



# **USM Presidential Task Force on STEM Workforce**

**Robert L. Caret, Chair**

**President**

**Towson University**

**February 13, 2009**

**FINAL REPORT**

## **Preamble:**

As recognized by the U.S. Department of Labor in its 2007 STEM Workforce Challenge report, both the economic growth and global competitiveness of the United States rely heavily on the nation's ability to generate and retain an adequate supply of skilled workers in Science Technology, Engineering, and Mathematics (STEM) fields.

The Base Realignment and Closure (BRAC) process which will transition an estimated 30,000-60,000 new jobs to Maryland, many of which are STEM professions, according to the Governor's BRAC Subcabinet, has brought to the forefront Maryland's urgent STEM need. In order to fulfill the demands for qualified workers in STEM fields, a coordinated and collaborative approach must occur in both the public and private sectors among educational institutions, agencies, businesses, and government.

Institutions of higher education, however, hold a crucial role in enhancing and strengthening the pipeline of students studying and graduating in the STEM fields at every level of education. College and universities have multi-dimensional influence on the makeup of the nation's workforce from the classroom to the boardroom. Colleges and universities train and prepare future educators that go on to motivate or influence the educational and career pathways of their students. At the same time, higher education institutions provide access programs in partnership with local elementary and secondary school students to broaden the academic horizons of students and generate interested in selected topics at an early age.

Once students arrive on campus, institutions must create and deliver additional academic opportunities for STEM majors and ensure they graduate. Furthermore, they must also create educational opportunities for those who seek career advancement or a career change.

This multi-faceted approach to address the need for STEM professionals is vital to supplying the high demand for highly skilled workers in these fields and institutions of higher learning provide the gateway to this much-needed supply.

As part of its mission the University System of Maryland, a public system of higher education comprised of 13 institutions, aims to provide knowledge-based programs and services that are responsive to the needs of the citizens of the State of Maryland and the nation. Several years ago the USM identified STEM as an area of concern and through its member institutions has sought to create early interest in STEM fields among K-12 and higher education students as well as provide professional development opportunities for the State's existing workforce. Cooperatively and individually the USM institutions have launched a number of initiatives and programs centered at STEM promotion including, teacher workshops, symposiums, K-12 summer learning academies, program-centered housing, scholarships, internships, expanded program offerings and more.

As a participant in the Governor's Commission on STEM, the USM determined the current landscape for STEM education within the system, where increased capacity can occur, and what the cost and necessary resources are to move forward with increasing the STEM pipeline of students.

Over the past six months, 12 of the 13 USM institutions participated in an extensive review of each institution's efforts to cultivate a continuous stream of STEM students and professionals and an evaluation of Maryland workforce data<sup>1</sup>.

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<sup>1</sup> USM STEM Workforce: Competitiveness and the USM. *Presentation to the Governor's P-20 Leadership Council Maryland STEM Task force Meeting, November 20, 2008* Office of Administration and Finance, Chief Operating Officer

This report accesses the combined results of each institutions best practices and methods and offers recommendations on areas where additional focus and further support is required to foster STEM growth in the State of Maryland.

**Findings:**

While many gaps between need and production exist, the largest gaps in the Maryland STEM workforce were determined to be in the following four fields: engineering, information technology, bioscience and STEM teaching.

Recommendations to address these workforce gaps were developed in the following categories:

- 1) Resources and Financial Incentives
- 2) Pipeline Creation/Career Awareness
- 3) Program Availability

Strategies and the costs associated are being developed for each campus to increase STEM production for each field.

To achieve growth in the STEM fields, the group is recommending focusing efforts in the following areas:

- 1) Increasing STEM graduates
- 2) Increasing STEM teachers
- 3) Increasing retention of STEM majors
- 4) Increasing current knowledge base of STEM educators

Many groups in Maryland have been struggling with the now all too similar problem of how to increase the number of qualified STEM graduates. In an effort to build upon rather than duplicate the work of others, the task force reviewed the recommendations from the MSDE Teacher Shortage Taskforce<sup>2</sup>, the GWIB Education Industry Initiative<sup>3</sup>, the Rising Above the Gathering Storm Report<sup>4</sup>, and the Tapping America’s Potential Interim report<sup>5</sup>, among others. Many best practices were also discussed such as the University of Texas, UTeach program. The recommendations from the reports reviewed have been consistent and will be reflected in the recommendations.

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<sup>2</sup> Maryland State Department of Education. “Maryland Teacher Shortage Task Force Report” 2008. [http://www.marylandpublicschools.org/NR/rdonlyres/517D465A-F0B5-40DD-BB4B-E98EA716EC46/18195/MD\\_TSTF\\_Report\\_0608.pdf](http://www.marylandpublicschools.org/NR/rdonlyres/517D465A-F0B5-40DD-BB4B-E98EA716EC46/18195/MD_TSTF_Report_0608.pdf) (2 September 2008)

<sup>3</sup> Governor’s Workforce Investment Board. “Maryland’s Education Industry: Report and Recommendations for the Governor’s Workforce Investment Board-Education Industry Initiative Steering Committee” 2008 <http://www.mdworkforce.com/pub/pdf/mdeducind.pdf> (2 September 2008)

<sup>4</sup> Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, “Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future” 2007. National Academy of Sciences, National Academy of Engineering, Institute of Medicine.

<sup>5</sup> Business Roundtable. “Tapping America’s Potential: The Education for Innovation Initiatives, *Gaining Momentum, Losing Ground*” 2008. [http://www.tap2015.org/news/tap\\_2008\\_progress.pdf](http://www.tap2015.org/news/tap_2008_progress.pdf) (2 September 2008)

**Data Review:**

Data on USM production of STEM enrollment for undergraduate and graduate programs and for STEM programs at each of the institutions were collected. These data are represented in Tables 1 and 2.

**Table 1:**

**STEM Total Enrollment**

<b>USM Schools</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
Bowie State University	881	758	602	692	667
Coppin State University	342	354	328	307	275
Frostburg State University	532	502	476	437	428
Salisbury University	917	879	828	872	867
Towson University	2,049	2,032	2,040	2,181	2,313
University of Baltimore	207	231	228	245	267
University of Maryland, Baltimore	279	268	283	288	270
University of Maryland, Baltimore County	5,349	5,256	5,073	5,048	5,079
University of Maryland, College Park	10,238	10,052	9,785	9,629	9,972
University of Maryland, Eastern Shore	896	835	946	969	934
University of Maryland, University College	4,395	4,879	4,588	5,192	5,379
<b>TOTAL:</b>	<b>26,085</b>	<b>26,046</b>	<b>25,177</b>	<b>25,858</b>	<b>26,451</b>
<b>4-Year Public &amp; Selected Schools</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
College of Notre Dame of Maryland	151	125	109	117	118
Goucher College	74	81	88	88	70
Hood College	257	270	288	283	328
Johns Hopkins University	5,508	5,767	6,052	6,031	6,726
Loyola College	513	541	504	544	578
McDaniel College	230	232	221	221	214
Morgan State University	1,835	1,757	1,518	1,561	1,545
Mount St. Mary's University	209	207	218	227	230
St. Mary's College	158	173	178	263	301
Villa Julie College	512	461	472	511	572
<b>TOTAL:</b>	<b>9,447</b>	<b>9,614</b>	<b>9,648</b>	<b>9,846</b>	<b>10,682</b>

Source: *MHEC Trends in Enrollment by Program*  
 Prepared by: TU Institutional Research- N.S. 9/16/2008

HEGIS Codes used to define STEM

Engineering	0500-0999	Math	1700-1799
Biology	0400-0499	Computer Science	0700-0799
Physical Science	1900-1999	Science Related Majors	4502 & 4999 & 9099

**Table 2:**

<b>*USM Schools: STEM Programs</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
Engineering (0900-0999)	5,898	5,900	5,879	5,765	5,915
Biology (0400-0499)	6,267	6,591	6,896	7,295	7,443
Physical Science (1900-1999)	1,546	1,883	1,777	1,941	1,970
Math (1700-1799)	1,226	1,311	1,254	1,288	1,377
Computer Science (0701)	4,791	4,285	3,725	3,514	3,423
Information Systems (0702)	5,703	5,635	5,091	5,398	5,736
Other- Computer Science (0799)	505	446	374	464	392
Science Related Majors (4902/4999/9099)	149	195	181	193	195
<b>TOTAL:</b>	<b>26,085</b>	<b>26,046</b>	<b>25,177</b>	<b>25,858</b>	<b>26,451</b>
<b>**4-Year Public &amp; Selected Schools: STEM Programs</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
Engineering (0900-0999)	3,136	3,314	3,408	3,473	3,480
Biology (0400-0499)	2,883	2,988	3,017	3,152	3,821
Physical Science (1900-1999)	817	802	855	907	1,034
Math (1700-1799)	430	473	488	519	559
Computer Science (0700-0799)	1,411	1,330	1,247	1,213	1,175
Information Systems (0702)	742	677	595	544	593
Other- Computer Science (0799)	0	0	0	0	0
Science Related Majors (4902/4999/9099)	28	30	38	38	20
<b>TOTAL:</b>	<b>9,447</b>	<b>9,614</b>	<b>9,648</b>	<b>9,846</b>	<b>10,682</b>

\*Note: USM Schools include: Bowie State Univ, Coppin State Univ, Frostburg State Univ, Salisbury Univ, Towson Univ, Univ of Baltimore, Univ of MD- Baltimore, Univ of MD- Baltimore County, Univ of MD- College Park, Univ of MD- Eastern Shore, Univ of MD- Univ College.

