Recent Initiatives to Improve Alignment and Instructional Quality in Science Education in the States

Implications for Massachusetts

Center for Science Education
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INTRODUCTION

In 2007, the National Science Board issued a report that called attention to the state of science, technology, engineering, and mathematics education in the United States. Although the United States has been a leader in innovation in science and technology, the report found that "the education system is failing to ensure that *all* American students receive the skills and knowledge for success in the 21st century workforce."[1]

In addition, results on the Trends in International Mathematics and Science Study (2003) demonstrated that 8th and 12th graders in the United States did comparatively worse than their counterparts in other industrialized countries.[2] These findings are consistent with a number of reports over the past two decades that have warned of an impending crisis resulting from a misalignment of K–12 education programs with the requirements for knowledge and skills necessary in a global economy.

The lack of achievement in science and mathematics education in the United States has resulted in a situation where many students do not have the knowledge and skills to adequately prepare them for the workforce or postsecondary education. In fact, 30 percent of entering college students must take remedial science and mathematics classes to enter college work.[3]

Despite these national deficits in the STEM disciplines, Massachusetts has emerged as a national leader in science education. In 2005, Massachusetts 4th graders tied for first in the nation in science achievement and tied seven other states for second place in 8th-grade science.[4] Massachusetts science standards have been rated an A by the Fordham Foundation in a 2006 survey[5] of state standards, and the state was the first to include technology and engineering in its rigorous state standards.

However, there are serious concerns even in Massachusetts regarding whether a sufficient number of students are mastering a rigorous STEM course sequence, and whether talented students are selecting science and STEM careers. Thirty-six percent of high school juniors expressed an interest in STEM careers in 2006–07, but that estimate is well below the national average and percentages in competitive states. STEM occupations in the state are expected to grow by over 18 percent in the next six years, with a total of 80,000 new positions in STEM fields becoming available.[6] In 2007, only 45 percent of 8th graders and 68 percent of 10th graders in Massachusetts schools scored at the proficient or advanced levels in mathematics.[7] In the advanced and proficient group in the sciences on the 10th-grade test, the scores were 34 percent in biology, 36 percent in chemistry, 25 percent in technology and engineering, and 46 percent in physics. In addition to these relatively low proficiency scores, there are persistently wide achievement gaps among low income, African-American, and Hispanic students in performance on these assessments. The new School-to-College database shows that in 2005, 28 percent of first-year public college students in Massachusetts had to enroll in a remedial mathematics course during their freshmen year.[8]

INSTRUCTIONAL QUALITY IN SCIENCE EDUCATION

The emphasis placed on science education in public schools has waxed and waned over the years according to the need for scientifically trained workers to fulfill national needs. Much of the emphasis on science education in the United States occurred after World War II, when innovations in business and defense industries began to require employees who had been educated in the sciences. That movement increased after the Soviet Union launched the first satellite in 1957 and the United States became engaged in the space race. It then decreased after the United States achieved success in engineering and technology related to space initiatives.[9]

With the publication of *A Nation at Risk* (1983),[10] there was a recognition that students were falling behind their counterparts in other industrialized countries in analysis and problem solving so essential for science learning. In 1989, the American Association for the Advancement of Science (AAAS) published *Science for All Americans,* outlining what students should know in science, mathematics, and technology.[11] Such reports made a clear case for overhauling curricula as a first step in improving science teaching and learning. The AAAS publication *Benchmarks for Science Literacy*,[12] as well as the National Research Council's *National Science Education Standards,*[13] were developed in an attempt to bring coordination and coherence to improving science education.

The National Science Foundation (NSF) responded by encouraging the development of more motivating and rigorous science curricula and instructional materials that could be used "as a centerpiece that schools and districts could use to refine professional development and classroom assessment."[14] These materials (authored through research-based development processes) not only were engaging to students, but they also taught science concepts in a deep and thorough way through the use of inquiry and connections with real-life experiences of young people. These materials and those that emerged in the next generation of curricula were able to transform textbook adoption and the process for selecting materials into an important learning opportunity.[15]

The NSF, along with the U.S. Department of Education and several other organizations, also provided grants to states and school districts to enhance teacher development and student learning in science throughout the 1990s. Evaluations of these programs indicate there were some improvements in teacher content and inquiry-based knowledge. However, because of insufficient funding, only a small number of school districts and about half of the states were recipients of this support. Even in funded sites such as Massachusetts and some of the large urban areas, there were problems in sustainability of programs over time due to systemic support factors, the amount of time required to master content, and competing programs and demands on teachers' time.[16]

