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The Role of STEM Programs for Educating Maryland's 21st Century Workforce

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CENTER FOR THE STUDY OF DEMOCRACY
Exploring Issues in Democracy and Liberty Throughout the World

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Table of Contents

This paper was produced by Dr. Michael Cain and Mr. Greg Robison for the Patuxent Policy Group, a collaboration of the Center for the Study of Democracy and The Patuxent Partnership.

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The Role of STEM Programs for Educating Maryland's 21st Century Workforce

Introduction

The Patuxent Policy Group, a collaboration of The Patuxent Partnership and the Center for the Study of Democracy, hosted a group of experts at St. Mary's College of Maryland to discuss STEM initiatives as academic ventures designed to support national goals of educating and producing more scientists and engineers for U.S. labor markets. The working group, moderated by Dr. Patricia Florestano, former Secretary of Higher Education, Maryland Higher Education Commission, convened panelists and participants from academia, government and industry, with a broad range of perspectives and experience. The discussions focused on how STEM educational policies can best assist with new competitive challenges facing Maryland in the global economy. What policies are needed to support STEM initiatives in Maryland and the nation?

Keynote speaker Dr. Pam Northrup, Dean, College of Professional Studies, University of West Florida, opened the program with a discussion of the National Flight Academy in Pensacola, and the work being done to interest students in STEM disciplines through an immersive aviation-based coursework.

This document reflects the perspectives of the panelists and participants and identifies key issues and policy solutions to K-12 education, especially as it relates to STEM programs in Maryland. The views expressed in this paper reflect the output of a group discussion and are not intended to represent the views of any particular individual. This paper was produced by Dr. Michael Cain and Mr. Greg Robison.

I. Main Findings

1. STEM studies are an indispensable component of education in the 21st century. This means every student in the United States should have an opportunity to access these programs. Policy decisions on STEM education should address racial and economic achievement gaps on standardized tests in STEM fields.

2. Equal access to STEM programs can help address current educational achievement gaps and assist Maryland with its goal of achieving college degree rates of 55% among adults by 2025.

3. Greater collaboration and coordination between K-12 school systems, institutions of higher learning, businesses and governmental agencies can enhance long-term economic growth by encouraging STEM education. Greater collaboration can improve student understanding of job opportunities provided by STEM education and motivate more students to pursue STEM coursework.

4. The Common Core State Standards are measures designed to align K-12 curriculum with the skills necessary to succeed in higher education. Many of these skills – including effective communication and critical thinking – are not limited to STEM education and are learned and reinforced through liberal arts curricula. Both the liberal arts and STEM-related disciplines need to be strengthened across curriculum. Communications, writing, and analyzing skills are vital to the success of our students. Technology and liberal arts must intersect for STEM initiatives to succeed.

5. Increasing the supply of new K-12 STEM teachers and providing institutional support to current STEM teachers for improving content knowledge are critical to the long-term health of STEM education. Retention of STEM teachers requires investments in salaries and building workforce capacities. Learning teams may be a cost effective way of improving instruction and increasing content knowledge of STEM teachers.

6. To achieve the full promise of STEM education policies, different methods of reaching all STEM students must be explored. Physical (or social) barriers between students and teachers can be exacerbated by distance or other social factors. Technology can help alleviate physical barriers to access, for example, by providing online course content to more students of every income group.

7. Programs that emphasize digital technologies in schools can provide new educational and learning opportunities. STEM programs in particular are poised to take advantage of these new trends. New educational and funding policies must be developed to overcome current barriers to implement new digital technologies. Providing meaningful access to STEM programs requires continued efforts by local and state governments to create public infrastructure that supports widespread Internet access.

8. Statistics associated with labor market projections should be widely diffused to researchers and policy makers in the fields of economics and education. This will allow educators to match curricular content to emerging skills needs and adjust learning outcomes that students need to succeed in academia and STEM professions.

II. STEM as Part of a Complete Education

Education of all disciplines should prepare students for life beyond K-12 schooling, whether it is preparation for the job market or further study in higher education. STEM programs should therefore enrich and complement other disciplines in K-12 schooling.

The overlap of skills taught in STEM subjects and the liberal arts supports recent discussions that students need a more rigorous education across the curriculum. Students need to learn critical thinking, effective communication, and collaborative decision making across all subjects and disciplines. Students should then practice applying these skills in all subjects to strengthen individual capacities in these core proficiencies.