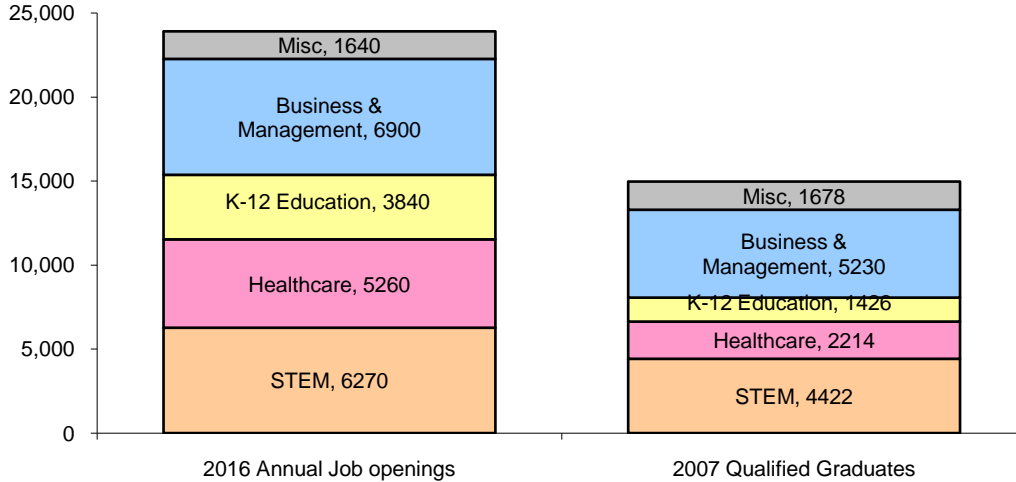
\*\*Note: 4-Year Public & Selected Schools include: College of Notre Dame of Maryland, Goucher College, Hood College, Johns Hopkins Univ, Loyola College, McDaniel College, Morgan State Univ, Mount St. Mary's Univ, St. Mary's College, Villa Julie/Stevenson

Source: MHEC Trends in Enrollment by Program  
 Prepared by: TU Institutional Research- N.S. 9/16/2008

**Workforce Gaps:**

STEM graduates were compared by job category to demand and need these data are summarized in Figures 1 and 2 and Table 3.

**Figure 1: Workforce Demand in Key Sectors  
Jobs Requiring College Degree**



Gaps in the STEM fields are greatest for the following categories: engineering, information technology, STEM teaching, and biosciences. The recommendations will address these specific fields. A detailed breakdown of the gaps is found in Table 3.

**Figure 2: The current USM STEM graduates compared to the 2016 job openings in selected STEM fields.**

**Maryland's STEM Workforce Needs**  
2004 USM Graduates, 2007 USM Graduates, 2016 Job Openings

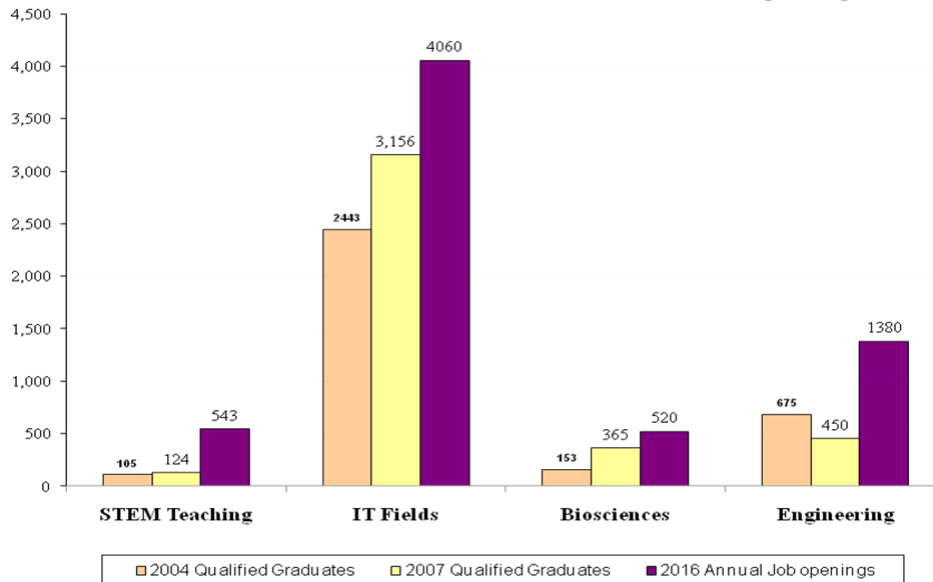


Table 3:

**Gap between Need Met by USM Graduates and  
Total Need in Key Workforce Need Areas**

**Academic Year 2006-2007**

Area	Total Qualified USM Graduates	Total Additional Graduates Needed	USM Goal to meet Demand (70% of need)	Key Areas
<b>Engineering</b>				
Bachelors	352	269	<b>188</b>	Civil Engineers, Electrical Engineers, Electronics Engineers Aerospace Engineers, Architects
Masters	87	131		
<b>Information Technology</b>				
Bachelors	3,130	824	<b>577</b>	Computer Software Engineers (Applications), Computer Programmers, Computer Hardware Engineers None
Masters	300	0		
<b>STEM Teaching</b>				
All	124	322	<b>225</b>	All
<b>Bioscience Professions</b>				
Bachelors	534	935	655	Civil Engineers, Biological Technicians, Electrical Engineers, Environmental Scientists & Specialists, Computer Software Engineers (Applications), Computer Programmers
		111	78	Without Engineering and IT duplicates
Masters	179	41	28	Medical Scientists
		152	<b>106</b>	Bachelors & Masters

Using these data the task force members reviewed constraints to increasing STEM production on our campuses in order to fill the observed workforce gaps. The task force considered those areas in which some institutions should be able to make progress with few additional resources and where institutions will need significantly more assistance to move forward. This review led to the following recommendations to increase the production of STEM graduates.

Measurement outcomes will be established for these recommendations and for the funds directed to achieve the desired outcomes. The highest priority recommendations listed below include items that fall under the purview of the State, USM, MSDE, MHEC and other educational and business partners. The list of USM focused recommendations are reflected in the attached funding request. Of significant importance are items in which state policy or governing agencies can take the lead in achieving success and consensus for the improvement of STEM education in the State of Maryland.

