult and complex. For example, just 46 percent of elementary teachers felt well prepared to teach early algebra (Malzahn, 2013). Further, according to data from the same national survey (but described in a different report which focused on elementary science instruction), only 40 percent of elementary teachers felt very well prepared to teach science, and only 4 percent felt very well prepared to teach engineering (Trygstad, 2013).

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The same national survey did not ask teachers about their preparedness to teach technology, but it did measure teachers' use of technology in the classroom. Only 33 percent of elementary mathematics teachers (Malzahn, 2013) and 25 percent of elementary science teachers used instructional technology (Trygstad, 2013). These percentages are quite low and suggest that interventions and supports are needed to help teachers feel better prepared and enable them to teach all of the STEM subjects in greater depth and more effectively.

03 BRIGHT SPOTS

Informal science education institutions (ISEIs), such as zoos, aquariums, and museums, are well used as sites for field trips for elementary students, but there is a national push from various informal and formal educational groups to further strengthen the partnerships between ISEIs and K–12 schools (Kisiel, 2013). ISEIs and their expert staff have the potential to provide significantly more support to elementary teachers and students beyond simply hosting field trips.

For example, in Chicago, the Peggy Notebaert Nature Museum offers workshops for classroom teachers throughout the year. In one such workshop designed for early childhood and early elementary teachers, museum staff helped teachers think about the pedagogical choices they were making in the physical learning environment of their classrooms in order to create a space for children to explore and learn STEM authentically (Schrementi, 2011). These types of workshops help develop teachers' pedagogical content knowledge. The Peggy Notebaert Nature Museum also partners with the Illinois Department of Natural Resources to offer workshops on topics such as Illinois' urban wildlife, which serve to develop teachers' content knowledge. Knowing that ISEIs and the experts within them have the capacity to provide additional resources or professional development to local teachers in STEM, particularly elementary teachers, schools could provide leave to their elementary teachers to attend these types of workshops. Through increasing teachers' content knowledge and pedagogical content knowledge, and through positive STEM learning experiences for the teachers, their confidence and interest in teaching STEM in their classrooms could improve as well.

04 CONCLUSION

In conclusion, as Nadelson et al. (2013) point out, many elementary STEM teachers lack confidence and feel unprepared to teach STEM, and yet it is during these elementary years that STEM learning is so foundational for students. It is thus critical to break out of this vicious cycle of elementary teachers perceiving themselves as ineffective STEM teachers, which is only fueled by broader community perceptions of elementary teachers' unwillingness and disinterest in teaching and learning STEM, which then feeds students' developing perceptions of who is good at and belongs in STEM (Hodgen & Askew, 2007). Schools, districts, ISEIs, universities, and teachers who have STEM expertise themselves must work together and find ways to facilitate and engage all elementary teachers in more positive STEM experiences. Supports, resources, and interventions that expose elementary teachers to STEM content through accessible, inclusive, and authentic experiences can increase their interest in and knowledge for teaching STEM, particularly for teachers who feel anxiety about teaching these subjects.

ABOUT THE GRAND CHALLENGES WHITE PAPERS

In 2017, 100Kin10 released an unprecedented representation of the big, systemic challenges to preparing and supporting STEM teachers following over two years of extensive research alongside more than 1,500 STEM teachers and hundreds of other education experts. As a part of this work, 100Kin10 commissioned a series of short white papers from well-versed thinkers and practice-oriented researchers to synthesize the most relevant research around the specific challenge areas. Together, they compose a thoughtful and well-rounded examination of the systemic challenges currently facing STEM teaching.

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