Liberal arts education in particular should be strengthened in STEM-related disciplines. A strong foundation of learning in these fields will supply our future workforce with foundational skills necessary to successfully adapt to new labor market needs. This will also enable future workers to better integrate knowledge in STEM fields to changing circumstances. The impact of these considerations on environmental or military decision-making processes, for example, highlights the importance of developing a workforce capable of operating responsibly in fields that increasingly depend on new technologies. A strong foundation in liberal arts is therefore an integral part of STEM education.

Ultimately, a high-caliber education itself has the potential to equalize students' future opportunities. STEM education is not the only way to achieve this goal, but it is a crucial component of a more robust curriculum. Cross-departmental collaboration is necessary to integrate STEM and non-STEM fields.

III. Engaging Student Interest in STEM Education

The presence of online and computerized technologies continues to expand in commercial, consumer and educational settings. Increased computer skills can be expected to expand in scope among young adults in the near future. Current students are usually technophiles; their comfort with new technologies is a reflection of their online habits and their willingness to experiment with new technical computer programs and products.

These trends in the digital habits of students have implications for educational policy. The natural technological interests of many students can be harnessed through the introduction of new digital technologies in classrooms across the curriculum. This holds the potential to increase students' interest in the curriculum and proportionately enhance their motivation to learn.

Programs that emphasize digital technologies in schools can also provide new educational and learning opportunities. Students can participate in real-world simulations and cooperative activities that are more active and engaging than traditional pencil-and-paper work. Activities modeled on real-world situations are not only attractive learning alternatives for students; they are also tailored to suit the developmental preferences of students by catering to nascent social interests. Adolescent students in particular stand to benefit from the additional opportunities for communication and socialization embedded in online collaboration. This can enhance students' autonomy and facilitate flipped or student-centered curricula, which may promote greater student learning and retention.

STEM programs in particular are poised to take advantage of these new trends. These programs can be incorporated in school curricula or be offered outside of the formal curricula in schools. LEGO Education, for example, exposes students to robotics instruction at all age and grade levels. Such programs can also provide opportunities to enhance curricula in both STEM and non-STEM fields. The National Flight Academy is another promising co-curricular program that serves to increase student interest in pursuing STEM education. This program exposes students to realistic simulations that require remote communication and collaborative decision-making.

3D printers provide important learning opportunities for both STEM and non-STEM students. Towson University's Object Lab primarily teaches college students about 3D printing; however, the lab also provides online opportunities to young learners in technology centers at different locations in the state. This type of experiential learning uses high-tech tools to teach basic skills about design and has considerable potential in STEM programs and technical education.

The use of online technology outside of STEM fields can be used to improve learning and increase future productivity of workers. It provides students with a vital experience that will prepare them for professional communities where distance between individual workers is increasingly irrelevant. This could potentially further students' technological education outside of traditional fields.

III. Engaging Student Interest in STEM Education

The perfunctory use of technology, however, does not guarantee improved learning outcomes. Educational policy requires us to research the efficacy of such programs before scaling them up nationally. Educators and policy researchers need to investigate best practices for incorporating technology into education and disseminate teaching methods that show demonstrable student performance increases throughout school systems. While we know that hands-on programs often foster greater student interest in science, performance gains need to be fully evaluated along with their costs.

Long-term studies that measure the impact of various programs on performance gain and student attitudes towards STEM education and job preferences will dispel any doubt as to a specific program's potential for enhancing student learning or interest in science. This is a worthwhile area of study, and could result in the diffusion of programs that both appeal to student learning preferences and enhance student learning.

IV. Providing Greater Access to STEM Education

STEM studies are an indispensable component of education in the 21st century. This means every student in the United States should have an opportunity to access these educational programs. Although there are multiple paths that permit greater student access to STEM education, there are many policy barriers that need to be addressed to achieve full access for all students.

Technology has decreased barriers to STEM. Distance learning can remove physical barriers that limit access to STEM curricula. However, a crucial requirement of distance learning is Internet access. Providing meaningful access to STEM programs requires continued efforts by local and state governments to create public infrastructure that supports widespread Internet access.

Online courses can also enhance access of students to a larger pool of highly qualified educators. Students can communicate and collaborate peer-to-peer or interact with experts in real time. This can transform social studies and foreign language classes into hands-on, real-world experiences. It can also foster joint projects between and within schools. These types of course tools can allow students to attend class even if they have health limitations, disabilities or if there is lack of qualified personnel in the vicinity.