## **RECOMMENDATIONS:**

### *USM Focused recommendations:*

#### **Resources and Financial Incentives**

- 1) Fund STEM programs on a premium basis (150% of the current funding guideline) with the funds aimed at incentivizing the development of critical need programs and scaling up targeted programs
- 2) Expand and ensure availability of State supported scholarships, tuition waivers, tuition discounts and loan forgiveness programs
- 3) Encourage MSDE, local school boards and the MSTA to provide competitive salaries for hard to fill STEM teaching positions

#### **Pipeline Creation/Career Awareness**

- 4) Develop, enhance and provide systemic funding for programs that have proven to be successful, such as weekend and summer academies and State mandated Professional Development Schools (PDS) , in providing teachers with the opportunities to remain timely in their fields , professionally engaged, and also provide the time and help to develop resource and enhancement materials for their classes
- 5) Partner with industry to sponsor summer science and math academies for students (e.g., ExxonMobil Bernard Harris Science Academy at BSU), internship and mentorships including early field experiences for STEM majors so that they can be exposed to teaching and STEM classrooms
- 6) Develop programs to build strong partnerships between STEM departments in universities and local secondary schools to provide strong enrichment and professional development activities for both elementary and secondary teachers
- 7) Develop programs with MSDE to reduce remediation needed by entering college students and to align high school graduation with college entrance requirements for math and the STEM fields
- 8) Expand professional development programs and pathways to certification and enhance options for career changers into all STEM fields

#### **Program Availability**

- 9) Expand availability of programs through online education
- 10) Provide enhancement funding to increase retention and graduation rates in the STEM fields for HBCU's per the Commission to Develop the Maryland Model for Funding Higher Education
- 11) Expand statewide associates degrees and continue to develop seamless articulation and transfer agreements



*Recommendations under the State's purview:*

The support of a wide range of partners is needed to achieve success in closing the gap between STEM graduates and STEM employment opportunities in Maryland. The following recommendations need the support of the State, Governor's Office, MDSE and MHEC to ensure their success.

- 1) Ensure professional staff development and overall classroom support occurs at all K-12 schools
- 2) Ensure open competition in the development of STEM graduate degree programs
- 3) Engage a marketing firm to clearly define avenues to reach schools and students to expand career awareness
- 4) Expand public relations efforts to attract second career professionals and retirees into the STEM fields, specifically STEM teaching

*Additional Best Practices:*

The recommendations above were selected as highest in priority and were deemed most likely to have the greatest impact to achieve the goals of this initiative. In addition, many other recommendations were discussed by the task force and were felt to be important tools in to address the STEM gap in Maryland. There are many regional needs and situations that may be better addressed through the practices listed. The list is provided for consideration by institutions.

- 1) Work with the local education associations (LEAs) to leverage their Federal enhancement funds for professional development efforts for teachers
- 2) Expand availability of mobile labs for science teachers in schools
- 3) Provide additional funds for support services for faculty and lab enhancements
- 4) Create and fund a system to provide teacher professional development opportunities and course work at no cost to Maryland school systems
- 5) Create targeted in-service programs for new STEM teachers
- 6) Revive (or invigorate) math and science clubs in K-12 schools
- 7) Organize competitions – essays, projects, robotics, science fairs - on annual basis
- 8) Expand outreach programs for young students such as the Towson University (TU) Hackerman Saturday Science Series and Make Science Fun at Bowie State University (BSU)
- 9) Reach out to the advisors and counselors at the middle and high school level to expand the awareness of careers in the STEM fields
- 10) Target "Way-to-Go Maryland" type programs to STEM fields
- 11) To help with career awareness, create entry level umbrella programs for students and develop a common language to be used by all institutions.
- 12) Expand bridge program efforts between K-12 , community colleges and universities
- 13) Expand regional higher education and existing program offerings
- 14) Facilitate the approval of graduate programs to fill the state's workforce demands
- 15) Encourage cooperative academic programs (multi-institutional efforts)
- 16) Create a specific planning focus at the state-level, perhaps through the P-20 Council, to parallel and support institutional level planning
- 17) Ensure policy decisions do not compete with the programmatic needs to meet the demands of educating a STEM workforce
- 18) A STEM Institute was developed earlier in Maryland but not funded. This is another recommendation worthy of additional consideration. See appendix 4

19) Several best practices from other states were discussed such as the UTEACH model at the University of Texas. A summary of this program is found in appendix 5

A budget has been developed for the costs associated with each of the recommendations. That budget is found in Tables 4 and 5.

<b>Table 4:</b>		<b>USM STEM BUDGET</b>							
High Priority Recommendations:									
	Yr 1	Yr 2	Yr 3	Yr 4	total	70% of total workforce gap/students	average cost per student	per student/per year cost	
STEM Secondary Education-50% comprehensive avg.	\$814,730	\$814,730	\$814,730	\$814,730	\$3,258,920	113	\$28,840	\$7,210	
STEM Secondary Education -50% research avg.	\$1,259,552	\$1,259,552	\$1,259,552	\$1,259,552	\$5,038,208	112	\$44,984	\$11,246	
Computer and Info Science Majors - 50% comprehensive	\$2,083,690	\$2,083,690	\$2,083,690	\$2,083,690	\$8,334,760	289	\$28,840	\$7,210	
Computer and Info Science Majors -50% Research	\$3,238,848	\$3,238,848	\$3,238,848	\$3,238,848	\$12,955,392	288	\$44,984	\$11,246	
Bioscience Majors - 50% comprehensive	\$382,130	\$382,130	\$382,130	\$382,130	\$1,528,520	53	\$28,840	\$7,210	
Bioscience Majors -50% research	\$596,038	\$596,038	\$596,038	\$596,038	\$2,384,152	53	\$44,984	\$11,246	
Engineering Majors (bachelors) research avg.	\$2,114,248	\$2,114,248	\$2,114,248	\$2,114,248	\$8,456,992	188	\$44,984	\$11,246	
<b>Fund increased STEM programs on a premium basis (additional 50% of the EFI cost per student)*</b>									
STEM Secondary Education-50% comprehensive avg.	\$407,365	\$407,365	\$407,365	\$407,365	\$1,629,460	113	\$14,420	\$3,605	
STEM Secondary Education -50% research avg.	\$629,776	\$629,776	\$629,776	\$629,776	\$2,519,104	112	\$22,492	\$5,623	
Computer and Info Science Majors - 50% comprehensive	\$1,041,845	\$1,041,845	\$1,041,845	\$1,041,845	\$4,167,380	289	\$14,420	\$3,605	
Computer and Info Science Majors -50% Research	\$1,619,424	\$1,619,424	\$1,619,424	\$1,619,424	\$6,477,696	288	\$22,492	\$5,623	
Bioscience Majors - 50% comprehensive	\$191,065	\$191,065	\$191,065	\$191,065	\$764,260	53	\$14,420	\$3,605	
Bioscience Majors -50% research	\$298,019	\$298,019	\$298,019	\$298,019	\$1,192,076	53	\$22,492	\$5,623	
Engineering Majors (bachelors) research avg.	\$1,057,124	\$1,057,124	\$1,057,124	\$1,057,124	\$4,228,496	188	\$22,492	\$5,623	
<b>SUBTOTAL</b>	<b>\$15,733,854</b>	<b>\$15,733,854</b>	<b>\$15,733,854</b>	<b>\$15,733,854</b>	<b>\$62,935,416</b>				
Weekend/Summer Academies	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$4,000,000	480		\$2,083.33	
Online resources	\$250,000	\$250,000	\$250,000	\$250,000	\$1,000,000				
Professional development schools	\$2,500,000	\$2,500,000	\$2,500,000	\$2,500,000	\$10,000,000				
Enhancement funding for HBCU's**									
Fund the scaling up or creation of targeted programs to meet demand (eg: IT)***									
<b>total</b>	<b>\$19,483,854</b>	<b>\$19,483,854</b>	<b>\$19,483,854</b>	<b>\$19,483,854</b>	<b>\$77,935,416</b>				
*The funding per EFT will be 150% of the funding guideline as a minimum									
**HBCU enhancement funding to increase retention and graduation rates will be determined by the Commission to Develop the Maryland Model for Funding Higher Education.									
***The 150% of EFI shall cover the cost of labor when scaling-up programs.									
These funds should be used for additional lab equipment needs, research assistants and teaching assistants and will be determined on a case-by-case basis.									

