

HJR 25
Study of Science, Math, and Technology Education
<http://dls.state.va.us/TechEd.htm>

Final Recommendations

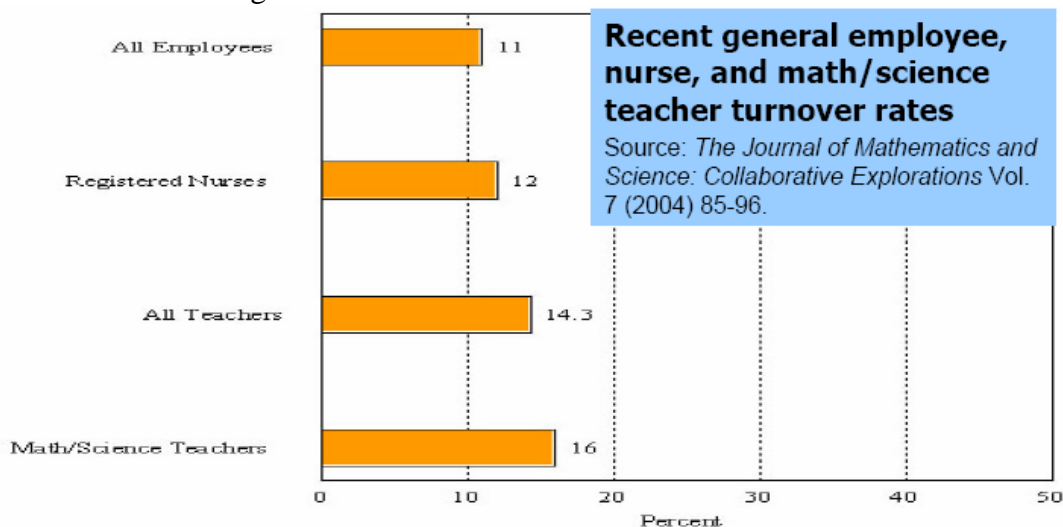
First Tier Rankings: These recommendations had the most significant consensus among the joint subcommittee members who responded.

Recommendation: Provide incentives (e.g., scholarships) for recruiting highly qualified science and mathematics students to accredited STEM teacher education programs.

Target: Current and entering undergraduate students.

Source: Dr. Susan Magliaro, Director, School of Education, Virginia Tech; Kathleen Stansbury, President, Virginia Technology Education Association; Dr. Stephen T. Thornton, Professor of Physics, University of Virginia. See July 16, 2007 meeting materials for more info.

Justification: Qualified and knowledgeable teachers will better prepare students and develop more interest among students. Additionally, math/science teachers have a relatively high turnover rate, requiring greater recruitment efforts. Table below pulled from presentation by the Virginia Mathematics and Science Coalition:



One of the most serious problems is that many new teacher graduates either never teach or quit before finishing five years. A 10%

forgiveness for loan values up to \$50,000 would amount to an incentive of \$5,000 per year for the teacher. We might also have other criteria for the new teacher to meet, but this would need to be studied by the Department of Education. The students would be required to pay back the loans if they do not teach in a Virginia school. Many states, including North Carolina, have similar programs.

More than 300 new middle school mathematics and science teachers will be needed each year in Virginia (based on 1997 estimate), however there are only 10 to 20 produced each year. The rate of preparation of teachers certified for grades 6-12 is not sufficient.

Implementation: Budget: Increase the number and/or value of Virginia Teaching Scholarships targeted for prospective STEM teachers. The Virginia Teaching Scholarship Loan Program provides financial support in the form of forgivable loans to students who are preparing to teach in one of Virginia's critical shortage areas or who are willing to teach in a school with a high concentration of low income students. Last year, 185 awards in amounts up to \$3,720 were made to eligible applicants. "Critical shortage areas" are determined by the Department of Education in an annual survey of all school divisions. Although the critical shortage areas change from one year to the next, Virginia has traditionally had shortages in the areas mathematics, science, career and technical education, and special education. In FY 2007, \$558,000 GF was appropriated to this program. The 2007 General Assembly increased the appropriation by \$150,000 for FY 2008, which will result in awards to approximately 40 additional students.

Recommendation: Immediately, require a K-8 mathematics specialist in each Virginia elementary school as per the endorsement requirements that are stipulated in the soon-to-be-approved licensure regulations.

Target: Individual K-8 public schools.

