Shifts in funding for science curriculum design and their (unintended) consequences

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Shifts in funding for science curriculum materials design and their (unintended) consequences

Abstract

Federal agencies in the Unites States invest heavily in the development of science curriculum materials, which can significantly facilitate science education reform. The current study describes the characteristics of K-12 science curriculum materials produced by federally funded projects between 2001 and 2010, and examines how these shifted over time as a result of changes in funding priorities. The portfolio review revealed a shift away from comprehensive curriculum, an overall decrease in some educative teacher supports, and an increase in reliance on technology-based materials. Moreover, findings revealed increasing support for research alongside development and for open access. Possible unintended consequences of these shifts are discussed pertaining to the depth of changes in teaching and learning, and to the scalability of materials.

Introduction

Federal policy makers in the United States have an active and enduring interest in science, technology, engineering and mathematics (STEM) education (Bybee, 2013; National Academies, 2007). Annual federal investments for STEM education are typically in the range of $2.8 to $3.4 billion (Gonzalez & Kuenzi, 2014), with a substantial portion of this spending supporting the development of curriculum materials intended to improve the quality of science teaching and learning (IES, 2008; Singer & Tuomi, 1999). These curriculum materials serve as tools that teachers can use to enact changes, and as such are important vehicles for reform (Carlson & Anderson, 2002; Remillard, Harris, & Agodini, 2014).

Landmarks in the history of science education reform in the United States, and in the ways policy makers and educators envisaged curriculum materials, came about in the 1990s with the publication of Benchmarks for Science Literacy (AAAS, 1993) and the National Science Education Standards (NRC, 1996). These documents signified a joint statement from the science and science education communities about what all students should understand and be able to do as a result of their school learning experiences (Carlson & Anderson, 2002), and laid the foundation for more recent reform movements. Moreover, they also provided a framework for focused science education funding from federal agencies (NRC, 2007) which, through their program solicitations, have had important influence on the direction of science education reform (Earle, 2011).

There are two compelling reasons to investigate how federal programs have historically shaped science curriculum development efforts. First, in an era of heightened scrutiny of federal spending, justification is needed for the expenditure of public monies on these programs (Milesi, Brown, Hawkley, Dropkin, & Schneider, 2014). Second, as funding priorities change over time to fit into the larger policy context, an examination of the potential (unintended) consequences of these shifts is crucial to guide future funding decisions as well as research and development efforts. In this paper we attempt to chart this territory by examining how shifts in funding priorities between 2001 and 2010 are reflected in the characteristics of funded K-12 science curriculum materials.

In the following sections we first provide a brief overview of the two major federal agencies supporting the development of curriculum materials for K-12 science education in the United States, and discuss changes in their funding priorities over time. We then describe key design features distilled from the literature and used to guide our analysis of the curriculum materials developed by the funded projects.

Portions of this publication are available only upon request. Please contact the authors.

References

Abramovich, S., Schunn, C., D., & Correnti, R. J. (2013). The role of evaluative metadata in an online teacher resource exchange. *Educational Technology Research & Development, 61*, 863-883.

Agresti, A. (2007). *An introduction to categorical data analysis.* Hoboken, NJ: John Wiley & Sons, Inc.

American Association for the Advancement of Science (AAAS) (1993). *Benchmarks for science literacy*. Washington, D.C.: AAAS.

Anderson, T. & Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher*, *41*(1), 16–25.

Belland, B., Walker, A., Olsen, M., & Leary, H. (2015). A Pilot Meta-Analysis of Computer-Based Scaffolding in STEM Education. *Educational Technology & Society, 18* (1), 183–197.

Bismack, A., Arias, A. M., Davis, E., & Palincsar, A. (2015). Examining student work for evidence of teacher uptake of educative curriculum materials. *Journal of Research in Science Teaching, 52*(6), 816-846.