<b>Table 5:</b>		<b>USM STEM BUDGET continued</b>							
Additional Best Practices Budget:									
	Yr 1	Yr 2	Yr 3	Yr 4	total	70% of total workforce gap/students	average cost per student	per student/per year cost	
Expand mobile labs (4-1 per region)	\$2,400,000	\$1,000,000	\$1,000,000	\$1,000,000	\$5,400,000				
Increase Loaner lab program	\$137,000	\$137,000	\$137,000	\$137,000	\$548,000	100		\$1,370	
Marketing/PR efforts for career awareness	\$100,000	\$450,000	\$350,000	\$250,000	\$1,150,000				
Expand Regional higher education offerings	\$600,000	\$150,000	\$150,000	\$150,000	\$1,050,000	total of 40-60 fte growth			
<b>total</b>	<b>\$3,237,000</b>	<b>\$1,737,000</b>	<b>\$1,637,000</b>	<b>\$1,537,000</b>	<b>\$8,148,000</b>				
*USM STEM Teacher Initiative "STEM-Teach"		See appendix for proposal and budget							

## **Appendices**

Appendix 1: Task Force Charge

Appendix 2: Task Force Members and Support Staff

Appendix 3: List of Meetings

Appendix 4: USM STEM Teacher Initiative “STEM-Teach”

Appendix 5: STEM Institute

Appendix 6: USM Institutions STEM Initiatives

## Appendix 1

### Presidential Task Force on STEM Workforce University System of Maryland August 1, 2008<sup>1</sup>

**Context:** Maryland is emerging as a powerhouse in the knowledge-based economy. With a high concentration of government labs, a growing technology based private sector, and a strong system of higher education, Maryland already ranks first in the nation in R&D expenditures per capita and second only to California in total R&D expenditures. The state is also ranked 2<sup>nd</sup> to Massachusetts in the recent Milken Institute's index of state research and technology capacity. In large measure, this success is driven by the education level of Maryland's workforce (percent of the population with bachelor's, Masters and PhD degrees), which ranks in the top five nationally.

Despite these glowing statistics, there are challenges on the horizon. There will be a large number of retirements in the coming decade as Maryland's highly educated 'baby boomer' population reaches retirement age. There is also a large demographic shift under way within the college age population. Under represented minorities, which have traditionally had lower college going rates, is the fastest growing segment of this population. Moreover, there is a shortage of highly qualified teachers in math and science in the K-12 sector, which – unaddressed – could have devastating effects on the development of the future workforce in STEM (science, mathematics, technology, and engineering) fields.

The USM has identified Maryland's competitiveness, including the development of a world class STEM workforce, as one of three overarching system wide priorities. In addition, Governor O'Malley has appointed a STEM Commission to address Maryland's workforce and R&D needs in the STEM areas. This Commission is co-chaired by the Chancellor and has strong representation from USM institutions.

**Charge:** The Presidential Task Force on the STEM Workforce is asked to both develop USM workforce development strategies for the USM's competitiveness initiative and to provide advice and support to the Chancellor and other USM representatives for their work on the Governor's Commission.

More specifically, the Presidential Task Force on the STEM Workforce is charged to study and report on the following issues:

- Projected state wide workforce shortages in the STEM fields, with special attention to the K-12 shortfall of highly qualified STEM teachers
- Targets for USM institutions to achieve in order to address STEM workforce shortages
- Strategies to achieve these targets
- Resources required to support the workforce development strategies
- Advice to the Governor's Stem Commission
- Actions and policies at the state level that would support the creation of a strong and vital STEM workforce in Maryland

In responding to these issues, the Task Force should consider these questions:

- Do we have appropriate programs in place to achieve the recommended STEM graduation targets?
- Do we have appropriate programs in place to recruit and prepare an adequate number of STEM teachers?

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<sup>1</sup> A second Presidential Task Force has been appointed to address competitiveness issues from a translational research and economic development perspective.

- Do we have appropriate financial incentives to achieve recommended enrollment targets?
- Do we have appropriate financial incentives to recruit STEM majors into STEM careers?
- Do we have adequate faculty in the right places to deliver the programs necessary to meet our enrollment and graduation targets?

**Task Force Composition and Report:** The Task Force will be chaired by Bob Caret, president Towson University, with membership drawn from the presidents and senior officers at USM institutions. The Task Force is asked to complete its report for the USM competitiveness initiative by the end of this calendar year. A status report should be developed by mid-October that will inform the USM's FY 2010 budget request. The Task Force is asked to be "on call" to support the Chancellor's efforts with the STEM Commission.

**Appendix 2:****STEM Presidential Task Force****Dr. George Acquah**

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**Appendix 3:**

**List of Meetings:**

September 2, 2008  
September 10, 2008  
September 24, 2008  
October 8, 2008  
October 29, 2008  
November 17, 2008  
December 4, 2008  
December 16, 2008

## Appendix 4:

### *USM STEM Teacher Initiative “STEM-Teach”*

**Summary:** USM proposes to develop a system-wide program to recruit more science and mathematics majors into teaching by establishing new programs within colleges of mathematics, engineering and sciences in collaboration with colleges of education, modeled, in part, on the successful programs at the University of Texas at Austin (UTeach). Simultaneously, USM will develop extensive professional development programs (including online masters programs) for current science and mathematics teachers aimed at enriching content knowledge and enhancing pedagogical content knowledge.

The initiative will be developed to include several pathways to educate and produce triple the number of new science, technology, engineering and math majors. It will include the following two types of programs, which will be discussed further below:

- I.     **PRODUCING NEW STEM TEACHERS**  
      Part 1: Recruiting New Highly Qualified STEM Teachers in Maryland  
      Part 2: Certification and Master’s Programs for Degree Holders
  
- II.    **SUPPORTING AND ENHANCING THE CURRENT STEM TEACHER WORK  
      FORCE IN MARYLAND**

The USM Initiative addresses the state’s high priority need to increase the number of science, technology, engineering, and mathematics majors graduating from Maryland universities and colleges. The USM will work with the Maryland State Department of Education, through this Initiative, to develop high quality standards for alternative certification. At the same time that this USM Board of Regents initiative is moving forward, a statewide blue-ribbon advisory committee has developed a proposal for a comprehensive state-wide STEM Institute, located at USM, to include innovative STEM academies as well as professional development centers in multiple school districts. USM is the largest producer of teachers in the state, and the USM Initiative is a critical program to provide STEM teachers. The USM Initiative would provide the support necessary for its institutions to develop the required programs. The USM STEM Initiative would also permit USM to be a strong partner in any state-wide effort to develop effective programs at multiple levels.

Funding for the program includes support for redesign of courses and curriculum, support for mentored field experiences and internships, and funds for scholarships and recruiting students into the program, as well as administrative support at the University System that would include research and program evaluation. The initial funding request is \$1.5 million in the first year of the project for planning and initial pilot implementation, with increases to \$3 million in year 2, and steady state funding of \$5 million annually to support the fully implemented program in year 3.



**Introduction:** Like many other states, Maryland is losing students from technology-related career paths in middle school and high school because of a lack of qualified, inspiring mathematics and science teachers. The National Academies' panel review of the current trends in education, economics, and science and technology conveys a sense of urgency and challenges states to respond with strategic planning around the first of the recommendations: "Increase America's talent pool by vastly improving K-12 science and mathematics education." (*Gathering Storm*, p.5, 2006)

## **I. PRODUCING NEW STEM TEACHERS**

### **Part 1: Recruiting New Highly Qualified STEM Teachers in Maryland**

As part of the solution to this problem, USM proposes to replicate a successful program that was developed in Texas to recruit more science and mathematics majors into teaching. The program, UTeach, developed at the University of Texas at Austin, was initiated in 1997; since then, UT has doubled the number of math majors and increased by 5-6 times the number of science majors being certified. They also have data that indicates that the 75% of the teachers who graduated in 2001 are still teaching.

Building on the successful UTeach model, the key elements of a USM STEM Teacher Initiative (*STEM-Teach*) to recruit and educate new STEM teachers include the following:

1. New pedagogy classes to replace the traditional courses focused on how to teach math and science, intermingled in the curriculum with discipline courses.
2. Adherence to national and state guidelines for math and science education.
3. Employment of outstanding, experienced high school and middle school teachers as instructors, advisors and field supervisors along with regular Science and Education faculty.
4. Inclusion of field experiences in the pedagogy courses at every level.
5. Providing monetary and tuition incentives to try the program.
6. Internships for students performing jobs that are relevant to the teaching profession.
7. Scholarships based on good performance in the program, especially for upper-division students.
8. Substantial support system, including assistance with lesson plans, curriculum and classroom management.

### **Part 2: Certification programs for degree holders.**

These programs can be designed either as post-baccalaureate certificate programs or master's certification programs. In this way, the project can expand to develop a one-year post-baccalaureate teacher certificate and a master's degree in Science and Mathematics Education. These options are of particular importance in meeting the needs

of individuals who have completed their baccalaureate degrees in STEM areas; the programs would be developed to meet the needs of the recent graduate as well as the “career changer.”

