How might we ensure teachers have access to quality STEM instructional materials?

FEW TEACHERS HAVE OPPORTUNITIES TO ENGAGE WITH CURRENT STEM CONTENT AND INDUSTRY.

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CONTEXT AND TRENDS

In recent years, the emphasis on providing students with quality education in the science, technology, mathematics, and engineering (STEM) disciplines has increased. In particular, a focus on real-world applications of STEM skills has been stressed, as STEM education is seen as crucial for workforce development (Volmert, Baran, Kendall-Taylor, & O'Neil, 2013). However, there is currently a shortage of teachers with the training and content knowledge needed to teach the STEM skills that will prepare students to address social and economic challenges in the world (Volmert et al., 2013). Since knowledge in STEM fields is rapidly changing, teachers require preparation and support to develop and maintain current understanding of the progress made in these disciplines (Foster, 2010). One way to support teachers in strengthening their STEM expertise is to provide high-quality instructional resources in the form of partnerships with others, such as STEM industry experts, university faculty, and STEM teachers across disciplines (Borgman et al., 2008; Foster, 2010; Volmert et al., 2013).

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DISCUSSION

Due to the rapid rate at which advancements are made in STEM fields in the 21st century, researchers have found that STEM teachers often do not have sufficient knowledge of current STEM careers and ways to implement instruction that supports students' preparation for these careers (Capobianco & Rupp, 2014; Hall, Dickerson, Batts, Kauffmann, & Bosse, 2011). As such, strong professional development programs are needed to strengthen and

maintain the currency of teachers' content knowledge, as well as their abilities to provide discipline-specific and integrated STEM learning experiences to their students. Forming partnerships between STEM teachers, university faculty, and STEM professionals is one way to strengthen teachers' practice by providing them with access to valuable sources of STEM expertise (Beaudoin, Johnston, Jones, & Waggett, 2013; Fulton & Britton, 2011).

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Partnerships between STEM teachers and university faculty, as well as among STEM teachers in different fields, have been effective at supporting teachers' growth. First, a variety of programs funded by the National Science Foundation's Math and Science Partnership program (2010) forged partnerships between universities and districts to support K–12 teachers. The nature of these collaborations varied but included, for example, K–12 teachers investigating new concepts with STEM faculty that they could use in their classrooms, as well as K–12 teachers and STEM faculty working together to lead professional development sessions. These partnerships between STEM teachers and university faculty enhanced teacher content knowledge, pedagogy, and self-efficacy in STEM teaching (Foster et al., 2010).

Additionally, partnerships that facilitate collaboration among STEM teachers across multiple subjects can effectively support teacher learning. Research shows that teachers who participated in learning teams with other K–12 STEM educators experienced multiple benefits, including the opportunity to engage in rich discussions about science and mathematics, improved STEM content understanding, and increased feelings of preparedness for teaching STEM content (Fulton & Britton, 2011). In particular, collaborating with STEM teachers in different fields can help teachers better integrate the STEM disciplines, an often unrealized goal of many STEM initiatives (Wells, 2008). Furthermore, collaborating with other STEM teachers who have previously worked in industry can be especially effective at supporting teacher learning.

Moreover, drawing on the knowledge of experts with experience in industry can help teachers improve their understanding of how STEM content is applied in real-world practice, thereby allowing them to teach STEM content in more applied ways (Hutchinson, 2013). Indeed, incorporating STEM professionals into education programs is considered a best practice, as professionals can offer key areas of expertise to STEM teachers who have not had experience in the field (Volmert et al., 2013). A report from the National Commission on Teaching and America's Future found that STEM professionals can provide a variety of resources to teachers, from "sharing special expertise, career experiences, or personal stories of professional achievement" to "coaching teachers-in-training or teachers who are trying to develop new skills (such as integrating technology into the classroom)" (Foster, 2010, p. 9). Foster (2010) also suggests that teachers and STEM professionals might collaborate in curriculum development and project design, and that professionals can both share content-related expertise and connect teachers with leaders in industry. However, while many individuals in local communi-

ties apply STEM content in their work (Nadelson, Seifert, & McKinney, 2014), determining how to form and maintain teacher–professional partnerships can be a challenge (Hodges, Grant, & Polly, 2013).