Blake, C. & Scanlon, E. (2007). Reconsidering simulations in science education at a distance: features of effective use. *Journal of Computer Assisted Learning*, *23*(6), 491-502.

Borgman, C., Abelson, H., Dirks, L., Johnson, R., Koedinger, K., Linn, M., Lynch, C., Oblinger, D., Pea, R., Salen, K., Smith, M., & Azalay, A. (2008). *Fostering learning in the networked world: The cyberlearning opportunity and challenge*. Report of the NSF task force on cyberlearning. Retrieved from: http://www.nsf.gov/pubs/2008/nsf08204/nsf08204.pdf

Bybee, R. (2013). *The case for STEM education: Challenges and opportunities*. Arlington, VA: National Science Teachers Association.

Carlson, J. & Anderson, R. (2002). Changing teachers' practice: Curriculum materials and science education reform in the USA. *Studies in Science Education, 37*(1), 107-135.

Cervetti, G., Kulikowich, J., & Bravo, M. (2015). The effects of educative curriculum materials on teachers' use of instructional strategies for English language learners in science and on student learning. *Contemporary Educational Psychology, 40*, 86-98.

Cheng, M. T., Chen, J. H., Chu, S. J., & Chen, S. Y. (2015). The use of serious games in science education: A review of selected empirical research from 2002 to 2013. *Journal of Computers in Education*, *2*(3), 353-375.

Chingos, M. & Whitehurst, G. (2012). *Choosing Blindly: Instructional Materials, Teacher Effectiveness, and the Common Core*. Brookings Institution. Retrieved from http://www.brookings.edu/~/media/research/files/reports/2012/4/10%20curriculum%20chingos%20whitehurst/0410_curriculum_chingos_whitehurst.pdf

Clements, D. (2007). Curriculum Research: Toward a Framework for Research-Based Curricula. *Journal for Research in Mathematics Education*, *38*(1), 35-70.

Conole, G. (2013). *Designing for Learning in an Open World.* Explorations in the Learning Sciences, Instructional Systems and Performance (Vol. 4). Springer, Science & Business Media.

Davis, E. & Krajcik, J. (2005). Designing educative curriculum materials to promote teacher learning. *Educational researcher*, *34*(3), 3-14.

Davis, E., Palincsar, A., Arias, A. M., Bismack, A., Marulis, L., & Iwashyna, S. (2014). Designing educative curriculum materials: A theoretically and empirically driven process. *Harvard Educational Review*, *84*(1), 24-52.

Dede, C. (2005). Why design-based research is both important and difficult. *Educational Technology*, *45*(1), 5-8.

Design-Based Research Collective (DBRC) (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher*, *32*(1), 5–8.

Devolder, A., van Braak, J., & Tondeur, J. (2012). Supporting self-regulated learning in computer-based learning environments: systematic review of effects of scaffolding in the domain of science education. *Journal of Computer Assisted Learning*, *28*(6), 557-573.

Drake, C., Land, T., & Tyminski, A. (2014). Using educative curriculum materials to support the development of prospective teachers' knowledge. *Educational Researcher*, *43*(3), 154-162.

Earle, J. (2011). How do funding agencies at the federal level inform the science education policy agenda? The case of the National Science Foundation. In G.E. DeBoer (Ed.). *Role of Public Policy in K-12 Science Education*. Greenwich, CT, USA: Information Age Publishing.

Feder, M., Ferrini-Mundy, J. & Heller-Zeisler, S. (2011). *The federal science, technology, engineering, and mathematics (STEM) education portfolio*. A Report from the Federal Inventory of STEM Education Fast-Track Action Committee. Committee on STEM Education, National Science and Technology Council. Retrieved from https://www.whitehouse.gov/sites/default/files/microsites/ostp/costem__federal_stem_education_portfolio_report.pdf

Feuer, M., Towne, L., & Shavelson, R. (2002). Scientific culture and educational research. *Educational Researcher, 31*(8), 4-14.