## **II. SUPPORTING AND ENHANCING THE CURRENT STEM TEACHER WORKFORCE IN MARYLAND**

A second important locus of activity for the USM STEM-Teach Initiative is an investment in the current workforce. According to the recent report, *Rising Above the Gathering Storm*,

- In 1999, 68% of US 8th grade students received instruction from a mathematics teacher who did not hold a degree or certification in mathematics.
- In 2000, 93% of students in grades 5-9 were taught physical science by a teacher lacking a major or certification in the physical sciences (chemistry, geology, general science, or physics).

Current research strongly demonstrates that teachers’ content knowledge has a direct impact on student learning outcomes. Professional development is key to supporting effective science instruction. USM will develop programs that create

- Opportunities for teachers to deepen their knowledge of science and mathematics content of the K-12 curriculum.
- Opportunities for special attention to elementary and middle school mathematics content knowledge through targeted professional development and innovative masters programs.
- Opportunities for teachers to learn how student learn science and mathematics and how to teach it.
- Opportunities for teachers to learn how to assess children’s developing ideas over time.
- Opportunities to learn how to teach science to diverse student populations.

Best practices in professional development parallel new teacher support programs in many ways, which allows USM to leverage the resources allocated to this project. In addition to some of the elements listed above, the initiative will partner with local school systems to develop:

- *Teaching mentor/ fellow programs* for the best teachers of science, mathematics, and technology to come for a summer, a semester or a year to further develop their skills. Activities will expand their role as expert teacher mentors and enhance their capacity to serve as teacher leaders supporting mathematics, science, and technology curriculum development and teacher enrichment in their schools.
- *Experiences in authentic science research labs for K-12 STEM teachers* to enrich the content knowledge of teachers and assist them in deepening their understanding of research and the scientific method.

- *Teacher resource and technology centers* with a library of printed and electronically accessible materials as well as sample lesson plans, materials, and information for using technology in classrooms for the teaching of science and mathematics.

### **III: PROJECT GOALS AND BUDGET**

#### **Goals:**

*Increase the number and diversity of students seeking teacher certification and develop these students into teacher leaders in their respective STEM disciplines.*

Specifically, over a five-year period the USM intends to (1) triple the number of science and mathematics students in the pipeline to become secondary science and math teachers and (2) triple the number of students graduating from USM institutions with secondary teacher certification in science and/or mathematics.

According to the most recent data collected by *MSDE Staffing Report (2006)*, USM institutions produced a total of 45 secondary mathematics teachers and 46 science teachers from undergraduate teacher education programs in 2004-2005.

#### **Budget:**

The budget for the USM STEM program to recruit more science and mathematics majors into teaching and to develop extensive professional development programs (including online masters programs) for current science and mathematics teachers can be described in three categories of expenses:

- expenses related to students (including student recruitment and support);
- expenses related to faculty (including hiring new faculty into the new programs, and supporting the development of professional development programs and courses); and
- program administration and support (including coordination at both the campus and system levels, and funding for evaluation, assessment and accountability).

Student-related expenses include tuition reimbursement for a cohort of 30 students per semester taking one one-credit course per semester at \$400 per course, and, in year two, a second cohort of 30 students per semester taking one one-credit course. In addition, in order to increase retention and reduce dropout rates from the program, the budget includes funding for advising, summer internship opportunities, and other student activities.

Faculty related expenses include two new faculty lines for master-teachers who will design and develop the new courses (one science and one math), and faculty support for those STEM faculty members who will be developing the new professional development programs, including online programs for current science and mathematics teachers. In

addition, the budget includes funding for mentor teachers in the high schools and middle schools who accept teacher candidates into their classes for field experiences

Administrative expenses include funding for program directors and staff support on the campuses whose main responsibilities will be recruitment of students into the program, program management, and accountability. At the University System, program administration will include staff support for overall program management across multiple campuses.





**MATH AND SCIENCE IN A CHANGING FUTURE:  
The Maryland STEM Initiatives (M-STEM)**

Report of the Governor's STEM Education Advisory Committee  
Annapolis, Maryland  
September 11, 2006

## FOREWORD

This report concerns science, technology, engineering and mathematics (STEM) education in Maryland. The Governor's Commission on Quality Education recommended that a statewide Summit on Mathematics, Science and Technology Education be held in response to growing concerns about workforce shortages and the inability of Maryland's students to compete at the highest international levels of mathematics and science. Governor Ehrlich hosted such a Summit\* on November 17, 2005 at the University of Maryland Biotechnology Institute's Center for Advanced Research in Biotechnology in Rockville, MD. Following the Summit, the Governor appointed an Advisory Committee on STEM Education and charged it with shaping the ideas from the Summit into a recommended plan of action. What follows is the report of the Advisory Committee.

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\* Financial and staff support for the Summit were provided by the National Alliance of State Science and Mathematics Coalitions (NASSMC), using grants from the National Aeronautics and Space Administration (NASA) and the U.S. Department of Education.

## *Introduction*

With the publication this year of Thomas L. Friedman’s analysis that *The World is Flat*, and the National Academies’ panel report *Rising Above the Gathering Storm*, American leaders have become acutely aware of the need to dramatically strengthen our scientific and technological capacities to ensure our future prosperity as a nation. They have been reminded once again that the key to this is greatly strengthened education in science, technology, engineering and mathematics (STEM). Truthfully, our nation is still “at risk,” and the world won’t wait.

In Maryland, as in many states, we have known for years that in mathematics and science our students are not generally competitive with the stronger students from major industrialized nations. This puts them at a distinct disadvantage when competing for jobs in the global economy. Our industrial leaders have been telling us they are unable to hire the workforce they need from Maryland schools and colleges. Effects on Maryland business and industry as well as major government laboratories that help drive our economy are being strongly felt. The work of the Governor’s Workforce Investment Board (GWIB) has amplified the message from industrial leaders. We have been making noticeable improvements in a number of areas, but we have yet to mount an educational response that is commensurate with the magnitude of the challenges.

The time has come to launch a bold performance-driven statewide effort to raise learning and teaching in mathematics, science, technology and engineering (the STEM fields) to **world-class** levels and to double over the next ten years the number of students graduating from Maryland institutions at all levels who are ready to enter the state’s workforce with strong technical backgrounds. As the framework for a statewide effort to reach these ambitious goals, this Advisory Committee recommends three major initiatives:

- *Raising the Bar* – Bringing rigorous mathematics, science, technology and engineering to a broader set of students today, thereby increasing opportunity for our young people and meeting our pressing technical workforce needs; and launching longer-term pilot projects that will expand over time and lead to world-class mathematics and science for all Maryland students.
- *Preparing and Supporting World-Class Teachers* – Recruiting, preparing and retaining the quality teachers we need for us to be internationally competitive in STEM education and the world economy;
- *Mobilizing Maryland* – A major public information/public engagement program to educate and excite students, teachers, parents and policy-makers about the issues we face in education and the workplace, and about the great new opportunities the state’s bold initiatives will bring to our people.

To lead these initiatives the Advisory Committee believes that the state needs a new mechanism, the **Maryland Institute of Science, Technology, Engineering and Mathematics (STEM) Education**. To be sustainable, the Institute will be established as a partnership among institutions of higher education, school districts, industry and foundations. Led by a top-level governing board and an operational coordinating council, the Institute will direct efforts in five critical areas: Service to School Districts and higher education, supporting especially district efforts to reach for world-class standards and strengthen their teacher workforces through the highest quality professional development and recruitment and retention of a new cohort of exceptional teachers; Research on STEM education, studying and disseminating research-based knowledge about how people learn and which programs work, so that policy-makers will have the most relevant and useful information for effective and efficient decision-making and students will benefit from the best research-based instruction, K-16; Public Information, developing and running the initiative *Mobilizing Maryland*; Advice to policy makers and the public on critical issues related to competitiveness and STEM education; and Coordination of major programs undertaken as part of the statewide effort to implement the action plan recommended herein. It is recommended that the Institute partnership be launched under the umbrella of the University System of Maryland.