The importance of distance learning opportunities are well known, but policies to realize these opportunities have not been implemented. Disseminating new digital educational models requires greater coordination across classrooms, departments, school systems and states. This requires the establishment of networks of educators outside physical classrooms. Logistical considerations related to this include mutually acceptable curricular goals, learning experiences, and performance expectations between disparate institutions. While bodies such as online universities have pioneered this model of outsourcing education to virtual classrooms, transferring it to public education would require massive curricular reconceptualization and professional development.

An important element to enhance the accessibility of STEM programs involves collaboration between schools and communities. There are two general approaches that have been pursued. One involves schools managing interactions between the students and the community; for example, sending students on STEM-related field trips or bringing STEM experts into schools to provide interest or experience-building events. This community involvement can increase student interest in STEM as well as provide greater understanding of local professional or volunteer opportunities that develop STEM skills. Another approach is school-community collaborations that highlight STEM opportunities to families. Publically informing students and the community of educational opportunities that ensure economic and academic competitiveness can increase the likelihood of students enrolling in these programs. Of course, some parents may not know or understand the importance of STEM education. This suggests that schools and community partners should continue to be proactive in educating all families.

In addition to collaborative community programs, curricular changes can be made within school districts to improve student access to STEM education. For example, instituting STEM academies within schools or sponsoring programs such as Project Lead the Way bring STEM education directly to students. Decisions on where and how to allocate funding for these programs must consider where they might best enhance accessibility. For instance, what location would provide accessibility for the most students or combat historic achievement gaps?

V. Addressing Achievement Gaps

It is a common misconception that STEM education within the United States unilaterally is falling behind international competitors, when measured by standardized testing scores. Disaggregated test scores from institutions such as the Program in International Student Assessment reveal that while white, Asian, and multiracial student scores on math and science tests were above international averages, these achievements were mitigated by African-American, Hispanic, and impoverished students who scored lower than international averages. This indicates that some students may not have full access to higher education and professional opportunities in STEM fields. A major concern for STEM funding and enrichment programs, therefore, is the elimination of achievement gaps to provide greater access "STEM for all," instead of creating a tiered system based on socioeconomic access.

The recently established state goal to increase by 2025 the percentage of Maryland's adult population with post-secondary collegiate degrees to 55% is directly compromised by achievement gaps. Minority groups are most affected by these educational achievement gaps; these groups also have the fastest growing populations in the state. It is projected that within ten years, the Hispanic population will represent 22% of Maryland's total population and African Americans will represent 33% of Maryland's total population. The persistence of achievement gaps threatens the likelihood that Maryland's population will reach these educational goals. Failure to address these persistent achievement gaps makes it extremely difficult for Maryland to maintain its leading role in fields from bio-tech to cyber security.

VI. Implementing Quality Curriculum

The Common Core State Standards (CCSS) now being instituted throughout Maryland were designed to ensure that our K-12 curricula trains students to master skills that postsecondary educators expect of high school graduates. The CCSS focus is on skills requisite for future professions, including critical thinking, communication, decision-making and effective collaboration.

CCSS has the potential to reverse the problems caused by No Child Left Behind (NCLB), which did not align K-12 instruction toward postsecondary instructor expectations. For example, NCLB measurements did not consider science testing when determining whether schools met their goals of achieving adequate yearly progress, effectively diminishing the importance of science to K-12 students. As a consequence, many science departments faced budget cuts due to their perceived diminished importance in school-wide success.

Increased funding is important for the success of CCSS in enhancing STEM education. A world-class K-12 education must be available to all students if the U.S. is to maintain its competitive edge. This caliber of education is only afforded when students have equal access to capable instructors and adequate facilities.

By 2015, the state of Maryland plans to triple the number of highly qualified STEM teachers. Policymakers also hope to triple the number of STEM teachers who use new technologies associated with research-based teaching methodologies. This will allow the implementation of new teaching methodologies that have proven successful in promoting student learning and retention. Research indicates that approximately 85% of all teachers use the same methodologies that they experienced as students. For instance, studies in flipped or student-centered classrooms statistically increase student learning and improve the student engagement levels in course materials. This comes at the price of the diminished perception of teachers' effectiveness. This drop in student affect is due to the misconception that teachers are teaching only while directly in charge of providing class content and directly managing student conduct.

Increasing the supply of new K-12 STEM teachers and providing institutional support to current STEM teachers for increasing subject matter capacities are critical to the long-term health of STEM education. Retention of STEM teachers requires investments in salaries and building workforce capacities. Recent studies suggest that learning teams are a cost-effective way of improving instruction and increasing content knowledge of STEM teachers. Learning team participation not only deepens and extends teacher competence areas, it also improves the instruction and delivery of STEM materials in the classroom.

