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Recommendations by the Virginia Tech School of Education
to the
HJR 25: Joint Subcommittee Studying Science, Technology, Engineering, and Mathematics in the Commonwealth at the Elementary, Secondary, and Undergraduate Levels

Chairman Cosgrove and the Members of the Joint Subcommittee:

Over the past decade, numerous national reports such as the 2007 consensus report of the National Academies[1], *Rising Above the Gathering Storm*, have all underscored the critical need for our nation to direct resources and efforts towards the preparation, recruitment, and retention of students in the science, technology, engineering, and mathematics (STEM) fields to stay competitive in the global economy. With the authorization of House Joint Resolution 25 and the efforts of your esteemed subcommittee, the Commonwealth of Virginia has embarked on a critical mission to improve the P-16 teaching and learning opportunities related to Science, Technology, Engineering and Mathematics (STEM) so that all students will engage in these fields of study successfully, and many will pursue careers in the STEM fields.

For over 40 years, the education programs at Virginia Tech have provided well-prepared P-16 educators in the STEM areas. In response to the national call, the School of Education has invested a great deal of resources into the advancement of STEM education, research and development, as well as increased our capacity to prepare an increased number of highly qualified STEM teachers. In addition, we have created a STEM graduate curriculum, and engaged in a range of outreach programs, such as our *First Robotics* partnership with Montgomery County Schools. Based on our efforts and lessons learned, we respectfully offer the following recommendations to the HJR 25 Subcommittee for consideration:

1. Support the creation of STEM teacher licensure, including initial and advanced endorsements, that prepares school leaders to implement an integrated approach in P-12 STEM education. This licensure will prepare teachers who may have primary expertise in any of the STEM areas to develop the interdisciplinary pedagogical content knowledge, as well as the awareness of the social utility and historical development of science, technology, technology education, engineering, and mathematics and the everyday knowledge of how these disciplines truly work together in the everyday world.

2. Focus the Teacher for Tomorrow Program on the recruitment of high school students into teaching in the STEM fields. Provide incentives for students, high schools, and universities to partner in these collaborative programs.

3. Provide incentives (e.g., scholarships) for recruiting highly qualified science and mathematics students to accredited STEM teacher education programs. Increase the number of Virginia Teaching Scholarships targeted for prospective STEM teachers.

4. 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.
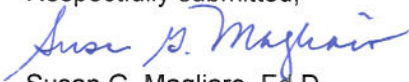
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[1] National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine

Invent the Future

5. Focus professional development for pre-service and practicing teachers on inquiry and problem-based approaches (e.g., learning how to teach science as inquiry). These pedagogies, rather than skills-based approaches or approaches where the students have to deduce the already-established correct answer, will embed motivation in academic tasks. Moreover, these types of approaches can shift the "location" of the schooling to community-based issues and/or issues encountered by STEM-oriented occupations. The academic work immediately becomes relevant and students begin to seek out the skills and knowledge that they need to solve the problems.

6. Expand the nature of the assessment system to challenge students with more open-ended problems such as those noted in the previous recommendation. The literature is clear that the kinds of problems that replicate the real world and motivate students are problems requiring complex and creative solutions. We need to prepare students for these problems and not expect that they will be able to be successful just because they have the basic facts and skills memorized.

7. 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. While our 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.

8. Finally, we'd like to close with a vignette from the young women who have been involved in our First Robotics program. For the several years, our faculty members have attempted to attract women and underrepresented groups into the STEM disciplines. This particular program has engaged in collaborative research and development with the College of Engineering to study the ways that this program engages students in robotics and follows these students as they move into post-secondary work. Specifically, this project speaks to the recruitment and retention issue. Initially, the young women chose to join the program because it was for a vocational credit, and they could meet with their friends after school, "I'm not sure that I would bring up the topic that it is 'engineering'… I don't love this because it's mechanical engineering… For me it's the competition, the afterschool, and the credits." Once involved, they agreed, "Yes, it is so cool to be in Robotics!" However, one young woman cautioned, "You want to make sure that you separate it out so that there is at least one girl in a group with the guys. If one girl is in the group, then the other girl will see it and think that she can do it too. At the same time, she's not being isolated with all of the guys. I think the isolated girl would hurt it. Making all girl groups in Robotics is not cool. It always ends badly." While these are just snippets from the program participants, these insights afford us all a window into thinking carefully about the ways to attract and retain promising scientists, mathematicians, and engineers.

In sum, the Virginia Tech School of Education is focused on the advancement of the general education, recruitment, and retention of K-16 students in the STEM disciplines. We believe that an interdisciplinary focus will bring to bear the expertise and resources necessary to address the need. We are positioned to contribute to the Commonwealth's initiative in substantive ways ranging from research to development and implementation in curriculum, instruction and assessment.

Respectfully submitted,

Susan G. Magliaro, Ed.D.
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