## Plan of Action – *Raising the Bar*

At the Governor's November 17, 2005 Summit on STEM Education, there was near-universal agreement that the time has come for Maryland to significantly expand the base of students highly trained in mathematics and science and strive to attain over time world-class performance levels in these subjects. Discussions of expanding the base emphasized strongly the importance of bringing rigorous mathematics, science and engineering to a broader set of students today, thereby helping to expand opportunity and meet our technical workforce needs. These technical workforce needs include the demand for greater numbers of (a) professional mathematicians, scientists and engineers; (b) teachers of mathematics, science and pre-engineering; and (c) a broader technically trained workforce for industry. *As part of a concerted effort to double our education system's output of such young people over the next decade, six more specific initiatives are recommended, after which we describe an additional program that will be needed to reach all the way to world-class standards for all our students:*

**STEM Academies.** One strategy to assist in bringing rigorous mathematics, science, technology and engineering to a broader set of today's students is the development of the Governor's STEM Academies, which will target the untapped potential of Maryland's students who traditionally have not seen the benefits of studying rigorous mathematics and science in order to pursue careers in these fields. These academies will be highly specialized schools staffed by teachers working along side scientists and mathematicians from universities and businesses. This collaboration establishes a partnership among the Governor's Office, the Institute of STEM Education, The Maryland State Department of Education, local school systems, higher education institutions, Maryland industries with strong engineering or scientific workforces, and the general business and scientific communities. These STEM Academies will offer a unique and rigorous course of study to include student research, exposure to the professional mathematics, science, engineering and technical community, and leadership skills development opportunities. The curriculum will provide a foundation of the knowledge and the advanced skills required for college success and future career opportunities in science, mathematics, engineering and technology. These innovative programs will afford the students access to advanced equipment and technology along with regular interactions with practicing scientists and mathematicians. The development and operation of the STEM Academies will provide a test bed for innovative approaches to learning. The 2007 State budget contained \$2M to begin implementing this program. It is being used to create an Academy at Chesapeake High School in Baltimore County and to support nine planning grants for future academies. *The Governor's Advisory Committee recommends that in each of the next five years substantial resources be included in the state budget for developing and enhancing STEM academies. In fiscal '08 these resources should be sufficient to support all proposals of high quality that result from the nine fiscal '07 planning grants.*

**Professional Development Centers.** *A network of regional STEM Professional Development Centers should be established to support the programs of the STEM Academies. These regional centers should be linked to school districts and higher education institutions, to support the transformation of teacher content knowledge and teaching methods, teacher preparation, and instruction in the science, technology, engineering and mathematics fields. Maryland industry should play a significant role in providing hands-on engineering and science applications for classrooms pre-K through 12. The work of these Centers should be coordinated by the Institute of STEM Education.* [For further detail on these Centers, see pages 11-12.]

**Requiring Four Years of Mathematics and Science** – At the Governor's November 17, 2005 STEM Education Summit, there was strong support for the idea of requiring four years each of mathematics and science for high school graduation, with exposure to math, science and pre-engineering age-appropriate concepts beginning with pre-K. More than 80% of students in high school report that they want to

continue with higher education. For all students who desire to go to college, it is very important to have continuous mathematical training in high school, because those students who have a lapse in their mathematical education are significantly more likely to need developmental mathematics when they enter college -- which slows down their progress to degree and is debilitating for them and highly expensive for our state. Of those who wish to go into the more scientific or technological disciplines, it is essential that they take substantive mathematics each year in high school, so that they will be ready for the mathematics and science and engineering that await them when they go to college. This is true even for the students taking AP courses. Demand for science education also continues to increase, reaching across biology, chemistry, physics and earth and planetary science. It is particularly important that students have enhanced laboratory experience in these areas. The Advisory Committee makes the following

*Recommendation: The State Board of Education should develop a policy and/or guidelines that encourage students to begin rigorous courses in mathematics and science prior to the ninth grade. Further, the State Board of Education should undertake a review of high school graduation requirements to ensure that those students who wish to go into more scientific or technological disciplines take substantive mathematics and science each year in high school. The advice of the Institute for STEM Education should be sought on the relationship of such requirements to the new goals the state is trying to reach and the major STEM initiatives being launched in Maryland.*

**Pre-Engineering Programs** – As awareness of the nation’s weakening competitive technological position has grown over the last decade, it has become clear that we have for too long neglected engineering in the K-12 curriculum. Education in the principles and practices of engineering, with exposure to engineering as a pragmatic career option, is integral to preparing the Maryland workforce and making mathematics and science relevant to student’s lives. The recent Department of Defense Base Relocation program, in which Maryland is the recipient of numerous new high tech government opportunities, has driven home the point that the K-12 educational program must not only teach students the fundamentals of mathematics and science, but it must also demonstrate the application of these principles to real-world issues, thus inspiring more students to make the personal investment in learning that will give them the option of pursuing engineering careers at the university level. This is a national imperative that was highlighted in the recent National Academies of Science and Engineering publication “Rising Above the Gathering Storm”. The Advisory Committee applauds the efforts under way in various parts of the state to give more students exposure to engineering design through programs such as *Project Lead the Way*, but pre-engineering experience must begin well before secondary school. Industrial support in providing age-appropriate engineering applications of science and math can provide faculty and students with a rich appreciation of engineering from the earliest education experience.

*Recommendation: The State Board of Education should seek ways to ensure that engineering demonstration, lesson plans, and technical encounters are integrated into the standard science and mathematics curriculum each year. For all scientific and math subjects, relevant engineering examples, and hands-on learning sessions should be provided that will both increase interest in math and science and bring the field of engineering to life for the students. Teachers can draw upon multiple industrial and academic resources available in Maryland and on the Internet to enrich their curriculum. These resources are being made available and updated regularly via the website of the Maryland Business Roundtable for Education.*

**Increasing STEM Majors in Colleges and Universities** – One of the two major goals that grew out of the November 17 Governor’s Summit on STEM Education deals with doubling the numbers of students who complete rigorous STEM programs by the end of high school. To be particularly effective in helping meet the state’s technical workforce needs, this increased number of well-prepared high school graduates should translate into increased numbers of STEM majors in the state’s colleges and universities. But such

translation is not automatic, even as we move toward our K-12 goals. Institutions of higher education need to be aware of the importance to the state's economy of producing more STEM graduates. They need to have programs to keep well-prepared students in the pipeline. Community colleges need to have ambitious programs for attracting into STEM fields students who have traditionally shunned these fields. One thing that will surely help in this regard is increased scholarships for STEM majors. But faculty can also help through organized programs of 'saving' rather than 'weeding out' STEM majors. As part of this effort, everything possible should be done to provide attractive scholarships for STEM majors, the existence of which will act as a "pull", attracting more high school students to study rigorous mathematics and science.

*Recommendation: The Governor's Advisory Committee recommends that a large-scale program be designed and launched to attack the basic question, "What can and should be done within Maryland's colleges and universities to significantly increase numbers of successful STEM majors?" It also recommends that the new Institute of STEM Education be charged with working with the Governor's Workforce Investment Board and other industry leaders to support the creation of such a program.*

**Analytical Data System** – The Maryland State Department of Education (MSDE) is in the process of revamping its student and teacher data system. MSDE has a \$5.9M grant from the U.S. Department of Education to develop a Maryland Longitudinal Data System (MLDS). One of the key features of the new system will be its use of individual student identifiers enabling us to quickly answer a variety of questions about which we presently lack proper data. One such question, which is of primary concern to the Advisory Committee, is "How many students complete rigorous mathematics and science programs in secondary school?" With the help and assistance of the state's mathematics and science supervisors, the Advisory Committee has developed an estimate, but it is only an estimate. With MLDS and the future help of the 24 school districts we should have much better data concerning this question and be able to track the data over time so that we know whether the state is better meeting its critical workforce needs.

But the Advisory Committee's concern goes well beyond this one question. An analytical system that is composed of data derived from individual student identifiers should enable district and state educational leaders to build a "best practices" capability for every school and district in Maryland. A limited form of such a capability exists now, but use of individual student identifiers will enable educational leaders to group classes, schools, and districts by demographic profile, identify those which are performing well above the norm, assess the systems, materials, technologies and/or pedagogies which undergird that performance, and help those schools and/or teachers with a similar profile which are not achieving at that level to do so.

Maryland has many exceptional teachers and many exceptional schools in virtually every demographic category, facing virtually every challenge, whether from impoverished communities, an inadequate tax base, or concentration of language challenged students. Yet these same educators, these same schools are performing at very high levels. They are doing something right – more often, many things right. The new data system should allow educators and schools to see the exceptional results in schools virtually identical to their own, realize that they are not unique, but rather learn a new way to do what every educator wants to do – reach and educate to their highest personal level, every child.

