SCHOOLS AND PRINCIPALS OFTEN ARE NOT ACCOUNTABLE FOR SCIENCE, TECHNOLOGY, AND ENGINEERING LEARNING.

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01 CONTEXT AND TRENDS

Conversations regarding the implementation of science, technology, engineering, and mathematics (STEM) programs are happening all over the country in classrooms, conference rooms, and principals' offices. Many a department chair, curriculum specialist, or principal has experienced stress, confusion, and hesitation in leading their faculty and staff in these new, exciting, and sometimes difficult conversations. Why is it so challenging for educators to engage in conversations about STEM programs and instruction? The reality for many is that STEM subjects are not well defined in school settings, and oftentimes science, technology, and engineering are undervalued subjects in schools. Many states lack strong engineering and computer science standards, and some states even lack strong science standards. Alongside this, many states are also without the structure and vision to implement STEM programs (Next Generation Science Standards [NGSS] State Leads, 2013; Holden & Lander, 2010).

02 DISCUSSION

For the past several years, the Next Generation Science Standards (NGSS) have given states guidelines for integrating science and engineering concepts into the curriculum to strengthen science teaching and learning. While 26 states have been involved in the development of the standards, only 18 have officially adopted them (Heitin, 2016). Alongside low adoption, there is another challenge with NGSS: The standards focus largely on science teaching and learning, and while they do include engineering practices, they do not include technology. For those states that haven't adopted NGSS or are without clear standards, the vital connection between science and engineering concepts is compromised, and thus students are unprepared to meet the demands of a 21st-century society (Moore, Tank, Glancy, & Kersten, 2015).

The NGSS can provide a solid foundation for students who wish to pursue STEM-related careers after graduation, but they are not necessarily STEM instruction standards (National Science Teachers Association, 2013). The lack of standards across STEM disciplines has resulted in many students with an interest in areas such as computer science, technology, and engineering lacking access to rigorous STEM classes (Stephenson & Wilson, 2012), as these subjects are still not widely integrated into many schools' curriculums (Hutchinson, 2012).

Clear and comprehensive STEM standards are only one aspect of fostering effective STEM instruction. A well-understood definition of STEM teaching and learning is also needed. Presently, the lack of a common and clear definition of what STEM education looks like is evident in the struggles of any classroom teacher who wishes to integrate STEM into his or her instruction. Many teachers have expressed a strong desire for more training, especially in the areas of content knowledge and pedagogy. For instance, STEM instruction requires teachers to ground the curriculum in real-world situations and to focus on performance-based assessments. This marks a departure from the more traditional approach to teaching in which content, not process skills, was the emphasis (Beaudoin, Johnston, Jones, & Waggett, 2013; Ben-David Kolikant, 2011). Teachers need ongoing professional development and support in order to grow their practice in the context of a STEM program. Additionally, teachers are the main curriculum-writers for many schools (Sapers, 2015), so their ability to effectively integrate STEM standards and learning activities into classroom curriculums is dependent on the quality and depth of the professional development and support they have received for doing so.

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Schools also experience confusion in determining which students should be eligible to enroll in STEM programs and discipline-specific courses (Nathan, Tran, Atwood, Prevost, & Phelps, 2010). Many states, districts, and schools hold onto the idea that higher-level science courses should be reserved only for the higher-achieving students (Emdin, 2009), thereby eliminating the opportunity for many students, including those with the highest needs, to benefit from critical STEM learning experiences. Without a clear structure and vision to STEM instruction, we will fail to give all students access to high-quality STEM teaching and learning experiences.

03

BRIGHT SPOTS

Many schools continue to struggle to establish a firm and shared definition of what constitutes a STEM education, including how to appropriately and effectively integrate key standards into course and classroom curriculums. Support and guidance for these schools is more available than one might think, however. Many universities have offered their resources and forged partnerships with schools to promote STEM education programming, and with little or no cost to the schools (Beaudoin et al., 2013). Partnerships like these can bridge the gap between the written STEM standards and their effective implementation in schools at all grade levels. Universities also offer teacher-driven professional development helping to ensure that teachers feel more prepared and confident in providing STEM instruction. One example of such partnerships is the Office of STEM Education Partnerships (OSEP) out of Northwestern University. The OSEP's mission is to connect K–12 students and teachers with STEM resources on the industry and university levels. One facet of the OSEP is to train approximately 300 teachers a year on new STEM instructional strategies and technology, as well as to provide opportunities for teachers to collaborate with scientists and engineers in order to share STEM education best practices (Jona, 2006).

