Comments on America COMPETEs Act Reauthorization
In Response to the House Science and Technology Committee
Survey on K-12 STEM Education Programs
By The Association for Computing Machinery &
The Computer Science Teachers Association

Thank you for soliciting community response to your survey related to federal science, technology, engineering and mathematics (STEM) education programs as the House Science and Technology Committee begins its work toward reauthorizing the America COMPETEs Act. The Association for Computing Machinery (ACM) – the largest professional society in the world for computing professionals – and the Computer Science Teachers Association (CSTA) – a national membership organization representing more than 8000 practitioners – are deeply committed to improving STEM education. As you are aware, our particular interest is in strengthening the quality and quantity of computer science education, especially in K-12 education. As the COMPETEs Act reauthorization moves forward, we look forward to working with you, your colleagues and other stakeholders to ensure the issues unique to K-12 computer science education are addressed.

Computer Science in Federal K-12 STEM Education Programs

In what follows, ACM provides answers to selected questions from your survey. We start by answering question number nine: What additional recommendations for K-12 STEM education should be considered part of the reauthorization effort?

Our primary concern is ensuring that federal programs intended to improve STEM education specifically address computer science education. Computer science is both a distinct discipline and an integral part of STEM. It underlies the advances in many scientific disciplines and is innovation and driving economic growth. It is often mistakenly assumed that computer science is part of the STEM education being offered in K-12 education, yet our surveys of the educational landscape shows that is not the case.

Because of accountability provisions in No Child Left Behind and the focus of states on that Act’s “core” disciplines in developing high school graduation requirements, investments in curriculum, pedagogy and professional development are focused on “core” courses. We have also seen a pronounced shift toward the presumed state adoption of the work of the “Common Core Standards Initiative” and its “college and career ready standards” in the Race to the Top competitive grant guidance and in the President’s proposed Fiscal Year 2011 budget. In practice, this means schools, states and federal programs emphasize mathematics, reading and natural sciences.
Therefore, well-meaning federal legislation intended to improve STEM education broadly often does not include computer science at the state and local levels, since it is not typically considered part of this “core.”

This same issue plays out in programs authorized by the COMPETEs Act. For example, NSF’s Math and Science Partnership has five types of awards, including Targeted Partnerships intended for “a specific disciplinary focus in mathematics or the sciences.” At a high level, the program seems broadly STEM focused. In fact, the COMPETEs Act amended what was then current law to clarify the scope of the program to include all of the STEM disciplines. However, guidance to grant applicants asks specifically for baseline data on how the proposals will improve student achievement in math and/or science standards. This focus – intended or not – is discouraging to applicants hoping to address computer science and creates a barrier for our field. Similarly, the significant public investments in math and science assessments rarely address computer science. Therefore, computer science proposals have difficulty meeting the baseline data requirements. This puts computer science proposals at a distinct disadvantage relative to math and science proposals, and would-be applicants frustrated.

Confusion about where computer science “sits” in K-12 education also creates challenges for computer science education. Many observers assume that computer science is the “T” in STEM, but this is, by and large, not the case. Computer science education focuses on teaching fundamentals of computing just as core mathematics, physics, chemistry and biology courses teach fundamental concepts. K-12 technology education, in contrast, spans a diverse and wide range of technology concepts about applying the use of science, not the fundamentals of computer science and computational thinking that underpin the technologies of the 21st Century. Further, when computing courses are considered part of technology education, they often focus on post high school vocations in information technology versus the fundamental knowledge of computing that college-bound students need. And, unlike science and mathematics courses, technology courses are not in the “core” of what students must take to graduate. For organizational purposes often used in federal and state STEM education computer science does not fit into any of the STEM areas. It stands on its own and, as fields of science and computation come together, computer science is driving innovation in all the other STEM disciplines.

This same confusion stymies teacher certification processes and complicates the status of “highly qualified” computer science teachers, which has implications for multiple COMPETEs Act programs. For example, the MSP award category Teacher Institutes for the 21st Century was created by the COMPETEs Act. The scope of the program is to serve STEM teachers who “are considered highly qualified.” The COMPETEs Act references the underlying definition of “highly qualified” in the Elementary and Secondary Education Act (ESEA). One of the requirements for teachers to be highly
qualified is certification and demonstrated knowledge in the subject area in which they teach. (Other programs in COMPETEs that rely on the highly qualified criteria include Teachers for A Competitive Tomorrow and the Robert Noyce Teacher Scholarship Program.)

A recent study\(^1\) by CSTA illustrated the broken certification system in states for computer science teachers. It found deep confusion among practitioners and administrators about teacher certification for computer science teachers. Many states simply do not have certification for computer science teachers, and, where programs exist, they often have no connection to computer science content. As a result, computer science teachers often have to be certified in another discipline -- including sometimes in “business” because that is where vocational technology courses are placed in many schools. While computer science teachers may follow certain pathways to become highly qualified, it is not often as a computer science teacher, which creates a significant barrier for improving computer science teaching using STEM-related professional development programs.

**Legislative Recommendations**

Given the growing importance of computing in society and the need for students -- particularly those going into STEM fields -- to understand the fundamentals of computing, broad support from the federal government for computer science education is needed to catalyze reform. We specifically recommend that Congress develop a grant program for computer science education that focuses on the following goals:

- Explicitly define computer science’s place in STEM education programs (in particular those authorized by the COMPETEs Act) and establish clear findings on what computer science is and how it differs from technology education and the integration of technology into the classroom.
- Authorize funding for states to develop plans to strengthen computer science education at the state and local levels. These plans would need to address teacher preparation, professional development, development of challenging state academic standards and assessments for computer science, secondary school graduation requirements, and development of curriculum to implement the standards.
- Create a national blue ribbon commission of state officials, discipline experts, practitioner organizations and practitioners to review state computer science teacher certification requirements and share best practices and certification models that states could adopt.