With the No Child Left Behind Act came increased attention to student outcomes in mathematics and literacy, pushing science education into the background. The emphasis on mathematics and reading has resulted in a situation where science may be ill-taught or not taught at all. Science is a complex discipline that requires a pedagogy that is based on both content knowledge and the *interaction* of that knowledge with the ways in which students learn. Teachers who are effective in science teaching must

- know particular areas of science content in depth, and
- understand that content in the context of pedagogical best practices in order to teach students content and a scientific way of thinking.

Challenges in science instruction vary at different grade levels. For example, elementary teachers often receive minimal instruction in science and are at a loss about how to teach, manage materials and curricula, and begin building the foundations of science in the limited time afforded them. At the middle school level, teachers are often not certified in science and do not have the advanced knowledge needed to teach higher level courses. At the high school level, states are challenged to ratchet up requirements and rigor of science courses, ensure they address the advancements in science, and are being strongly encouraged to offer advanced placement and international baccalaureate levels.

Just keeping science on the front burner is the most critical issue facing science education. A recent survey by the Center on Education Policy indicates that 53 percent of districts surveyed stated they had cut instructional time in science per week by 75 minutes as the result of increasing demands for instructional time for mathematics and English language arts.[17] The Massachusetts STEM Indicators Project has determined that 73 percent of 4^{th}-grade classrooms devoted less than three hours per week to science instruction. In contrast, 89 percent of classrooms devoted from five to seven hours for math instruction per week.[18] In teacher preparation programs, the lack of emphasis on science has resulted in 30 percent of prospective teachers failing the mathematics and science parts of the Massachusetts Tests for Educator Licensure from 1993 to 2005.[19]

In their report *Rising Above the Gathering Storm,* the National Academy of Sciences has documented a number of actions that federal and state governments must take to influence America's prosperity in the 21st century. In the area of K–12 education, the report states:

> Improvements in student achievement are solidly linked to teacher excellence, the hallmarks of which are thorough knowledge of content, solid pedagogical skills, motivational abilities, and career long opportunities for continuing education.[20]

Science education leaders also stress the importance of curricular materials that can be used as a source for both teacher professional development and student learning. Standards-based curricula provide student lessons and learning guides that teach inquiry and content in the classroom, and solve the problem of inadequate content knowledge, inability to manage materials, poor sequencing and lesson planning, and inability to inspire the types of questions that are central to the teaching of science.[21]

A recent report by the Chief State School Officers reviewed the effects of 25 recent professional development programs for teachers in mathematics and science that were implemented in 14 states.[22] One-third of the studies included effects on student outcomes as a measurable outcome of the program, and those evaluations showed that there were positive student outcomes if three conditions were met: (1) the programs focused on content in mathematics and science; (2) the programs included on-site follow up in classrooms; and (3) the teacher-contact time in the program reached 50 hours or more.

A major concern in the efforts to improve instructional quality is the matter of equity and access. Students from low-income homes may arrive at the school door with substantial deficits in language and problem solving. They may then be assigned to schools with fewer resources than middle-class schools, when in effect, they need more of everything: qualified teachers; rich curricula; time for learning; and time for music, art, and experiences that middle-class children have as a matter of course.

If programs to increase rigor in science do not include access and support for this group of students, then wide-scale improvement efforts will fail to fulfill a fundamental obligation. In a recent assessment of where Massachusetts has been in school reform, and what path the state might pursue in the future, the new Secretary of Education Paul Reville noted:

> We underestimated the impact of poverty on student achievement and continue to be naïve about its impact. We cannot get all students to a high standard if we pretend they all have the same learning needs that can be met in the same way…. We must, institutionally, give to poor children what middle class families are able to routinely do for their own. This means deep and constant support.[23]

COHERENCE AND ALIGNMENT IN SCIENCE EDUCATION

The United States has a unique system of education organization and governance. Most of the preK–12 enterprise is governed and funded by local school districts. States provide major portions of educational funding through various formulas, but in many states, decisions on science curricula, instruction, and graduation requirements are left to local districts. This system contributes to varying curriculum and instructional programs, standards for learning, and graduation requirements and assessments.

