ELEMENTARY TEACHERS OFTEN LACK ACCESS TO STEM PROFESSIONAL DEVELOPMENT.

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01 CONTEXT AND TRENDS

Elementary students are minimally exposed to science, technology, mathematics, and science (STEM) content areas (National Research Council [NRC], 2012), resulting in limited opportunities for students to explore their interests in STEM at an early age. Young students' lack of STEM learning results in few students deciding to pursue science, engineering, or other STEM-oriented fields as a career, as research shows that these types of decisions are often determined by the time a student reaches the sixth grade (Gerlach, 2015). Student's limited exposure to STEM in the elementary years also decreases the ability for students to be critical consumers and thinkers in their everyday lives (NRC, 2012).

Low levels of early exposure to STEM may be in part due to the limited background knowledge of some elementary teachers in these subjects, as well as the lack of training and learning opportunities in STEM content and pedagogy that are provided to elementary teachers throughout their careers (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013). Focused professional development (PD) in the STEM subjects is likely to improve teaching practices, particularly if the PD includes experiences that provide space for teachers to reflect on their practice and include opportunities for teacher collaboration (Saylor & Johnson, 2014; Cotabish, Dailey, Robinson, & Hughes, 2013). It has been found that STEM PD improves teacher confidence, efficacy, and teacher perceptions of STEM in terms of content, practices, and knowledge (Nadelson et al., 2013).

Teachers play an essential role in building the foundation for students' STEM learning development and long-term interest in STEM subjects, and therefore PD in STEM will provide enormous benefits to elementary teachers. Elementary teachers who are provided with the knowledge, resources, and tools that enable them to view themselves as STEM educators and content experts in these subjects will likely be in a better position to provide a strong STEM foundation for their students.

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DISCUSSION

STEM PD can effectively enhance instruction in STEM classrooms. However, there are several reasons as to why STEM content and professional supports for elementary teachers are often limited, including elementary teachers' role as generalists, policy-driven instruction, and a belief among some teachers that not all students need to or can learn STEM.

Elementary teachers in the United States are often viewed as generalists because they teach all core content areas, rather than having a specific area of expertise, as is the case in elementary classrooms in other countries, like China (Li, 2008; Ma, 1999). As a result, many preservice programs in the U.S. provide elementary teacher candidates with few courses in science, technology, and engineering, leading to limited content knowledge in these disciplines (Gerstein, 2015; Li, 2008) and therefore limited expertise. As a result of the limited exposure and training teachers receive in STEM content, elementary teachers may experience anxiety and lack confidence when teaching these subjects (Murphy, 2011). Teachers may themselves form an identity as generalists, limiting their own perceptions of what they can and should teach (Levy, Pasquale, & Marco, 2008). PD can be a means to build the content knowledge and confidence of elementary teachers in STEM (Cotabish et al., 2013).

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Current education policies also play a role in the lack of support elementary teachers have in STEM subjects, as they often place a heavy focus on standardized testing and accountability, which results in the deprioritization of subjects that do not have high-stakes tests, such as science, technology, and engineering. For example, in many cases these education policies often determine how instructional time is allocated. In many elementary classrooms, most instructional time is spent on reading/language arts and math, especially in grades K–2 (NRC, 2011; NRC, 2012; Wright & Neuman, 2014; Honey, Pearson, & Schweingruber, 2014). Engineering instruction across K–12, for example, is minimal in comparison to math, reading, and technology in most schools (Honey et. al, 2014). Given this reality, educators—both school leaders and elementary teachers—need support in considering how to effectively integrate STEM learning in developmentally appropriate ways, while still meeting the math and literacy achievement expectations for their students (Honey et. al, 2014).

Priorities of school principals and central offices often dictate resource allocation (Coburn, 2005), therefore impacting how PD funds are utilized. This has resulted in content-specific professional development focused on math and reading/language arts, with limited, if any, support for other content areas (Spillane, Diamond, Walker, Halverson, & Jita, 2001). To truly establish strong STEM education and career pipelines and pathways for students, there is a need for policies that prioritize and incentivize PD opportunities for elementary teachers not just in math and reading, but in all of the STEM subjects, including science, technology, and engineering.

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It has also been found that some educators have a deficit mindset when it comes to their conceptions of who can and cannot succeed in learning and doing STEM. Deficit mindsets are present when teachers "teach down" to students and don't provide them with challenging content due to their own low expectations of the students (Delpit, 2006; Gay, 2010; Wright & Neuman, 2014). At times, deficit mindsets are also held among education leadership, further affecting how resources (including PD) are allotted. A pilot study that examined the ways by which school leaders in Chicago identified and activated resources to support elementary science instruction, for example, found that science learning was not a priority because school leaders believed that the students they largely served—students from low-income families—did not have the capacity to learn content beyond the basics of math and reading (Spillane et al., 2001). This mindset limited the resources allocated to content that was deemed too advanced, resulting in a disservice to some of our most vulnerable students while sacrificing an untapped pool of STEM potential and talent.

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BRIGHT SPOTS

Although the opportunities for STEM PD for elementary teachers are limited, there are various bright spots across the country that are doing great work with teachers to enhance pedagogical knowledge, content knowledge, and pedagogical content knowledge.

One organization that works to enhance teacher understanding, as well as confidence to integrate science and engineering content areas, is the Museum of Science, Boston: Engineering is Elementary (EiE). Providing teachers with the opportunities to engage in engineering through hands-on lessons as well as co-constructing knowledge with teachers can potentially lead to increased confidence in both their content knowledge and their pedagogical knowledge (Hynes & dos Santos, 2007).

Another opportunity for early childhood and elementary teachers to participate in PD on implementing and integrating engineering in creative ways is the Bay Area Discovery Museum (BADM): Institute of Museum and Library Sciences Professional Development Workshop. BADM also provides free PD to educators who serve in Title I schools or federally sponsored preschools.

The Early Math Collaborative at the Erikson Institute believes that by changing what teachers both do and think about math, the quality of instruction in preschool and kindergarten can effectively improve. The Early Math Collaborative develops PD based on the "whole teacher" approach, which focuses on enhancing the attitudes, knowledge, and practice of teachers (Chen & McCray, 2012).

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CONCLUSION

Despite the perceptions and policies that continue to hinder the widespread opportunities for elementary teachers to deepen their knowledge and confidence in STEM content and pedagogy, some organizations across the country have developed programs to help fill this void. It is important to note that STEM PD should not be one-day quick fixes, but rather opportunities for learning over a period of time (Cohen & Hill, 2000).

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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