**World-Class Standards--A Pilot Project.** In addition to the sorts of new programs just described – programs bolstered by the teacher and public information initiatives in the next two sections – bigger and bolder steps will be required if we are to reach world-class performance levels for Maryland's students. These steps must bring greater coherence to curricula and be aimed at raising performance levels of all students. The plan the Advisory Committee recommends is to start with mathematics and then do science in a second phase.

Mathematics is key to raising performance in all STEM areas to world-class levels and the following bold strategy is proposed:

*Recommendation: Using a proven world-class curriculum, a large-scale pilot project should be launched by the Maryland Institute of STEM Education in cooperation with as many as possible of the state's 24 school districts, aimed at raising the mathematics learning of all students to internationally competitive levels. If the pilot proves successful after the first few years, it should be expanded to as many of Maryland's schools as possible. Careful research and evaluation, as well as awareness of applicable state and federal laws should help guide the effort.*

These are the six key steps the Advisory Committee envisions for carrying out this recommendation:

1. Immediately begin a small research project to identify proven world-class curricula, large parts of which are importable to Maryland. A preliminary analysis by the Governor's STEM Advisory Committee concluded that such importation is essential if significant progress is to be made at raising mathematics learning to world-class levels in real time. The Committee has done some preliminary research on possible curricula.
2. Launch a pilot project in carefully selected elementary schools from as many Maryland school systems as possible to begin using the imported curriculum for grades K-2. Over the next several years, phase in the curriculum in stages in these schools, starting from the earliest grades and working up the grade levels. Build in an evaluation plan from the beginning.
3. Provide comprehensive professional development for teachers and principals in the selected schools during a one-year preparation period for first uses of the curriculum, and then continue active professional development as the curriculum is implemented in stages, for example grades 3-4 followed by grades 5-6. Develop learning communities to enhance professionalism and progress.
4. Develop a phase-in plan that opens the use of the new curriculum in lower grades to all elementary schools in the state, even as exploratory work on upper grade levels continues in the initial selected schools. Pave the way for all of this through extensive publicity about the program and extensive professional development for teachers and administrators. Control the rate of program expansion by research-driven assessments of the preparedness of the administrators and teaching staffs in new schools admitted to the program.
5. As the initial work in grades K-6 proceeds, identify the curriculum to be used for 7-12 and lay the groundwork for its implementation as soon as the first cadre of students completes grade 6. The research that the Advisory Committee has already done suggest that there may be more than one possible choice for the 7-12 curriculum, even under the constraint that it must fully integrate with the K-6 curriculum.
6. Proceed with implementation of the curriculum up the grade levels, meanwhile expanding its use at lower grade levels, as in step 4.

It is intended that a similar strategy for science education should be developed by the Institute of STEM Education soon after it is established. A starting point for the deliberations could be *A Shared Vision*, the document developed recently by the Maryland Science Supervisors Association (MSSA).

## Plan of Action -- *Preparing and Supporting World-Class Teachers*

As Maryland's schools strive toward greater numbers of students completing rigorous mathematics and science programs and eventually world-class student performance levels, there will be greater demands on the state's teachers of mathematics and science, including elementary teachers. They will face the dual challenges of more demanding curricula and more diverse groups of students. We will need to strengthen the skills and effectiveness of existing teachers and we will need to attract into the profession greater numbers of teachers who have enthusiasm for mathematics and science as well as strong content knowledge. In addition, we will need to provide competitive salaries and professional working conditions, giving teachers time to think, plan and learn – conditions necessary for retaining our best teachers and enabling them to do their demanding jobs effectively. These teacher issues are perhaps the most important ones we face in trying to build the base and reach for world-class levels of performance.

### **Shortages**

At present there are serious shortages of qualified teachers of mathematics and science. The shortage of highly-qualified teachers is made evident by two simple sets of data:

- A. In 2005, Maryland's 24 school districts sought to hire 1,375 new qualified teachers of mathematics and science, but were able to find only 960. In other words, there is about a 30% shortfall in the supply of new math and science teachers. This general situation has existed for some years and is worsening.
- B. Using the definitions established for the federal No Child Left Behind (NCLB) act, 25% of (middle and secondary) mathematics and science classes and 16% of elementary classes are taught by non-highly-qualified teachers.

School districts are energetically trying to improve their recruitment programs and increase their "yield". One superintendent after another told the Advisory Committee of their frustration at not being able to hire the qualified math and science teachers they need, especially ones with strong content backgrounds. The state began the process of addressing challenges of this type some years ago through The Quality Teacher Incentive Act of 1999. This legislation is not, however, focused on STEM areas and the critical need they represent, nor are its numbers quite up-to-date. (For example, it speaks about using \$1,000 signing bonuses to attract new teachers, which would not do much in today's highly competitive math and science teacher market.) Other programs that are run by the state department of education (MSDE) and contribute to improved recruiting and retention of teachers are listed in the (annual) Teacher Staffing Report that MSDE publishes. There is a battery of them and they are a positive force. But again, they lack a specific focus on mathematics and science and in the Advisory Committee's opinion they do not reach high enough or far enough. There is a need to review all of these programs and requirements with an eye to targeting STEM areas and up-dating dollar amounts. But a great deal more than reviewing and updating needs to be done.

### **Finding 200 Additional New STEM Teachers Each Year**

The 2005 National Research Council report, "Rising Above the Gathering Storm", headlined one of its calls to action with, "Ten Thousand Teachers; Ten Million Minds." The intent of the exhortation was to call for 10,000 new highly qualified teachers of mathematics and science in the United States every year for the next decade, and through their skills to reach 10,000,000 young minds. Based on Maryland's share of the U.S. population, this scales to 200 new highly-qualified teachers of mathematics and science every year for the next decade, through whose efforts we will reach 200,000 young minds. It is fair to say that, as a call to action, "Two Hundred Teachers, Two Hundred Thousand Minds" is not much of a "grabber" line. But make

no mistake about it, this represents a very demanding goal for the state of Maryland. It is a goal that the Advisory Committee feels Maryland must take very seriously. The initial focus must be on the teacher part of it, of course.

Where will these new, highly-qualified and highly-motivated teachers come from? The answer is, “From inside and outside the state, from colleges of education and alternative sources. But it will take a large battery of aggressive programs to attract the people we need.” The Governor’s STEM Education Advisory Committee urges that six steps should be taken to help attract more highly capable people into teaching in STEM fields.

*Recommendation: Each year for the next decade, 200 multi-year college scholarships should be provided to young people who intend to become teachers of mathematics and science.*

Half of these may be available under federal programs recently launched. But half or more of them should be provided by the State of Maryland as Governor’s STEM Teaching Scholarships and carry with them certain conditions, namely, that the student: (a) is majoring in a STEM field; (b) has an approved plan for completing the STEM degree and teacher certification in 5 years; (c) agrees to serve as a Maryland public school STEM teacher, at least one year for each year of scholarship money received; and (d) agrees to repay any scholarship money that is not matched by such service.

*Recommendation: The Maryland Institute of STEM Education and the Governor’s Workforce Investment Board should help develop and launch an aggressive industry-led program of utilizing scientifically-trained retirees from industry and government as STEM adjunct teachers in Maryland.*

There is a very large pool of mathematical, scientific and engineering know-how in the workforces of Maryland industry and the many government laboratories and facilities around the state. Large numbers of them are retiring in the near future. At NASA alone, a significant percentage of the workforce is retiring in the next 5-10 years. These individuals represent a resource that ought to be tapped as much as possible to participate as teachers in Maryland’s STEM Education Mobilization. This may require development of a fast-track certification program for certain types of teachers. Great ingenuity and flexibility should be used in designing both the recruitment and certification aspects of this program. One possible use of retirees might be as AP teachers or teachers in other advanced programs.