The state standards and assessment movement, which was led by states and began in the 1980s, was an important effort to bring coherence to elementary and secondary education at the state level. The standards movement sent the message to local school districts that the state had an interest in the outcomes of student learning and that there had to be some accountability for school performance.

As a result, schools have been undergoing a major transformation in their operations. Groups of educators have endeavored to align curricula to state grade-level expectations; undertaken vertical discussions from preK–12 on curriculum goals and interventions for students; assessed students regularly as they progress through the curriculum; and focused on student data to make instructional decisions.[24] This process of curriculum alignment is in various stages in schools and systems across the country. As cited previously, much of the emphasis on curriculum alignment and accountability has been focused on literacy and mathematics. Although NCLB requires states to develop standards and assessments in science, those results are not required to determine Adequate Yearly Progress under the law.

But as the important effort to align mathematics and language arts curricula to state standards has proceeded, several states have been engaged in efforts to make state standards and graduation requirements more rigorous. These higher standards reflect the need to prepare students for a global economy and, therefore, require all students to take more science, technology, engineering, and mathematics coursework. States are also requiring students to demonstrate proficiency in these areas. The spotlight is moving from a preoccupation with aligning curricula in just mathematics and literacy to larger issues focused on ensuring American students are competitive in all STEM areas with their global counterparts.

States are approaching the tasks of increasing the rigor of their academic programs, including science, and aligning their preK–12 curriculum programs in a number of ways. Some have formed P-16 Councils of representatives from various stakeholder groups to chart a course for alignment, college and work readiness, and accountability. Other states have worked through their legislatures to upgrade their science graduation requirements to reflect international benchmarks. Still others are working at improving the quality and alignment of science programs within and across districts but have not yet defined what college readiness and career readiness means.

Without this important work of alignment, students may miss courses and curricula necessary for college and work readiness. Students may be "shut out" of higher level science and technical courses necessary for post-high school success by virtue of not having had access to certain math or science courses in middle school. Without requirements for taking more difficult courses, some students may opt to take easier courses that do not lead to college or work readiness.

In a description of the coherence problem, the National Science Board (2008) has stated:

> STEM content standards and the sequence in which content is taught vary greatly among school systems, as do the expectations and indicators of success…. Students do not always obtain mastery of key concepts at the elementary and middle school levels, thus limiting success at the high school level.[25]

This opinion has been shared by the National Governors Association in their work on Innovation America. A 2007 report, *Building a Science, Technology, Engineering and Math Agenda,* states:

> This misalignment has resulted in a system in which students participate in incoherent and irrelevant course work that does not prepare them for higher education or the workforce.[26]

STATE INITIATIVES TO ADDRESS COHERENCE AND ALIGNMENT

States are addressing the issues of coherence, instructional quality, and student support through a number of these innovative initiatives. Interviews with education department personnel in Kentucky, Ohio, Michigan, Indiana, Minnesota, Virginia, North Carolina, and Rhode Island have provided us with an up-to-date review of initiatives in progress.

States were selected for interviews on the basis of their efforts to increase rigor and their student and teacher programs in science and STEM areas. Wherever possible, we tried to differentiate between those programs that are in the process of being implemented and those that are desirable and planned but have not been implemented. We have also highlighted those policies that relate specifically to science.

Some of the states have been identified as "local control states." In local control states, such as Massachusetts, local school boards have decision-making power over curricula, instruction, and graduation requirements. Efforts to provide statewide coherence may be difficult to implement when local districts have this authority. In our conversations with several states, there were a variety of pathways that states used to recognize the issues presented and work with local districts to enhance science education.

Although states are taking different pathways towards alignment and instructional quality in science and STEM subjects, there are some common themes among the mix of policies and programs. A summary of the program and policies that most states are implementing is included below. In the area of alignment the common themes are as follows:

1. Establishing a P–16 Council to lead the statewide discussion on STEM policies, define college and career readiness, and lead the implementation of a multi-agency effort to improve STEM education.

2. Establishing rigorous graduation core requirements aligned with career and college readiness. Many states have moved to make the requirements mandatory. These increased standards most often include three years of laboratory science and three to four years of mathematics.
3. Developing and administering graduation proficiency assessments, Algebra II assessments, and other end-of-course assessments.
4. Easing the transition to college and careers by redesigning high schools, including establishing early-college, dual-enrollment, and STEM high schools, with an emphasis on online course development.
5. Developing preK–16 data systems that track students from elementary through high school and into careers or college.
6. Aligning career and technical (CTE) education course content with rigorous academic standards.