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BRIGHT SPOTS

Despite the challenges of sustaining partnerships, there are many programs, schools, and school districts working to improve teachers' access to high-quality instructional resources by facilitating collaborative partnerships between teachers and industry professionals, university faculty, and other STEM experts (e.g. Capobianco & Rupp, 2014; Foster, 2010; Fulton & Britton, 2011). One model of this type of support is the Kenan Fellows Program at North Carolina State University.

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The mission of the Kenan Fellows Program is to "advance K–12 STEM education by providing educators with relevant, real-world professional learning and leadership development, through innovative collaborations with partners committed to 21st-century education and workforce preparation." Kenan Fellows participate in a two-year program in which they take part in professional development institutes, conferences, seminars, and summer externships with industry and university scientists who act as mentors (Powell-Moman & Brown-Schild, 2011). With guidance from these mentors, fellows enhance their content knowledge and improve classroom instruction by developing an inquiry-based curriculum project. Fellows also learn about modern technology tools that they can utilize in their classrooms, as well as progressions in STEM fields that are leading to new areas of need in STEM careers and education. To expand the program's reach, alumni take on leadership roles, working to improve STEM education and collaboration in their own schools and communities. In an analysis of 23 fellows who participated in the program from 2008 to 2010, fellows reported both increased feelings of self-efficacy for inquiry-based teaching and a greater focus on the depth of concepts taught, rather than the breadth of topics covered (Powell-Moman & Brown-Schild, 2011).

A variety of other programs also work to provide teachers with access to STEM experts and instructional resources. Several of these are the Partnership in Innovative Preparation for Educators and Students (PIPES; Abrams and Khaliqui, 2013), the Economic Opportunities Through Education by 2015 initiative (EcO Network; Foster, 2010), Citizen Schools, and the i-STEM professional development program (Nadelson, Seifert, Moll, & Coats, 2012). The National Aeronautics and Space Administration also offers many online and in-person professional development opportunities for K–12 teachers. Finally, given the recent explosion of the technology industry, partnerships between teachers and technology companies have increased. For example, the Information Technology Industry Council (2010) released a report entitled Educating the Innovators of Tomorrow: A High-Tech Industry Blueprint, which highlighted the many collaborations between K–12 teachers and technology companies, such as Intel, Micron, Microsoft, and Hewlett-Packard.

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CONCLUSION

To enable teachers to provide high-quality STEM education to students, policies and incentives must be established to encourage K–12 educators, university faculty, and industry experts to form meaningful collaborations. These communities can work together to share knowledge and develop high-quality instructional resources that allow teachers to provide a relevant and engaging STEM education to their students. Due to the rapid changes in STEM fields, the imperative to connect K–12 educators with experts in the field who can provide access to current content knowledge is increasingly urgent (Foster, 2010; Volmert et al., 2013). While many promising partnerships currently exist, STEM professionals often remain an untapped resource for helping to strengthen the quality of STEM education in the United States.

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

Abrams, G. D., & Khaliqi, D. H. (2013). *Partnership in Innovative Preparation for Educators and Students (PIPES)*. DTIC Document. Retrieved from http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA597339

Beaudoin, C., Johnston, P., Jones, L., & Waggett, R. (2013). University support of secondary stem teachers through professional development. *Education*, 133(3), 330–339.