Source: Dr. Susan Magliaro, Director, School of Education, Virginia Tech.

Justification: While my first recommendation speaks directly to truly advancing the STEM initiative, we understand it will take time to develop the criteria for a K-8, 8-12, or K-12 STEM specialist or coordinator who will be able to provide teachers with support (e.g., professional development, co-teaching, etc.) (c.f., K-12 STEM Education Specialists/Coordinators in Anne Arundel and Prince George's County in MD). In the meantime, we can advance with what is already in process for approval (i.e., the mathematics specialist endorsement), and ensure that K-8 students are receiving high quality instruction in

mathematics education. See July 16, 2007 meeting materials for more info.

Implementation: The Board of Education has amended its teacher licensure regulations, effective September 21, 2007, to include an endorsement for a mathematics specialist, similar to the current endorsement for the reading specialist, to serve as a resource for mathematics for teachers in grades K-8. The Board also recommended to the 2007 General Assembly that the Standards of Quality be amended, in § 22.1-253.13:2 of the Code of Virginia, to say that: "Local school boards shall employ one full-time equivalent position per 1,000 students in grades kindergarten through eight to serve as a mathematics teacher specialist." The amendment was not approved. The fiscal impact of this amendment is estimated to be \$42.1 million GF in 2007-2008 and \$42.4 million GF 2008-2009.

Recommendation: Widespread implementation of Project Lead the Way

Target: Localities

Source: Most recently Jim Batterson, Special Assistant on loan from NASA to the Secretary of Education on behalf of three panels of practicing engineers and scientists, and Delegate Englin, joint subcommittee member.

Justification: Panels recently assembled to provide gap analysis of required courses in Virginia public schools found that there is no "STEM" program in VA, as there is no engineering requirement. Engineering courses are electives taught solely through career and technical education programs. The "engineering design process", which differs from the "scientific method", should be required content, and one way to obtain that content would be through Project Lead the Way because its courses cover almost all that would be needed to learn the engineering design process. Engineering courses bring a hands-on approach to learning science and mathematics, which can open new four-year college academic and career options for children whose learning modalities are not strongly abstract or theory-centric.

Implementation: Localities. Currently only 14 of 132 school divisions have implemented the program, which is considered a turn-key national engineering program. A Project Lead the Way Startup Matching Fund established by the General Assembly whereby the state will match the start-up costs for a school division and thereafter the school division will bear the annual ongoing costs, may encourage localities to consider the program.

More Information: Project Lead The Way is a not-for-profit organization that partners with public schools, organizations in the private sector, and higher education institutions to increase the number and quality of engineers graduating from the nation's education system. The curriculum is a four-year, flexible sequence of pre-engineering courses that, when combined with college preparatory mathematics and science courses in high school, introduced students to the scope, rigor, and discipline of engineering and engineering technology. The courses are Principles of Engineering, Introduction to Engineering Design, Digital Electronics, Computer Integrated Manufacturing, Civil Engineering and Architecture, and Engineering Design and Development. Project Lead The Way recommends that the program be offered to the top 80 percent of students in the school, including not just the students in the top 10 percent of their class and students who excel in mathematics and science, but also underachievers who might get hooked by a high tech, hands-on class, and struggling students who learn best by doing. See <http://www.pltw.org/index.cfm>.

Second Tier Rankings: These recommendations received a slightly lower response from the joint subcommittee members who responded.

Recommendation: Support fast track career switchers programs such as those being operated by community colleges. Unlike the program listed above, this program would address practicing professionals that would like to move from a non-teaching to a teaching career. Candidates for this program would already possess at least a bachelor's degree.

Target: Community college students.

Source: Glenn DuBois, Chancellor, Virginia Community College System. See July 16, 2007 meeting materials for more info.

Recommendation: Financial incentives of up to \$5,000/year for outstanding math, science, and technology teachers in middle and high school; based on teacher performance (accountability).

Target: Teachers for grades 6-12.

Source: Dr. Stephen T. Thornton, Professor of Physics, University of Virginia. Kathleen Stansbury, President, Virginia Technology Education Association.

Justification: A recent article in the Washington Post summarized some of the recent efforts concerning pay differentials. Teachers in highly valued positions should be rewarded accordingly. Teacher unions are mostly against this idea, but several school systems and states have implemented it.

Implementation: National Board Certification is an example where high quality teachers are recognized. The Virginia Department of Education should be able to define other criteria, including increased SOL scores for students. Such incentives should be guaranteed for periods up to five years. See July 16, 2007 meeting materials for more info.

