EDUCATION PARTNERSHIPS, INC.

Research Brief
Science Graduation Requirements

Question: What might be the advantages of having a 3 year Science graduation requirement over a 2 year requirement?

Summary of Findings: According to the National Center for Education Statistics (Table 153), there are almost as many states that require a minimum of 2 credits of science for graduation (22) as there are those that require 3 credits (21). (4 don't set a minimum requirement – it's up to districts, 1 requires 1 credit, 1 requires 4 credits, and one uses outcomes instead of credits.) According to the *2000 High School Transcript Study*, between 1990 and 2000, not only did the average number of science credits taken increased from 2.8 to 3.2 (that's an average for *all* students, not just college track), but science mean grade point average went from 2.39 to 2.67. Of the 16 course subjects covered by the 2000 High School Transcript Study, mathematics and science courses proved the most difficult for high school students. In 1987, only 6 states required more than 2.5 credits of science, but in 2000, 20 states required more than 2.5 credits.

The real issue, however, seems not to simply be the number of credits taken, but the need to revise and update science curriculum and instruction. In a position paper, The Council of Scientific Society Presidents puts forth the following: Doubling investment in the nation's science and mathematics education, based on sound educational research, to provide all the nation's children an effective educational outcome in mathematics and science, must be a top national priority over the next decade.

Three major arguments have been used to point out the need for reform in science education. First, America's economic position appears to be declining. The second argument for reform arises out of the data that show that many students are simply not taking advanced science classes, and those who do are scoring below other technological nations. Further, reports that discuss low morale among teachers and low expectations for student achievement also address the crisis that science education is facing. The final argument, although not voiced as often because it is not tied to economic decline or dropping test scores, is that improved science education can play a significant role in liberating human thought. Throughout history, advances in science have had significant influences on society that have allowed improvements in the living conditions and affluence of many people.

Science for All Americans (published by Project 2061) lists four considerations to achieve scientific literacy in America.

1. The curriculum must be changed so that it:

- Covers a reduced amount of material
- Weakens or eliminates subject-matter boundaries
- Pays more attention to the connections among science, mathematics, and technology
- Presents the scientific endeavor as a social enterprise that influences and is influenced by human thought and action
- Fosters scientific ways of thinking

2. Effective science instruction must be based on learning principles that derive from research and on the best practice that is consistent with the spirit and character of scientific inquiry.

3. Educational reform must be systemic, dealing with all aspects and components of the educational system. It must focus on the learning needs of all children, in all subjects, and in all grade levels. Positive conditions must be established and maintained if reform is to be sustained.

4. Reform must be collaborative, involving administrators, university faculty members, community, business, labor, and political leaders, as well as teachers, parents, and students.

Project 2061's suggests the following for good science instruction:

- Start with questions about nature.
- Engage students actively.
- Concentrate on the collection and use of evidence.
- Provide historical perspectives.
- Insist on clear expression.
- Use a team approach.
- Do not separate knowing from finding out.
- Deemphasize the memorization of technical vocabulary.

Project 2061's *Checklist for Excellence in Science Instruction* provides the suggestions below on curriculum and instruction based on best practices of the teachers and researchers. The checklist can be used to look at current practices in your school and to jointly set new goals with parents and community groups.

- Curriculum based on the "less is more" principle
- Curriculum that calls for a comprehensive repertoire of learning and problem-solving strategies
- Collaborative teaching and learning involving student-generated questioning and sustained dialogue among students and between students and teachers

- Teachers building new information on student strengths
- Authentic tasks in the classroom such as solving everyday problems, collecting and analyzing data, investigating patterns, and keeping journals
- Opportunities for students to engage in learning out of school with community members
- Homework that is challenging enough to be interesting but not so difficult to cause failure
- Respect for multiple cultures and perspectives
- A rich learning environment with places for children to investigate real world phenomena and think on their own
- Instruction that enables children to develop an understanding of scientific concepts as well as a mode of scientific thought

Online Resources:

Table 153. State Requirements For High School Graduation, In Carnegie Units: 2001
http://nces.ed.gov/programs/digest/d01/dt153.asp

The High School Transcript Study: A Decade of Change in Curricula and Achievement, 1990-2000
National Center for Education Statistics
This report presents findings from the 2000 High School Transcript Study (HSTS 2000) and examines the trends and changes in high school curriculum and student course taking patterns for the past decade. This publication allows policymakers, researchers, education agencies, and the public to examine the current status of the curricula being offered in public and non-public high schools. The HSTS 2000 collected 20,931 transcripts of students graduating from 277 American high schools. Results from the HSTS 2000 are presented with respect to earned course credits, grade point average, and education achievement, as measured by the National Assessment of Educational Progress 2000 Mathematics and Science assessments. In addition, results are compared across the four High School Transcript Studies between 1990 and 2000 (HSTS 1990, HSTS 1994, HSTS 1998, and HSTS 2000). Findings are presented throughout the report by selected student and school characteristics, including student gender, student race/ethnicity, school type (public vs. nonpublic), and region of the country.
http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2004455

CSSP Issue Paper: Federal Support Of Science And Mathematics Education
CSSP Position: doubling investment in the nation's science and mathematics education, based on sound educational research, to provide all the nation's children an effective educational outcome in mathematics and science, must be a top national priority over the next decade.

http://aets.chem.pitt.edu/cssp.htm

The Need for Science Education Reform
R.A. Knuth, B.F. Jones, and S. Baxendale
NCREL, Oak Brook, 1991
Poor ability in science, math, and technology will certainly hamper our ability to maintain a leading role in the global village. It is imperative, therefore, to carefully, thoughtfully, democratically, but urgently engage in the task of science education reform. Fortunately, research in three major areas including scientific thought, learning, and teaching is providing the groundwork for science education reform.
http://www.ncrel.org/sdrs/areas/stw_esys/3science.htm

Project 2061
The American Association for the Advancement of Science (AAAS) founded Project 2061 in 1985 to help all Americans become literate in science, mathematics, and technology. Its work has earned the project a reputation as the "single most visible attempt at science education reform in American

history" They have produced several important documents, including: Science for All Americans, Benchmarks, and Blue Print.
http://www.project2061.org/

Science for All Americans online
http://www.project2061.org/tools/sfaaol/sfaatoc.htm

Benchmarks online
http://www.project2061.org/tools/benchol/bolintro.htm

Blue Print online
http://www.project2061.org/tools/bluepol/blpintro.htm

Less Is More: Trimming the Overstuffed Curriculum
Through a science curriculum "diet," districts discover that less topics could fatten students' understanding
By Lisa Fratt
Overstuffed and undernourishing is the way many experts describe the science curriculum. The Third International Math and Science Study characterizes U.S. math and science curricula as "a mile wide and an inch deep." Instead of forcing students to digest more and more content and vocabulary as science continues to advance, experts recommend a science curriculum "diet" to help take a bite out of the nation's current science achievement woes. Yes, that's right. Less is more. This unburdening of the science curriculum is already occurring as individual teachers eliminate topics in their overloaded textbooks. But there is a better, less haphazard,

approach.
http://WWW.PROJECT2061.ORG/publications/articles/ARTICLES/DA.HTM

The Trouble With Textbooks
By Stephen Budiansky
The science books used in the classroom today provide a lot of facts, but they don't help children grasp the most basic concepts about the world we live in. The only thing the books utterly fail to do, according to scientific and educational experts who have examined them closely, is teach science. A recent study of middle-school science textbooks by Project 2061—a science and mathematics curriculum reform initiative of the American Association for the Advancement of Science—found that not a single one of the books met even the minimum requirements for effectively teaching science. "Our students are lugging home heavy texts full of disconnected facts that neither educate nor motivate them," says George Nelson, a former astronaut who directs Project 2061.
http://WWW.PROJECT2061.ORG/publications/articles/ARTICLES/ASEE.HTM

Date: 6/1/2004 Submitted By: Mike Muir, Maine Center for Meaningful Engaged Learning