Fishman, B., Penuel, W., Allen, A., Cheng, B., & Sabelli, N. (2013). Design-based implementation research: An emerging model for transforming the relationship of research and practice. *National Society for the Study of Education Yearbook*, *112*(2), 136-156.

Fortus, D. & Krajcik, J. (2012). Curriculum coherence and learning progressions. In B.J. Fraser et al., *Second international handbook of science education* (pp. 783-798). Springer Netherlands.

Gonzalez, H. & Kuenzi, J. (2014). *Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer*. Congressional Research Service. Retrieved from http://digital.library.unt.edu/ark:/67531/metadc122233/m1/1/high_res_d/R42642_2012Aug01.pdf

Grossman, P. & Thompson, C. (2008). Learning from curriculum materials: Scaffolds for new teachers? *Teaching and Teacher Education*, *24*(8), 2014-2026.

Hohlfeld, T., Ritzhaupt, A., Barron, A., & Kemker, K. (2008). Examining the digital divide in K-12 public schools: Four-year trends for supporting ICT literacy in Florida. *Computers & Education, 51,* 1648-1663.

Inan, F. & Lowther, D. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development*, *58*(2), 137-154.

Institute of Education Sciences (IES) (2007). Toward a Learning Society. Director's Biennial Report to Congress (IES 2007-6004). Washington D.C.: U.S. Department of Education. Retrieved from https://ies.ed.gov/director/pdf/20076004.pdf

Institute of Education Sciences (IES) (2008). *Rigor and Relevance Redux.* Director's Biennial Report to Congress (IES 2009-6010). Washington D.C.: U.S. Department of Education. Retrieved from: http://ies.ed.gov/director/pdf/20096010.pdf

Institute of Education Sciences (IES) (2009). Request for applications. Education Research Grants. Retrieved from http://ies.ed.gov/funding/pdf/2009_84305A.pdf

Institute of Education Sciences (IES) (2011). Request for applications. Education Research Grants. Retrieved from http://ies.ed.gov/funding/pdf/2012_84305A.pdf

Institute of Education Sciences (IES) (2014). Request for applications. Education Research Grants. Retrieved from http://ies.ed.gov/funding/pdf/2014_84305A.pdf

Klahr, D., Triona, L. M., & Williams, C. (2007). Hands on what? The relative effectiveness of physical versus virtual materials in an engineering design project by middle school children. *Journal of Research in Science teaching*, *44*(1), 183-203.

Krajcik, J., McNeill, K. L., & Reiser, B. J. (2007). Learning-goals-driven design model: Developing curriculum materials that align with national standards and incorporate project-based pedagogy. *Science Education*, *92*(1), 1-32.

Linn, M. (2003). Technology and science education: starting points, research programs, and trends. *International Journal of Science Education*, *25*(6), 727-758.

Looi, C., Sun, D., Wu, L., Seow, P., Chia, G., Wong, L., Soloway, E., & Norris, C. (2014). Implementing mobile learning curricula in a grade level: Empirical study of learning effectiveness at scale. *Computers & Education*, *77*, 101-115.

McKenney, S. & Reeves, T. (2012). *Conducting Educational Design Research*. Routledge.

Milesi, C., Brown, K., Hawkley, L., Dropkin, E., & Schneider, B. (2014). Charting the Impact of Federal Spending for Education Research A Bibliometric Approach. *Educational Researcher, 43*(7), 361-370.

National Academy of Sciences, National Academy of Engineering, & Institute of Medicine (2007). *Rising above the gathering storm. Energizing and employing America for a brighter economic future*. Washington, D.C.: National Academies Press.

National Research Council (NRC) (1996). *National science education standards*. Washington, D. C: National Academy Press.

National Research Council (NRC) (1999). *Designing mathematics or science curriculum programs: A guide for using mathematics and science education standards*. Washington, D.C.: National Academy Press.