A number of recent reports have documented the fact that both career and college readiness require the same level of rigorous coursework in high school. Among our sample states, all are either developing early-college and dual-enrollment high school-to-career and college options, or instituting career courses and planning as high school requirements. In addition, upgraded standards and graduation requirements apply to all students.

STATE INITIATIVES TO ADDRESS INSTRUCTIONAL QUALITY

When states begin the process of upgrading and aligning academic programs to levels that respond to college and work readiness, they also must address the problem of school and teacher capacity to implement reforms in science education. States are now focusing on how to provide supports and equitable systems for all students to have access to accelerated programs. In our state review, there are a number of initiatives that address these issues:

1. Redesigning teacher preparation programs to provide more instruction in science and mathematics content, and providing incentives for undergraduates, graduates, and mid-career science professionals to pursue science teaching.
2. Establishing professional development programs in science that are based on the findings of a decade or more of professional development studies across the country.
3. Providing funding, support, access, and a variety of programs for students from low income homes, so that they will have an equal opportunity to master the science curriculum and transition to science careers or college.
4. Using standards-based instructional materials and proven instructional systems to teach teachers and well as students; defining best practices and curricular systems and establishing a state resource center in science and other STEM subjects.

The ability to use standards-based materials in science teaching must be coupled with professional development. States are recognizing the need for intensive support and professional development for teachers coupled with standards-based instructional materials. They are locating these resource centers together, either online or through regional academies and math/science centers throughout the state.

FOCUS ON MASSACHUSETTS

Massachusetts has much to be proud of in the area of science education and student achievement. Even so, Massachusetts is competing in the international arena in the STEM disciplines and must do more in order to boost both student achievement and interest. Despite 15 years of education reform efforts, low income, African-American, and Hispanic students score significantly below their peers on state assessments across disciplines.[27] On the 2007 MCAS Science & Technology Engineering 8th Grade assessment, only 10 percent of students from low-income homes scored at the Proficient or Advanced levels. The average score for other students was 33 percent.[28] Research has shown that students who arrive at school with learning needs require a rigorous and aligned curriculum, a personalized learning environment, and supportive adult relationships in order to succeed.

Massachusetts is taking a number of steps to enhance student and teacher performance in mathematics, science, technology and engineering. A recent EDC Report[29] lists six STEM Pipeline projects, 11 regional mathematics and science partnerships, several professional development programs, and 14 major public/private partnerships focused on student and teacher learning. A recent grant awarded to Mass Insight will provide five regional programs to upgrade teacher professional development for teaching advanced placement courses.

In addition, the state is one of the few that has developed and is now using a student data system that will allow faculty and staff to track student performance over time from kindergarten through the college years. This past academic year, high schools received feedback on how their graduates fared in college programs. A list of the Massachusetts initiatives follows:

- Partnering with the American Diploma Project in the development of an end-of-course assessment for Algebra II. This test has been developed but there are insufficient funds in Massachusetts for its administration.
- Upgrading teacher licensure and teacher preparation programs in mathematics. There are no current plans to do so in science.
- Board of Education adoption of a recommended core curriculum, the Mass Core, that includes three laboratory sciences and four years of mathematics. A Certificate of Mastery has also been adopted by the Board that includes several measures that correlate with college readiness. These programs have not yet been implemented.
- A "grassroots" effort to begin the discussion of college readiness with regional sessions that include high school and college faculty defining what readiness means.
- The development of a Web-based portal for career planning that will enable students to begin planning for post-secondary careers or college experiences early.
- A focus on dropout prevention that includes support for urban schools.
- Three early college programs in urban areas that include partnerships among K–12 schools and community colleges. These programs are focused on students who might drop out of school.
- Over 60 charter schools and 20 pilot schools that have more flexible organizational structures and hiring practices, extended schedules, and smaller class sizes. Charter schools are independent schools; pilot schools are public schools. Three pilot schools and five charter schools have STEM emphases in the curriculum.
- The development of the comprehensive data system mentioned above.[30]

Although the state has high standards and student performance and has a number of ongoing STEM partnerships (e.g., Mathematics and Science Partnerships supported by the U.S. Department of Education and the NSF), there has not been a strategic and comprehensive effort to address these issues at the top levels of government. There are a number of public/private groups working on various issues related to alignment and improved instruction in science, mathematics, and other STEM disciplines. However, there has not been an effort to form a P–16 Council to serve as the major policy leader in improving STEM education, as has occurred in other states.

