



Association for  
Computing Machinery

*Advancing Computing as a Science & Profession*

Comments on Draft NSB/EHR-07-9  
**A NATIONAL ACTION PLAN FOR ADDRESSING THE CRITICAL NEEDS OF  
THE U.S. SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS  
EDUCATION SYSTEM**

The Association for Computing Machinery (ACM) submits the following comments on the National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics (STEM) System.

With over 80,000 members worldwide, ACM is an educational and scientific society uniting the world's computing educators, researchers and professionals to inspire dialogue, share resources and address the field's challenges. ACM strengthens the 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.

We agree with the National Science Board (NSB) on the value of STEM education to the nation, and share the Board's concerns that much more must be done improve STEM education and attract more students to this field. We also welcome the NSB's statement that STEM education is a core mission for the National Science Foundation (NSF).

We are particularly concerned with computer science education. This field has driven innovations that have created entirely new economic sectors, such as the World Wide Web, and technologies that are now vital to peoples' daily lives. Statistics from the National Science Foundation and the Bureau of Labor Statistics show that demand for graduates in computing and mathematical science fields far outstrip the supply of graduates.<sup>1</sup> With computers and computer science playing a part in other high-technology fields, the need for graduates with computer science skills is even greater. Just like other STEM disciplines, computer science is challenged to fill this future need. This makes declining interest in computer science in the k-12 system and among undergraduates troubling. From 2002–2004 while AP exam taking in other disciplines rose overall by 19%, the number of students taking the computer science A exam dropped by 8%, and the number taking the computer science AB exam decreased by 19%. Further, undergraduate enrollments in computer science have dropped by 39% from their height in 2002. Increasing participation in all STEM disciplines is important, and increasing participation in computer science is critical to filling this gap between supply and demand in computing-related fields.

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<sup>1</sup> See chart 5 on the Computing Research Association's workforce webpage:  
<http://www.cra.org/govaffairs/itworkforce.php>

As the NSB goes forward with this action plan, we want to ensure that computer science is a principal part of any STEM education policy action. We are generally supportive of the report and of other efforts to improve STEM education. Our comments that follow should be considered from that perspective.

### **Comments Related to Computer Science**

While the report avoids defining what constitute STEM disciplines, there are parts of the report that appear to exclude certain parts of the STEM education environment. Examples include:

- The recommendation that “The *National Science Foundation* should lead an effort to create a national roadmap to improve pre-kindergarten to college (P-16) STEM education, drawing on its national standing in the science and engineering communities and its expertise in science and engineering research and education” and the supporting text leave it unclear whether NSF will focus on all aspects of STEM education. This recommendation should direct NSF to draw on all of the disciplines within STEM and in which NSF has national standing – e.g., mathematics, physical science, computer science, engineering – and all of the grade levels in P-16. For example, NSF should draw upon the resources of the Computer and Information Science and Engineering Directorate, the Education and Human Resources Directorate, and the computing community to include computer science in the proposed roadmap.
- The list of organizations that should be considered for positions on the National Council for STEM Education (Appendix A) fails to include any representation from computing or computing education. The Computer Science Teachers Association should be considered in the STEM Educators group, and the Association for Computing Machinery, along with the Computing Research Association, should be considered in the STEM Disciplinary Societies group.

There is an unfortunate tendency in STEM education to look at technology and computers in a very narrow context – as tools used in support of education. Computers represent more than just tools. They embody a field of knowledge and ways of thinking that have transformed society. The Action Plan can better distinguish between the use of educational technology (tools) to support learning across the curriculum and computer science education as an academic discipline (knowledge) that involves scientific concepts such as algorithms, representation, abstraction, decomposition, and complexity. These ideas are critical to our field as well as economic competitiveness, and are not taught as part of the other sciences. It is therefore crucial that computer science be explicitly identified as a STEM discipline.

## **General Comments**

The main recommendations of the Action Plan – greater coherence in the STEM education system and well-qualified and highly effective teachers – are consistent with the STEM education community’s consensus for some time now. An additional value of a more coherent STEM education system is less marginalization of some STEM disciplines. By emphasizing analytical, critical thinking and problem solving skills in addition to content knowledge, the Action Plan can better emphasize the connections between disciplines.

### *Coordination with Existing Efforts*

While the purposes of the National Council for STEM Education include serving as a clearinghouse for best practices in STEM Education, some of its purposes are more prescriptive. In these situations, such as the development of National STEM teacher certification standards (page 9), it is important to be mindful and aware of existing projects, as acknowledged in the text of the recommendation for national pre-K-12 STEM content guidelines (page 8).

Teacher standards are of particular interest in computer science. High school computer science teachers face major challenges in attaining certification to teach their subject. There is no conformity of requirements from state to state and no computer science requirements at all in many states. In states where there is no computer science certification available, computer science teachers must be certified in some other additional discipline. In states where certification for computer science exists, it is often highly problematic, requiring teachers to demonstrate knowledge in some discipline other than computer science (for example business or technical applications). The Computer Science Teachers Association has conducted extensive research and outreach in this area should inform any national effort. We would welcome coordinated work with the National Council on this issue.

### *Coordination and Organization of Federal Programs*

The Action Plan does not go into any detail about the proposed relationship between the NSTC Committee on STEM Education and the National STEM Education Council. As described, the two committees have distinctly different areas of STEM Education to cover, and it’s not clear to what extent the interaction between Federal STEM education programs and state and local governments – at least at the pre-K-12 level.

The Action Plan advocates that the Department of Education create a new Assistant Secretary of Education for STEM Education to better coordinate internal programs and with other agencies and organizations. The Plan does not say what level of control this position should have over the Department’s STEM programs. It is difficult, if not impossible, to coordinate programs within a Federal agency without authority to oversee related programs. The Plan should advocate that the position have authority (including over budget decisions, as appropriate) over all Department STEM Education programs.

## *Public Outreach*

We welcome the recommendation that NSF should engage in public awareness and appreciation efforts for STEM fields. Computing, as a field, is grappling with a public perception issue where its courses are concerned. ACM, through its Education Council, has undertaken an effort to educate students and parents about the opportunities a computer science education can afford.<sup>2</sup> In addition, several leaders of the computing community, including ACM, are engaged in a major effort to help shape the image of computing as a field.<sup>3</sup> We appreciate the investments in innovative computing education, and outreach efforts already made by NSF, and agree that more resources and coordination are needed to make a significant, long-term impact.

## **Conclusion**

Thank you for preparing this Action Plan and soliciting public comment. Computer science education is a fundamental part of the STEM education portfolio. It can prepare the future workforce with critical skills it needs in the 21<sup>st</sup> Century as computing-intensive fields become increasingly widespread in economies and society. We welcome the NSB's attention on issues related to STEM education and look forward to working with you to ensure that bolstering computer science education is a principal part of your efforts.

If you have any questions, or would like additional information, please contact Cameron Wilson, Director of ACM's Office of Public Policy, at 202-659-9711. We look forward to continued leadership from the National Science Board on STEM Education.

Sincerely,

Robert Schnabel, Ph.D.  
Chair  
Education Policy Committee, Association for Computing Machinery

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<sup>2</sup> See <http://computingcareers.acm.org/> for more information.

<sup>3</sup> See <http://imageofcomputing.com/> for more information on this effort.