National Research Council (NRC) (2007). *Taking Science to School: Learning and Teaching Science in Grades K-8*. Washington, D.C.: National Academy Press.

National Science Foundation (2014). *Strategic Re-envisioning for the Education and Human Resources Directorate*. A Report to the Directorate for Education and Human Resources National Science Foundation. Retrieved from http://www.nsf.gov/ehr/Pubs/AC_ReEnvisioning_Report_Sept_2014_01.pdf

National Science Foundation (2002a). *Instructional Materials Development* (Document No. NSF 02-067). Retrieved from http://www.nsf.gov/pubs/2002/nsf02067/nsf02067.html

National Science Foundation (2002b). *Information Technology Experiences for Students and Teachers* (Document No. NSF 02-147). Retrieved from http://www.nsf.gov/pubs/2002/nsf02147/nsf02147.htm

National Science Foundation (2003). *Instructional Materials Development* (Document No. NSF 03-524). Retrieved from http://www.nsf.gov/pubs/2003/nsf03524/nsf03524.htm

National Science Foundation (2004). *Instructional Materials Development* (Document No. NSF 04-562). Retrieved from http://www.nsf.gov/pubs/2004/nsf04562/nsf04562.pdf

National Science Foundation (2006). *Discovery Research K-12* (Document No. NSF 06-593). Retrieved from http://www.nsf.gov/pubs/2006/nsf06593/nsf06593.htm

National Science Foundation (2008a). *Innovative Technology Experiences for Students and Teachers* (Document No. NSF 08-526). Retrieved from http://www.nsf.gov/pubs/2008/nsf08526/nsf08526.htm

National Science Foundation (2008b). *Discovery Research K-12* (Document No. NSF 08-502). Retrieved from http://www.nsf.gov/pubs/2008/nsf08502/nsf08502.htm

Penuel, W., Fishman, B., & Cheng, B. (2011). Developing the area of design-based implementation research. Menlo Park, CA: SRI International.

Penuel, W., Fishman, B., Cheng, B., & Sabelli, N. (2011). Organizing research and development at the intersection of learning, implementation, and design. *Educational Researcher*, *40*(7), 331-337.

Puntambekar, S., & Hübscher, R. (2005). Tools for scaffolding students in a complex learning environment: What have we gained and what have we missed? *Educational psychologist*, *40*(1), 1-12.

RAND Mathematics Study Panel (2003). *Mathematical proficiency for all students: Toward a strategic research and development program in mathematics education* (Publication No. MR1643.0OERI). Santa Monica, CA: RAND.

Reiser, B. (2004). Scaffolding complex learning: The mechanisms of structuring and problematizing student work. *The Journal of the Learning Sciences*, *13*(3), 273-304.

Remillard, J. T., Harris, B., & Agodini, R. (2014). The influence of curriculum material design on opportunities for student learning. *ZDM Mathematics Education, 46*(5), 735-749.

Roseman, J. E., Linn, M. C., & Koppal, M. (2008). Characterizing curriculum coherence. In J. Kali, M. Linn, J.E. Rosseman (Eds), *Designing coherent science education: Implications for curriculum, instruction, and policy* (13-36). Teachers College, Columbia University.

Rutten, N., van Joolingen, W. R., & van der Veen, J. T. (2012). The learning effects of computer simulations in science education. *Computers & Education*, *58*(1), 136-153.

Singer, M. & Tuomi, J. (Eds.). (1999). *Selecting Instructional Materials: A Guide for K-12 Science*. National Academies Press.

Van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher–student interaction: A decade of research. *Educational Psychology Review*, *22*(3), 271-296.

Webb, M. E. (2005). Affordances of ICT in science learning: implications for an integrated pedagogy. *International journal of science education*, *27*(6), 705-735.

Zhang, M. (2014). Who are interested in online science simulations? Tracking a trend of digital divide in Internet use. *Computers & Education*, *76*, 205-214.