The STEM Planning Committee sponsored by the University of Massachusetts includes representatives from higher education, elementary and secondary education, and business and nonprofit organizations from across the state. The group has developed a plan that lists several key outcomes in the areas of alignment and instructional quality that should be met to improve STEM education.[31] Although influential in the state discussion on STEM, the group has no formal authority to induce change in current governmental structures.

The Board of Elementary and Secondary Education chair has recently appointed a group of influential business executives, legislators, and nonprofit leaders to a 21st Century Skills Task Force to "encourage school districts to provide all students with the skills necessary to succeed in the 21st Century." [32] The Partnership for 21st Century Skills is an organization that promotes student development in global awareness, communication and collaboration, critical thinking and problem solving, and creativity as skills that students must have to be successful in the 21st century.[33] The organization is working with several states to integrate these areas into current curriculum and assessment frameworks.

The Goddard Council was established by legislation in 2003 that sought to promote educational initiatives that would improve STEM education in Massachusetts. The Council includes business and education partners and is overseen by the Board of Higher Education. The Council is embarking on a strategic planning and implementation process that should provide some focus to its operations.

It is not clear how these groups might, in combination or independently, be able to provide the leadership needed to communicate the importance of STEM education, as P–16 Councils have done in other states. In June 2008, the Governor's Readiness Report, *Ready for the 21st Century: The New Promise of Public Education,* was released to the public. The report includes a number of actions to improve education that are designed to unfold over the next decade. The State Science and Technology Coalition of the Massachusetts Legislature has reconvened to respond to the governor's recommendations and to provide their own perspective on the future of STEM education in the Commonwealth. In addition, in October 2008, the annual STEM Summit will be held, bringing together an estimated 600 representatives from business, industry, preK–12 education, institutions of higher education, and policy makers to discuss STEM progress in Massachusetts.

We have listed the major policy and programmatic initiatives of our sample states and compared those initiatives with the Massachusetts response below. Although there may be a number of regional or local initiatives underway in Massachusetts that are related to these areas, we are identifying only comprehensive state-sponsored programs.

Other State Initiatives	Massachusetts State-Sponsored Programs Available
P–16 Council/College and Career readiness defined	No
Rigorous standards in science and STEM subjects	Yes
Mandatory graduation core curriculum with rigorous science courses defined	No; recommended only
Proficiency college and career readiness assessments in STEM subjects	In process-some are in place.
PreK–16 curriculum alignment/state guidelines for scope and sequence of STEM curricula.	No
High school redesign	No; 20 pilot schools
Early-college/dual-enrollment/STEM high schools. Early college high schools provide high school and community college courses in a 5 year program leading to an AA degree or 24 hours of college credit. Dual enrollment schools permit high school students to take courses for college credit while in high school.	No
Developing a bank of course/college credits transferable from high school to college and from community college to four-year institutions.	No
High school to college admissions, placement, tuition remission, scholarship and other student incentives for STEM study	No; the Abigail Adams scholarships are available for students who pass the MCAS assessments in all subjects in the Advanced category
Comprehensive preK–20 data system	Yes
CTE alignment and rigor	Rigor but not aligned yet
Early middle school intervention and support	Dropout legislation and support for urban areas
Career planning courses or plans required	No; working on portal
Teacher prep/licensure upgrades in science	No
Teacher incentives for science teaching, especially in hard-to-teach schools	No
Guidelines for PD in science that stress 50–120 hours and in school support	No; there are a number of professional development programs that have these as a basis, but no statewide guidelines
Regional professional development collaboratives	In process; may be regional initiatives but limited coordination
Master's degree science specialist	No
Model curriculum resource bank in science	No

Massachusetts has approached the issue of coherence and instructional quality by developing rigorous standards and the 10th-grade MCAS assessments to produce some coherence and proficiency determinants in the system. This approach has not, until recently, addressed a core-curriculum or college-readiness definition.

This non-centralized approach has been documented in a previous study by EDC[34] that lists 17 major public-private partnerships involved in STEM areas and a host of other initiatives involving schools, colleges, and universities that are not coordinated by the state. There are many positive examples of the effects of this grassroots approach, including innovative programs and involved students and teachers.