The increasing push for integrating computer science standards into the curriculum may be among the most difficult for schools and teachers to address. Computer science education is unfamiliar to many teachers, particularly generalists or teachers outside of the field, and is not yet well defined in the broader education community (Stephenson & Wilson, 2012). Even in the NGSS, there has been acknowledgement that the standards can be confusing in terms of instruction in these areas. To address this confusion and ambiguity, the Computer Science Teachers Association (CSTA) has released a set of revised K–12 standards to help clarify and define effective technology instruction. Additionally, schools and school districts have been adopting and implementing these standards in the curriculum. The San Francisco Unified School District (SFUSD) has begun an initiative entitled *Computer Science for All in SF* in which the computer science standards are implemented in K–12 schools. SFUSD has outlined a timeline to be fully realized by the 2016–2017 school year that makes computer science a compulsory subject starting in the elementary grades and continuing into high school ("Framework & Standards," n.d.).

Outside of traditional learning spaces, many companies, such as Google and Apple, have offered funding, as well as affordable professional development, to further support computer science and technology education in schools (Stephenson & Wilson, 2012). In addition, many universities and organizations have offered computer science camps for girls and minority students (Stephenson & Wilson, 2012). One exemplary instance of such outreach is the Compugirls program based out of Arizona State University. Compugirls offers girls from under-resourced school districts in Arizona, Colorado, New Jersey, and Wisconsin opportunities to engage in technology-based learning in a culturally responsive setting through summer workshops and after-school courses (Zacharias, 2014).

04 CONCLUSION

Strong STEM instruction has the ability to engage all students in authentic critical thinking experiences and to prepare the nation's students to become lifelong learners and problem-solvers as well as career-ready for the jobs of the 21st century. While states, districts, and schools tackle the issue of defining what effective STEM education and teaching and learning look like, they need not seek solutions on their own. Many parents, community members, universities, and even tech industry leaders like Google have heard the call and are offering their support. Preparing the next generation to be scientifically literate is the responsibility of many, and it starts with difficult conversations about what we want our students to know (and what they need to know) about science, technology, and engineering.

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.

REFERENCES

Beaudoin, C. R., Johnston, P. C., Jones, L. B., & Waggett, R. J. (2013). University support of secondary STEM teachers through professional development. *Education, 133*(3), 330.

Ben-David Kolikant, Y. (2011). Computer science education as a cultural encounter: A socio-cultural framework for articulating teaching difficulties. *Instructional Science: an International Journal of the Learning Sciences, 39*(4), 543–559. DOI: 10.1007/s11251-010-9140-7

Emdin, C. (2009). Reality pedagogy: Hip hop culture and the urban classroom. In W. M. Roth (Ed.), *Science education from people to people* (pp. 70-77). New York, NY: Routledge.

Framework & Standards. (n.d.) *In Computer Science for All in SF.* Retrieved from http://www.csinsf.org/standards--framework.html

Heitin, L. (2016, August 31). *Here's What We Know About the Next Generation Science Standards Tests.* [Blog Post] Retrieved from http://blogs.edweek.org/edweek/curriculum/2016/07/next_generation_science_standards_lessons.html

Holden, J. P., & Lander, E. (2010, September 15). *Executive Report Prepare and Inspire: K–12 Science, Technology, Engineering, and Math (STEM) Education for America's Future*. Retrieved from http://files.eric.ed.gov/fulltext/ED516009.pdf

Hutchison, L. F. (2012). Addressing the STEM teacher shortage in American schools: Ways to recruit and retain effective STEM teachers. *Action in Teacher Education, 34*(5-6), 541–550.

Jona, K. Network of STEM Education Centers. (2006). *In Center Profiles.* Retrieved from http://serc.carleton.edu/StemEdCenters/profiles/74065.html

Moore, T. J., Tank, K. M., Glancy, A. W., & Kersten, J. A. (2015). NGSS and the landscape of engineering in K–12 state science standards. *Journal of Research in Science Teaching, 52*(3), 296–318.

Nathan, M. J., Tran, N. A., Atwood, A. K., Prevost, A., & Phelps, L. A. (2010). Beliefs and expectations about engineering preparation exhibited by high school STEM teachers. *Journal of Engineering Education, 99*(4), 409–426.

National Science Teachers Association (NSTA) Position *Statement: The Next Generation Science Standards.* (2013). Retrieved from National Science Teachers Association: http://www.nsta.org/about/positions/ngss.aspx

Next Generation Science Standards Lead States. (2013). *Next Generation Science Standards: For States, By States (Lead State Partners)*. Washington, DC: The National Academies Press.

Sapers, J. (2015, February 26). *Common Core's unintended consequence? More teachers write their own curricula.* Retrieved from http://www.pbs.org/newshour/updates/common-cores-unintended-consequence-teachers-write-curricula./

Stephenson, C., & Wilson, C. (2012). Reforming K–12 computer science education... what will your story be? *ACM Inroads, 3*(2), 43–46.

Zacharias, M.C. (2014, December 12). *CompuGirls: Young women have role to play in technology field.* Retrieved from https://nsf.gov/discoveries/disc_summ.jsp?cntn_id=133634&org=NSF.