

SCIENCE EDUCATION POLICY

ACS POSITION

America needs well-educated scientists and engineers to remain competitive in the global marketplace. To equip today's students with the skills to fill the technical jobs of tomorrow, we must improve science, technology, engineering, and mathematics (STEM) education at the K-12, undergraduate, and graduate levels. We also need to encourage talented people to enter science and engineering fields. To achieve these goals, policymakers should

- Enable lifelong, rigorous, inquiry-based science education in both formal and informal settings to improve the scientific understanding of all our citizens.
- Ensure adequate state and federal support for pre- and in-service teacher training to strengthen the quality of teaching and enhance student learning.
- Encourage the best and the brightest students, particularly those from under-represented groups, to pursue scientific careers.

In order to meet these goals, our nation must pursue a systematic approach to improving science education. Policymakers should see the education system as an integrated *pipeline*, a system with many different and interrelated elements that must be periodically evaluated and improved using the most *systematic* means possible. A systematic approach requires expanding proven approaches and methods that yield measurable results and also focusing much of our attention and creativity on areas where the science education pipeline is weakest.

In order to compete in the global economy, our nation must effectively recruit the best and brightest students—from every part of our society—into STEM fields. Policymakers at all levels of government should support widespread efforts to encourage more of our best and brightest students to study in the STEM subjects and pursue science and technology careers. We also must work to broaden the diversity of the science education pipeline and increase the participation of groups that are under-represented in the STEM fields.

IMPROVING K-12 SCIENCE EDUCATION

Preparing Well-Educated Teachers

- We support recruiting, retaining, and valuing teachers who are well prepared in science.
- We support lifelong, professional-development opportunities for science teachers that help improve both their content knowledge and pedagogical skills.
- We support creating opportunities for mid- and late-career science and technology professionals to contribute their expertise to the education system.

Implementing High Standards

- We encourage the development of rigorous, high-quality science standards.

- We support science as a core subject at all educational levels and an essential element of a well-rounded education, with the goal that all students should be proficient in science and all schools should be held accountable for student performance in science.
- We promote curricula that emphasize scientific reasoning and inquiry-based learning.

Facilitating Inquiry-Based Learning

- We consider it essential for schools to have adequate resources and facilities to promote inquiry-based learning and laboratory-based courses.
- We encourage partnerships between businesses and educational entities that enhance opportunities for students to learn in a hands-on environment and gain exposure to real-world science.

Building on Educational Research

- We support robust investments in educational research in order to improve student achievement in the STEM subjects.
- We support educational research efforts in the STEM subjects that guide the development of model programs, tools, and methods for improving the teaching and learning of science.

STRENGTHENING HIGHER EDUCATION

Investing in Higher Education Capacity and Infrastructure

- We support substantial investments to provide two- and four-year colleges and universities with modern facilities, instrumentation, and world-class infrastructure.
- We support efforts targeted at improving university capabilities to recruit students in the STEM fields, especially those from under-represented groups.
- We support initiatives to encourage partnerships between universities, industry, and business organizations that would strengthen, expand, and diversify the STEM education pipeline at all levels.

Strengthening STEM Teacher Education Programs

- We support efforts to improve coordination between teacher-education programs and STEM departments at higher education institutions.
- We support initiatives that improve the rigor of, and standards for, existing STEM teacher education programs, especially in the area of increased science content knowledge.
- We support the creation and expansion of dual-degree programs in teacher education designed to produce graduates with STEM degrees and concurrent teacher certification.

Improving the Alignment and Coordination of STEM-related K-12, Higher Education, and Workforce Programs

- We support the creation of formal coordinating councils to improve the alignment of K-12, higher education, and workforce training programs in the STEM subjects.
- We support systematic efforts across states to improve and align science standards and curricula.

Encouraging Student Research Opportunities

- We support the expansion of undergraduate research experiences, including support for summer, academic-year, and international projects.
- We support the development of opportunities for undergraduates to participate in external experiential research programs.

APPENDIX: SPECIFIC POLICY RECOMMENDATIONS FOR SCIENCE EDUCATION

POLICY RECOMMENDATIONS FOR K-12 EDUCATION

1. Preparing Well-Educated Teachers

- Ensure adequate funding for science teacher in-service professional development programs that use inquiry-based methods and student-centered learning.
- Provide financial incentives to encourage high school teacher participation in summer research and other external activities at higher education institutions, companies, and government laboratories.
- Require science teachers to take education courses that emphasize content knowledge, peer-reviewed research in science education and human cognition, and use of technology.
- Promote the use of appropriately certified teachers to teach science at all levels.
- Provide assistance to teachers through mentoring by master teachers, science specialists, or scientists.
- Ensure that working conditions for science teachers are consistent with National Science Education Standards and ACS guidelines and that teachers have adequate time for planning and preparation.
- Evaluate teacher effectiveness in multiple ways to identify professional development needs.
- Support adjunct teacher programs that provide opportunities for experienced science and technology professionals to bring their expertise into the classroom.