One cannot argue with success, and the fact that Massachusetts students are ranked in the top tier on national assessments is proof that the standards and programs are having a positive effect. Yet, one wonders about this approach as a strategy for a major public policy issue that, by definition, suffers from incoherence and quality issues. When each segment of the education and nonprofit community develops its own rules and roadmaps, how can the state ensure that all students have an equal opportunity to gain proficiency for STEM careers and college opportunity?

ACTIONS FOR CONSIDERATION

From our review of other state efforts and current Massachusetts initiatives, we have developed a list of actions that might be undertaken as Massachusetts seeks to improve alignment and instruction in science education. These action items are divided into two sections: actions that will be new and those that build on initiatives that are already in place.

A major theme of the work to improve science education must be an effort to ensure that each action has, as part of its design, a process to mitigate the science achievement gap among students from low-income homes. Increasing rigor must be accompanied by increasing support and access so that all students have the opportunity to achieve at high levels and experience success.

New Initiatives

1. Establish a P–16 Council comprising the governor, legislative leaders, the secretary of education, chancellor of higher education, and commissioner of education, as well as business and nonprofit leaders to define college readiness and lead the effort to improve science and STEM education in the state.
2. Introduce multiple pathways to high school graduation and early college credit with a state system for dual-enrollment and early-college high schools with access for all students. Develop a set of on-line courses.
3. Cross-walk enhanced Mass Core rigorous standards with career and technical education and vocational education; align these programs with readiness standards for college and careers (especially in STEM areas); and provide smooth transitions.
4. Enhance science requirements for teacher licensure and improve teacher preparation and recruitment programs in the area of science. Consider programs that attract science majors and mid-career professionals to teaching and that offer a variety of incentives for teaching, especially in hard-to-staff schools. Consider introducing a master-teacher-science-specialist program, with a particular emphasis on elementary science specialists.
5. Provide scholarships and tuition remission for high school students who attain the Certificate of Mastery and who are interested in teaching in science and STEM fields.
6. Develop guidelines for professional development in science that are based on research and best practice.
7. Develop a library and resource system that identifies standards-based materials and curricula in science and that connects those resources to professional development centers.
8. Develop a bank of high school courses that are easily transferable for college credit and a similar bank of community college courses transferable to any public four-year institution in Massachusetts.

9. Implement the Massachusetts core curriculum as the desired curriculum and provide incentives to schools and districts to encourage all students to pursue that curriculum. (Such incentives might be guaranteed admission, scholarships, or tuition remission at Massachusetts public colleges, and STEM scholarships and grants for students pursuing teaching careers. Whole school incentives might include financial awards and recognition.)
10. Expand on the Certificate of Mastery to include student portfolios, encourage adoption of the Certificate for all students, and tie the Certificate to college tuition remission, scholarship assistance, and placement. Ensure that *all students* have access to the resources that will set them on the path to mastery, from elementary school through high school and beyond.
11. Continue development of the PreK–16 data system.
12. Develop regional math and science centers that locate professional development and curriculum materials and resources close to school districts and that build sustainable relationships necessary for multi-year improvement projects.
13. Upgrade the recently developed career portal for easy planning and access to science and STEM programs.

Because many of the other state initiatives discussed in this report are new or in the process of being implemented, there has not been a widespread evaluation of the effects of these state comprehensive efforts on student learning. There is a reasonable assumption that increasing teacher quality and coherent and aligned instructional services will improve student learning in science and other curriculum areas. However, there is a danger that in the process of increasing graduation requirements and proficiency assessments, students who need the most support to gain access to the system will be left behind.

As several states have recognized, implementing programs that skim the most proficient students for advanced work and college entrance leaves a large proportion of students unprepared for college or work. **Any public policy put in place to increase rigor and graduation requirements must ensure that the right supports, at the right time, are instituted to ensure that all students will have access to college and careers.**

Science education is important to ensure students have access to highly skilled jobs that will be critical for the state's economic success in the 21st century, but knowledge of science is important for another reason. In the 21st century, virtually all activities of life intersect with science and technology. The argument that science education is critical for jobs and economic progress in the 21st century is a sufficient argument to produce changes in the way we enhance science education. But just as important is the fact that in this technological age, all citizens must have basic scientific knowledge to make day-to-day life decisions.

This report was written by Nancy Richardson, Barbara Brauner Berns, Judith Opert Sandler, and Lisa Marco.

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