Instructors and other staff in K-12 institutions share responsibility to ensure that students do not fall behind their peers in terms of science and math achievement. Student enrollment in remedial classes carries many negative consequences, including increased student attrition, increased risk of dropping out of school, and decreased levels of college and career preparedness. These consequences are even more pronounced in students who must repeatedly enroll in a course. In light of this, it is essential that schools monitor student performance and provide timely, appropriate interventions to underachieving students who are in STEM courses.

VII. STEM and U.S. Labor Markets

There are many new companies and professions related to STEM educational fields, from social media to medical breakthroughs. The military has a vested interest to advance STEM education. Many new jobs have been created in industries from biofuels to unmanned systems, with expansion from Aberdeen in the northeast to Patuxent River in Southern Maryland. Similar opportunities have been created across the U.S. Many other institutions also have the potential to employ STEM graduates: for example, information technologies, new materials engineering, alternative fuels, manufacturing medicine and environmental sciences.

Institutions can assist in the creation of companies that hire STEM graduates or incentivize companies to employ them. The InvestMaryland program has been successful in contributing to commercial growth of high-tech companies. The current strategic plan of the University System of Maryland calls for the creation of 325 companies over this decade that use high-tech skills and equipment. STEM education is a catalyst for the creation of private firms that depend on STEM graduates.

Current projections on the growth of job opportunities in STEM fields are not static and have considerable variation associated with them. There is a need for greater study of emerging professional opportunities on the local, regional and global scale. This requires data development on labor markets, better data access and regular monitoring of labor market trends.

Statistics associated with labor market projections should be widely distributed to researchers and policy makers in the fields of economics and education. This will allow educators to match curricular content to emerging skills needs and adjust learning outcomes that students require in academia and STEM professions.

Greater collaboration and coordination between K-12 school systems, institutions of higher learning, businesses and governmental agencies can enhance economic growth. A side effect of greater collaboration is its influence on student choice in K-12 education and student access to STEM. An understanding of future job opportunities provided by STEM education, for example, can motivate students to pursue STEM coursework. Students can also learn about local applications of STEM education and gain valuable industry experience through participating in field trips, internships, and projects that allow students to interact with their communities.

Policies that support STEM education improve U.S. global competitiveness by improving technical capacities in the workforce. As reflected by current trends in the labor market, STEM programs are a critical element of U.S. educational needs. These policies, while important, will not provide a “one size fits all” solution to all our labor market challenges. To maintain the competitive edge of our labor force, U.S. educational policy must address socioeconomic inequalities that influence learning in K-12 education.

VIII. Conclusions

Future investments in STEM education hold the promise of advancing multiple economic, educational and social goals in Maryland. Strong STEM educational programs throughout the state will serve to ensure Maryland's top educational rank within the country. Maintaining this ranking will further contribute to the reputation of Maryland as a great place for families to educate their children and a profitable place for businesses to locate.

Strong STEM educational programs promise to produce graduates that advance existing research within the state, ranging from biotechnical advances that restore the health of the Chesapeake, to technical discoveries in unmanned aerial vehicles that will change the landscape of aviation. Whatever the discoveries, a highly educated, technical workforce will reinforce the attractiveness of our state as a place to do business. Maryland's investments in STEM education promise to enhance innovation within the state and contribute to job creation.

STEM education promises to make a difference in the lives of ordinary Maryland citizens. STEM can prepare students to be informed citizens by grounding them in basic scientific skills necessary to understand complex technological changes in the 21st century. STEM can also prepare students for changes in the job market that require strong preparation in mathematics and the sciences. Investments in STEM education should broaden the benefits of these programs to all Maryland students while eliminating barriers to STEM education. This will ensure that investments in STEM educational programs benefit us all.

CENTER FOR THE STUDY OF DEMOCRACY

A joint project of St. Mary's College of Maryland and Historic St. Mary's City

The Center for the Study of Democracy

The Center for the Study of Democracy was founded as a joint initiative of St. Mary's College of Maryland and its partner institution, Historic St. Mary's City, the site of Maryland's first capital. The purpose of the Center is to explore contemporary and historical issues associated with democracy and liberty in national and international contexts. The Center provides a forum for presentations by government officials, journalists, and scholars; publishes scholarly writings on subjects of civil governance; encourages and supports public participation in political processes; and engages undergraduate students in study and research on related subjects.

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The Patuxent Partnership works with government, industry and academia on initiatives in science and technology, hosts programs of interest to Naval Air Systems Command (NAVAIR) and the broader DoD community, supports workforce development including education initiatives and professional development.
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