Similar Program: Although not a performance incentive, the Virginia Middle Teacher Corps is a program that provides the structure and incentives for school divisions to hire experienced mathematics teachers for middle schools (grades 6, 7, and 8) that have been designated as “at risk in mathematics.” A salary differential of \$10,000 was provided to a teacher who is a new hire to a school or school division, and a \$5,000 salary differential is provided to a teacher currently at an eligible school. In the first year of the program, 2005-2006, 21 teachers were placed. In 2006-2007, 18 teacher corps members remained in the program and five were added. Recruiting successful, high quality middle school mathematics teachers to work in at-risk schools continues to be a challenge. In 2006-2007, Standards of Learning pass rates on the grade 6 test increased in 13 or the 16 participating schools in which at least 10 students participated. The pass rates on the grade 7 test increased in all the participating schools in which at least 10 students participated. The pass rate on the grade 8 test increased or did not change for 12 of the 19 participating schools in which at least 10 students participated.

Recommendation: Support the Commonwealth Scholars program (part of the national State Scholars Initiative) to encourage students to take a more rigorous course of study. This course of study specifies Algebra II as the third math requirement (the standard diploma requires three years but does not specify Algebra II), and specifies physics as the third laboratory science requirement (the standard diploma requires three years but does not specify physics).

Target: Students in grades 9-12.

Source: Glenn DuBois, Chancellor, Virginia Community College System. See July 16, 2007 meeting materials for more info.

More Information: The Commonwealth Scholars program provides instructional support for students who pursue the Commonwealth Scholars Core Course of Study, which includes four years of English, three years of mathematics (Algebra I and II, and geometry), three years of science (biology, chemistry, and physics), three and a half years of social studies (selected from U.S. and Virginia history, world history, geography, economics and financial literacy, U.S. and Virginia government), two years of health and physical education, and two years of a language other than English. <http://vcef.net/page.php?id=10> Virginia is in the third year of a two year, \$300,000 pilot project to encourage students in 11 participating school divisions to take rigorous courses that go beyond the minimum graduation requirements for a Standard Diploma.

Recommendation: Support industry education outreach programs.

Target: K-12 students.

Source: Micron Technology, Inc.

Justification: Several private and public entities have preexisting education outreach programs (e.g. Micron and NASA) and it may be possible for the state to support these programs.

Implementation: One option could be to provide matching state funding to deliver "science-in-a-box-modules" to schools across the Commonwealth. These boxes would contain all of the necessary materials for teachers to provide an innovative, but SOL based, science or math lesson. Additional matching funding could also be provided for teacher training programs during the summer.

Recommendation: Strengthen teacher recruitment policies in mathematics and science (Recruitment):

- Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P-12 and extending through graduate school, that include incentives such as scholarships, signing bonuses and differential pay.
- Strengthen the content and quality of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P-12 students for success in higher education and the workplace.

- Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction (Retention):

- Develop and implement research-based induction programs for all new mathematics and science teachers.
- Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support and professional isolation.

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom (Renewal):

- Provide ongoing, research-based professional development programs focused on both content and improved instructional skills for all mathematics and science teachers.
- Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.
- Establish statewide data collection systems that track student progress, teacher effectiveness and employment trends of mathematics and science teachers.

Source: Citing a report from the Business-Higher Education Forum, Dr. Stephen T. Thornton, Professor of Physics, University of Virginia.

Justification: Study after study throughout the United States point out that the quality of teachers is most important. The report of the Business-Higher Education Forum ([more info](#)) discusses the three R's: Recruitment, Retention, and Renewal and provides justification for the above recommendations. See July 16, 2007 meeting materials for more info.

Recommendation: To assess the demand for STEM graduates by Virginia's technology industry, conduct an industry assessment survey every two years and provide the report findings to Virginia's Universities.

Target: State Council for Higher Education

Source: Peter Jobse, President and CEO, Center for Innovative Technology.

Recommendation: Develop alternative licensure programs based on professional standards with strong pedagogical preparation in the STEM content areas and a strong mentoring component that maximizes available university support and elearning technologies.

Target: Current undergraduate students.

Source: Dr. Susan Magliaro, Director, School of Education, Virginia Tech. See July 16, 2007 meeting materials for more info.