2. Implementing High Standards

- Develop inquiry-based science curricula, based on content frameworks such as those provided by the National Science Education Standards or AAAS Benchmarks, and include chemistry components at appropriate grade levels.
- Evaluate students' science achievement regularly, with evaluation instruments that incorporate content knowledge, hands-on activities, scientific process skills, and higher-level cognitive skills.
- Hold schools accountable for student performance in science.
- Mandate at least three years of laboratory-based science for all secondary school students, integrated across the disciplines and throughout the secondary school years, and including a scientific ethics component.
- Support the use of computers and web-based tools for appropriate purposes such as simulations, experimental investigations, and drills, but generally not as a complete replacement for laboratory experiences.
- Support the development of chemistry courses that present the broad scope of modern chemistry, including environmental protection and green chemistry.
- Support Advanced Placement, International Baccalaureate, or similar advanced programs as a second-year chemistry option.
- Support efforts to provide incentive grants to individual states to improve the quality of their science standards.

3. Facilitating Inquiry-Based Learning

- Provide support, such as scholarships, for high school student participation in science-focused experiential programs and activities during the school year and the summer.

- Ensure that science teachers have adequate facilities (classrooms and laboratories) and other resources necessary for safe hands-on, inquiry-based science instruction, supported by adequate budgets for supplies, equipment and equipment maintenance, and access to online resources.
- Establish school/business/government/professional society alliances for regular introduction of current STEM information into the classroom.
- Establish tax incentives to encourage business involvement in K-12 science education.
- Develop school- and community-based beyond-the-classroom science experiences for students and the general public.

4. Building on Educational Research

- Support development of national assessment instruments to identify factors that lead to successful science learning and work to strengthen those factors in every community.
- Support robust investments in educational research that provide the foundation for improved student achievement in the STEM subjects.

POLICY RECOMMENDATIONS FOR HIGHER EDUCATION

5. Investing in Higher Education Capacity and Infrastructure

- Support a healthy balance of approaches for research support, including individual investigator grants, collaborative grants, and research centers.
- Expand funding for graduate student support through traineeships and fellowships, and support opportunities for graduate students to participate in external experiential programs. Ensure that graduate teaching assistants and postdoctoral fellows are accorded appropriate compensation, benefits, and recognition.
- Encourage graduate student education and faculty promotion policies that value both teaching and research activities.
- Support construction or remodeling of chemistry facilities and funding for modern instructional laboratory equipment and instrumentation, including maintenance and faculty training.
- Establish and maintain online library resources and information retrieval services to provide access to current developments.
- Provide preferential assistance to students studying in the STEM subjects through existing student aid programs such as Pell Grants and the GI Bill.
- Provide assistance to evaluate, modernize and generally improve the content and curricula of science education programs in higher education.
- Make scholarship information widely available to prospective STEM students.
- Address systemically the advancement of members of under-represented groups into academic careers.

6. Strengthening STEM Teacher Education Programs

- Support development of programs for pre-service teachers that include both pedagogy and appropriate content so that future K-12 teachers can complete their teacher certification requirements within a typical four-year bachelor's degree program.
- Support efforts to improve coordination between teacher-education programs and STEM departments at higher education institutions.
- Establish scholarships to assist STEM students to pursue teaching careers.

- Support development of graduate degree programs designed to give teachers advanced content knowledge.
- Support teacher certification requirements that embody rigorous, inquiry-oriented, laboratory-based coursework.
- Modify existing teacher certification programs to permit experienced scientists to begin teaching after completing a suitable internship, with additional education credits required for permanent certification.

7. Improving the Alignment and Coordination of STEM-related K-12, Higher Education, and Workforce Programs

- Establish tax incentives to encourage individuals to enhance their technical competence through continuing education, and support development of retraining programs for individuals whose careers have been impacted by economic restructuring and outsourcing.
- Provide funding for programs, projects, and activities designed to attract and retain students from groups under-represented in the scientific disciplines.
- Ensure that students can transfer science course credits seamlessly between high schools, two- and four-year colleges, and universities.
- Establish alliances among two- and four-year institutions, businesses, government, and professional societies for curriculum revision, cooperative faculty activities, and sharing of resources and instrumentation.
- Support the improvement and alignment of workforce STEM training and education programs that are conducted outside of institutions of higher education.

8. Encouraging Student Research Opportunities

- Provide opportunities for sustained undergraduate research, including support for summer, academic-year, and international projects.
- Support development of opportunities for undergraduates to participate in external experiential research opportunities.
- Develop programs that allow majors in other sciences and non-science majors to experience chemical sciences research first-hand.