Borgman, C. L., Abelson, H., Dirks, L., Johnson, R., Koedinger, K. R., Linn, M. C., Lynch, C.A., Oblinger, D.G., Pea, R.D., Salen, K., Smith, M.S., & Szalay, A. (2008). *Fostering learning in the networked world: The cyberlearning opportunity and challenge. A 21st-century agenda for the National Science Foundation.* Report of the NSF Task Force on Cyberlearning. Retrieved from https://works.bepress.com/borgman/329/

Capobianco, B. M., & Rupp, M. (2014). STEM Teachers' Planned and Enacted Attempts at Implementing Engineering Design-Based Instruction. *School Science and Mathematics*, 114(6), 258–270.

Foster, E. (2010). A New Equation: How Encore Careers in Math and Science Education Equal More Success for Students. *National Commission on Teaching and America's Future.* Retrieved from http://eric.ed.gov/?id=ED512647

Foster, K. M., Bergin, K. B., McKenna, A. F., Millard, D. L., Perez, L. C., Prival, J. T., Rainey, D.Y., Sevian, H.M., VanderPutten, E.A., & Hamos, J. E. (2010). Partnerships for STEM Education. *Science*, 329(5994), 906–907. Retrieved from http://doi.org/10.1126/science.1191040

Fulton, K., & Britton, T. (2011). *STEM Teachers in Professional Learning Communities: From Good Teachers to Great Teaching*. Washington, DC: National Commission on Teaching and America's Future.

Hall, C., Dickerson, J., Batts, D., Kauffmann, P., & Bosse, M. (2011). Are we missing opportunities to encourage interest in STEM fields? *Journal of Technology Education*, 23(1) Retrieved from http://scholar.lib.vt.edu/ejournals/JTE/v23n1/hall

Hodges, C. B., Grant, M., & Polly, D. (2013). Beyond one-shot workshops: Three approaches to STEM teacher professional development. In *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 4795–4800). Retrieved from https://www.editlib.org/p/48887/proceeding_48887.pdf

Hutchinson, J. (2013). *School organisation and STEM career-related learning*. York, UK: National STEM Center. Retrieved from http://derby.openrepository.com/derby/handle/10545/303288

Information Technology Industry Council. (2010). *Educating the Innovators of Tomorrow: A High-Tech Industry Blueprint*. Retrieved from http://content.yudu.com/Library/A1p3tj/EducatingtheInnovato/resources/index.htm?

Nadelson, L. S., Seifert, A., Moll, A. J., & Coats, B. (2012). i-STEM summer institute: An integrated approach to teacher professional development in STEM. *Journal of STEM Education: Innovations and Research*, 13(2), 69.

Nadelson, L., Seifert, A. L., & McKinney, M. (2014). *Place-Based STEM: Leveraging Local Resources to Engage K–12 Teachers in Teaching Integrated STEM and for Addressing the Local STEM Pipeline*. Presented at the 2014 ASEE Annual Conference, Indianapolis, IN. Retrieved from https://peer.asee.org/22916

National Science Foundation. (2010). *Math and Science Partnership Program: Strengthening America by advancing academic achievement in mathematics and science*. Arlington, VA: Author. Retrieved from https://www.nsf.gov/pubs/2010/nsf10046/nsf10046.pdf?WT.mc_id=USNSF_80

Powell-Moman, A. D., & Brown-Schild, V. B. (2011). The influence of a two-year professional development institute on teacher self-efficacy and use of inquiry-based instruction. *Science Educator*, 20(2), 47.

Volmert, A., Baran, M., Kendall-Taylor, N., & O'Neil, M. (2013). *"You have to have the basics down real well": Mapping the gaps between expert and public understandings of STEM Learning*. Washington, DC: FrameWorks Institute. Retrieved from http://www.nuestroframework.net/assets/files/PDF_STEM/STEMMTG10-18-13_proofedandformatted.pdf

Wells, J. G. (2008). *STEM education: The potential of technology education*. In 95th Mississippi Valley Technology Teacher Education Conference, St. Louis, MO (Vol. 41). Retrieved from http://www.mississippivalley.org/wp-content/uploads/2015/12/Wells_2008_MississippiValleyConference_STEM-ED_TE-Potential.pdf