Implementation: The Career Switcher Alternative Route to Licensure Program is designed to entice individuals from various occupational and life experiences to become classroom teachers, thereby increasing the quantity and diversity of applicants to the profession. It was created in response to a resolution by the 1999 General Assembly to develop an alternative pathway to teaching for individuals who have not completed a teacher preparation curriculum but have considerable life experiences, career achievements, and academic backgrounds that are relevant for teaching. Applicants must have a bachelor's degree from an accredited institution; five years of professional work experience; coursework required for the desired teaching area; and qualifying scores on the professional teacher's examinations. They must complete a minimum of 180 clock hours of instruction, including field experience. During the first year of teaching, they are assigned a trained mentor and must participate in a minimum of five seminars associated with instructional categories and topics, for a minimum of 20 cumulative instructional hours. The General Assembly has appropriated \$240,392 GF each year in support of this program.

Recommendation: A career and technical education (CTE) approach to STEM literacy for the broad population of students, through CTE academies and rigorous standards for CTE programs.

Target: Students in grades 9-12.

Source: Glenn DuBois, Chancellor, Virginia Community College System. Kathleen Stansbury, President, Virginia Technology Education Association. See July 16, 2007 meeting materials for more info.

Justification: The courses provided by Technology Education as part of CTE offers a framework for the implementation of STEM curriculum. At the high school level, current courses that include STEM based education include Biotechnology Foundations, Bioengineering, Geospatial Technology, Principles of Technology and Introduction to Engineering. Middle school Technology Education offers courses titled Introduction to Technology Education, Innovation and Invention, and Technological Systems that are ideally suited to provide integrated instruction on STEM content/concepts.

Information Update: Virginia has received a \$500,000 grant from the National Governors Association Center for Best Practices to improve science, technology, engineering, and mathematics education. It provides the opportunity to develop STEM-focused Governor's Career and Technical Academies that are partnerships of business and industry; public school divisions; higher education institutions, including community colleges, universities, and/or private postsecondary institutions, as applicable; and may also include local government, including workforce and economic development entities. These academies will have the primary focus of increasing the readiness of high school graduates for college-level work and other postsecondary pathways in STEM areas. It is anticipated that these academies will be operational in the fall of 2008.

Recommendation: Establishment of Math and Science Academic-Year Governor's Schools

Target: Students in grades 9-12.

Source: Various presenters and subcommittee members.

Justification: The Thomas Jefferson High School for Science and Technology is an academic-year school created to improve education in science mathematics and technology, with a high rate of success.

Implementation: Encourage local school divisions to form exploratory groups to determine whether such a school could be supported in the locality.

Alternative Recommendation from Dr. Cannaday:

One way to make these programs more widely available to students would be to establish regional science, technology, engineering, and mathematics resource centers. A regional science, technology, engineering, and mathematics resource center may have the following roles:

- Conduct science, technology, engineering, and mathematics professional development programs that strengthen teachers' academic backgrounds, enhance teaching credentials, introduce cutting-edge and emerging content, and create communities of learners.
- Deliver and coordinate student-level programs for the general student population through school and on-site lessons; Web-based courses and other distance learning opportunities; and summer, Saturday, after-school, and adult-child programs.
- Provide training on and loan instructional kits and specialized equipment to teachers.

- Provide regional leadership and coordination for activities that benefit all partnering school divisions (e.g., grant-writing, regional resource documents, etc.).
- Coordinate special academic year, after school, or student enrichment programs for highly-motivated, high achieving students in science, technology, engineering, and mathematics such as summer regional Governor’s School programs, or other similar kinds of programs.

Recommendation: Technology Education should be integrated throughout the elementary school curriculum for each learner, grades K-5, and taught by elementary teachers.

Target: K-5 students.

Source: Kathleen Stansbury, President, Virginia Technology Education Association.

Justification: Past experience in elementary school related design, engineering and technology projects, funded by the National Science Foundation, indicates that elementary teachers are more confident and competent in integrating learning across the school curriculum when they use contexts and activities provided by Technology Education.

Implementation: Required teacher training would ensure that all elementary teachers are able to integrate technology across the curriculum. In-service training through the development of Design and Engineering Training Centers in the eight Superintendent Regions and pre-service courses through the university system are two recommended methods of teacher training. These educational improvements can be facilitated by changing both Virginia’s Educational Standards of Quality and the Standards and Regulations for Public Schools in Virginia.

The recommendations with only one or two responses from the joint subcommittee members were removed from the final list.