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\(^1\) See [http://www.csta.acm.org/ComputerScienceTeacherCertification/sub/CertificationStudyReport.html](http://www.csta.acm.org/ComputerScienceTeacherCertification/sub/CertificationStudyReport.html)
• Authorize funding for states and local education agencies to implement computer science education plans.
• Authorize funding for building capacity at a national level to prepare young people to understand computing and its importance in the economy and to strengthen computer science education in the country’s K-12 public education system.

We recognize that the proposed legislative approach is likely to cross the jurisdiction of the House Science and Technology and the House Labor and Education Committees. We look forward to working collaboratively with both committees on these proposals.

Responses to Other Selected Survey Questions

1a) What should be the primary mission of the National Science Foundation at the K-12 level?

NSF should play a leading role within the federal government on STEM education programs within K-12. NSF is unique among federal agencies because it can link classroom instruction and informal education to cutting-edge discipline research by bringing together its research roots in numerous scientific and engineering disciplines and its STEM education programs. NSF is also well positioned to support programs that address research questions about how students learn generally and how they learn domain-specific concepts. In particular, when it comes to K-12 programs at NSF, the agency should support programs that seek innovative proposals and develop best practices to:

• Answer key questions about how students internalize scientific concepts and discipline specific knowledge;
• Promote student learning;
• Increase engagement in STEM;
• Improve professional development for teachers that focuses on both content and pedagogy; and,
• Develop and disseminate innovative curricula solidly grounded in research that employs learning strategies that truly engage and enrich students.

1b) What do you see as the appropriate balance between funding for basic research on education versus education program development/implementation grants at NSF?

There is a real need to conduct both general education and domain-specific research for STEM fields. In computer science education, there is little research on how students learn computing and computational thinking concepts. As noted above, this lack of
research hurts computer science curriculum development in programs that seek answers on how new approaches will change student performance from an established baseline. We need to develop this baseline in K-12 computer science education. Among all the agencies supporting education, NSF is best positioned to conduct this research. It should be a foundation priority.

However, because NSF is the lead agency for STEM education, it must also continue to support programs that develop specific programs for improving classrooms (including teacher development) and building capacity for education reform within the STEM fields. Other agencies do not appear to have the same degree of broad STEM focus that NSF does; therefore, program implementation grants should not be cut with the assumption that these programs will be addressed in other parts of the federal government.

2) What should be the primary mission of science agencies other than NSF regarding K-12 STEM education? Should they be primarily focused on developing the STEM content knowledge of students (and/or teachers), or should they be dedicated toward programs to inspire and excite children and the public about STEM?

Regardless of how a mission-specific agency focuses on the spectrum of STEM education activities – from supporting instruction to inspiring students – they need to develop STEM education programs that support the agency’s mission. Their mission informs them about the workforce or research challenges to be addressed through K-12 engagement. For example, DARPA recently launched a program, “Computer Science - Science, Technology, Engineering, and Mathematics (CS-STEM) education”\(^2\), focused on both informal and formal aspects of K-12 computer science education because the Department of Defense recognized that there needs to be a sufficient U.S.-born workforce in computing for security clearance purposes. The program recognizes the two major issues preventing this goal: 1) the current pipeline is showing indications of its inability to meet this need, and 2) students are not adequately exposed to the positive aspects of computer science education in the K-12 system, leading to a declining interest in postsecondary study of the discipline. Additionally, when an agency develops a program for K-12 STEM education, they need to survey other agencies to determine whether the goals of their program are covered elsewhere or how their program can be coordinated with existing programs.

3) Rank in order of importance how mission agencies should prioritize their K-12 STEM programming.

\(^2\)https://www.fbo.gov/index?s=opportunity&mode=form&id=88b3ebc24fb6377fac6b1107d8d96b84&tab=core&_cview=0
1) professional development for pre-service and in service teachers
2) curriculum development
3) informal education
4) partnering with or “adopting” schools through the networks of national labs and research facilities
5) supporting and coordinating volunteerism among the federal STEM workforce
6) bringing students into national labs and research facilities during the summer
7) helping build specialty STEM schools through networks of national labs and research facilities

5) How can agencies better disseminate STEM education materials to schools and the general public?

Agencies need to support professional associations (especially educational practitioner organizations) in the development, dissemination, and promotion of best practices and educational resources. For example, in the field of computer science, professional associations such as ACM and the Computer Science Teachers Association have been building the professional community and providing professional development and resources that are directly linked to learning and teaching priorities.

These organizations also provide the most direct link to those practitioners who, with sufficient support and relevant resources, are most likely to work for and achieve systemic and sustainable change. Their credibility within educator communities also allows them to tap volunteers who are willing and able to pilot, evaluate, and disseminate curricula and resources and to interact with parents who are key decision makers regarding their children's educational pathways and career choices.

About

Association for Computing Machinery (ACM)

With over 90,000 members worldwide, the Association for Computing Machinery is the world’s largest educational and scientific computing society, uniting computing educators, researchers and professionals to inspire dialogue, share resources and address the field’s challenges. ACM strengthens the computing profession’s collective voice through strong leadership, promotion of the highest standards, and recognition of technical excellence. ACM supports the professional growth of its members by providing opportunities for life-long learning, career development, and professional networking.
Computer Science Teachers Association (CSTA)

The Computer Science Teachers Association is a professional membership organization committed to supporting the teaching and learning of computer science in K-12. Formed in 2005, it now encompasses more than 7,300 members, primarily practitioners teaching in K-12. CSTA is a national leader in the conduct of academic research and the provision of professional development for teachers and the distribution of teaching, learning, and informational resources focused on computer science.