*Recommendation: Schools and school districts should make more extensive use of specialized teachers in order to improve instruction and lighten the loads and decrease the demand for traditional classroom teachers.*

The concern in this recommendation is based on the Advisory Committee’s understanding of what is going to be required for us to reach the demanding goals in STEM education that the Committee has recommended. The point being made here is not about certification, even though alternative forms of certification may be involved. The point is that we are not going to reach world-class performance levels in mathematics education unless we make extensive use of elementary mathematics specialists, as is done in the countries that outperform us in international comparisons. Such teachers are used extensively in a number of states, including our next-door neighbor, Virginia. We would be far better able to infect students with the enthusiasm and ideas of science if we had and utilized a cadre of elementary science specialists. We need to get ambitious programs underway as soon as possible to prepare and certify such elementary specialists. Such specialists could be described as ‘elementary teachers and then some’. But other types of specialized ‘assistant’ teachers with less demanding preparation can and should be utilized. Where memorization and drill are important – and this is true in many places in mathematics and science – drill and memorization teachers can be utilized. They would be something akin to strength coaches on a football team. Still another type of specialized teacher should be the AP or International Baccalaureate teacher, someone such as a

retiree from industry who has exceptional content knowledge but not perhaps the full range of teacher skills necessary for managing a middle school class in the inner city. Such specialized teachers are only going to be utilized by the schools if there is encouragement to do so. On-going interaction between school district teachers and staff on the one hand and leaders of the major STEM initiatives on the other could help promote use of specialized teachers. One responsibility of the Institute of STEM Education will be to see to it that these interactions occur regularly. Groups such as the Maryland Council of Supervisors of Mathematics (MCSM) and the Maryland Science Supervisors Association (MSSA) can play an important role here.

*Recommendation: Legislation should be developed that permits school districts to make strong use of differential salary scales, paying up to 10% more for highly qualified teachers in STEM fields, and offer \$5,000 or more signing bonuses to new teachers with strong STEM content backgrounds.*

We are in a critical situation and must do everything possible to attract capable young people into teaching, especially in fields like mathematics and physics where more serious shortages exist. The differential pay should be large enough that word of it trickles down to young people thinking about careers in teaching. Signing bonuses should be large enough that word of them also trickles down to these young people. The bonuses should be viewed not only as means to successful recruiting but also as attractions to future prospects. The state should allow as much flexibility in this as possible, recognizing the pressures school districts are under and the importance of having our STEM initiatives succeed.

*Recommendation: The State Board of Education should do everything possible to speed up the teacher certification process and make it even more flexible than it now is, especially with regard to fast-track certification of individuals with strong content backgrounds and special types of teachers. In deciding what to do and when to do it, the Board should lean heavily on the advice and counsel of the Institute of STEM Education.*

We have teacher needs in STEM fields that are critically important for the economic future of our state and we will need to use every strategy at our disposal to deal with these. One thing we must be is fast on our feet. We have conditional certificates, allowing individuals to be brought on board as teachers while working on their certification and we have alternative certification, usable in some cases where individuals are following non-traditional paths to teaching. But we need to further speed up the route to certification, mindful of the pressures that our districts are under. And we need to take account of new types of teachers: elementary specialists, instructional assistants, teaching coaches for drill and memory work, AP teachers, etc. We need to anticipate the more extensive use of these sorts of specialized teachers that our STEM initiatives will require. For this reason, a review of the certification processes that is begun early and works with Institute of STEM Education is our Committee's recommended course of action.

## **Preparing the Teachers We Need**

Maryland teachers that are hired each year come from in-state (60%) and out-of state (40%). The in-state hires are about equally divided between those who are new to the teaching profession and those who are experienced teachers. A March, 2006 study published by the Maryland Higher Education Commission (MHEC) found that the colleges of teacher education in the state could produce significantly more STEM teachers than they now do if they could find the candidates. This underscores the importance of initiatives such as those just recommended to attract more talented young people into STEM teaching. But it also suggests that our universities need to do even more than they are now doing to find STEM teacher candidates. The Governor's STEM Education Advisory Committee recommends two steps to increase the state's STEM teacher productivity:

*Recommendation: Our universities should make teacher education a top priority. As part of this they should launch major initiatives enabling college and university students to obtain a degree in a STEM field and teacher certification in one integrated four-year program – initiatives similar to the UTeach program in Texas and the CalTeach program in California.*

If done well, such programs can become a powerful way of recruiting beginning STEM majors into teaching. They also force some rather deep thinking by faculty about the content that is desirable and/or necessary for STEM teachers. This is particularly important as we move into an era of higher content demands in our schools, including those aimed at attaining world-class performance levels. In some universities there is an apparent gulf between the faculties of education and those of the sciences, and this gulf needs to be bridged.

To indicate the sort of progress that can be made with this type of program, we quote a portion of the February 28, 2006 testimony before the Texas Senate presented by Dr. Mary Ann Rankin, Dean of the College of Natural Sciences at the University of Texas, Austin:

“At The University of Texas we have developed a highly successful teacher preparation program for math and science majors called UTeach. Research 1 universities have not traditionally assumed much responsibility for teacher training, and indeed prior to establishment of the UTeach program, UT Austin had very few majors pursuing certification: 4 science; 19 math in 1996 from a body of about 8300 majors. It was usually a fall back or last resort for students who did not achieve their primary goal such as admission to medical school, or graduate school, and many who were certified did not actually go on to teach.

In 1997 we decided to create a program that would attract large numbers of strong math and science majors to teaching, and prepare them for success; we believe we have achieved that goal. Since the inception of the UTeach program we have doubled the number of math majors and increased by 5-6 times the number of science majors being certified. Enrollment is at 449 students this year and this year’s 74 graduates will bring the total number of grads to about 350. Approximately 89% are teaching, planning to teach, or actively searching for teaching positions. 75% of those who graduated in 2001 or before are still teaching.”

California’s CalTeach program is similar in spirit but organized somewhat differently. It has exceptionally strong support from industry. It should be emphasized that both of these programs are interdisciplinary in character and function well only because of close cooperation among faculties in disciplinary sciences and in education.

The Advisory Committee regards STEM (Science, Technology, Engineering and Mathematics) as more than the sum of its parts. STEM, as educators and content experts here in Maryland and across the nation increasingly understand it, is a “metadiscipline,” focusing on learning experiences that require not only knowledge of STEM’s constituent disciplines but the ability to apply that knowledge to real-world problems. It involves students in the processes of discovery and invention, and in creative thinking. In a STEM approach to education, students engage authentic problems that require them to draw on their prior knowledge in mathematics and science, and they are highly motivated to acquire the new knowledge needed to solve the problems at hand. A curriculum based on this understanding of STEM develops ways of thinking and problem-solving that lay the foundation for scientific inquiry, technological innovation, and the pursuit of careers that respond to the rapidly changing demands of our 21<sup>st</sup>-century economy.

*Recommendation: Maryland should evaluate the content and efficacy of the state’s four-year teacher preparation programs, with an eye to increased content demands in STEM areas, the roles of specialized teachers of various sorts, and the roles of the STEM Professional Development Centers. A focused study of teacher education programs and their effectiveness should be started as soon as possible and carried out in close consultation with the Institute of STEM Education and in close coordination with the review of teacher certification recommended above.*



Some of the questions that will need to be dealt with are these: Are we turning out teachers with sufficient content knowledge to bring rigorous mathematics and science to a significantly larger group of students than we now do? Will our teacher graduates be able to handle the demands of world-class curricula to be used in the major pilot projects? Do we prepare elementary math and science specialists? If not, how are we going to do so? What additional resources will be required? Should there be programs to prepare specialist teachers of other types? How can the recruitment programs of our teacher colleges be strengthened? How strongly is each college of teacher education linked to its university's disciplinary faculties in STEM fields?

### **Retaining the Strong Teachers We Hire**

Half of the teachers we hire leave in their first five years on the job. In a period when STEM teacher talent is in short supply, it is absolutely vital that this outflow be controlled. Among the reasons teachers give for leaving, three stand out:

- teaching salaries are not competitive with those of jobs the STEM teachers can get in industry;
- the life of a teacher in our system is too hectic and provides too little time for reflective thinking;
- administrative support is either weak or lacking altogether.

These are not vague and ethereal matters. They are all things that it is within our power to do something about. The Advisory Committee feels that it is imperative to do something about each one of them.

*Recommendation: Legislators, school boards and superintendents should develop multi-year plans for raising pay scales for STEM teachers, bringing them more into line with salaries in industry. Maryland should set a goal of lifting teachers' salaries collectively out of the bottom half of the national pay scale.*

Industry leaders were among the first to tell the Advisory Committee that it is quite unrealistic to think that we can have the teacher workforce we need without paying competitive salaries. It is unacceptable to continue having teachers in the lower half of salaried workers when they are the frontline of our attempts to keep our state economically competitive. We have gone along for years pretending that this is not so. But it is. The urgency of the situation that our state and our country face in STEM education should be used as the driving force behind a systematic effort to raise salaries to levels that will enable us to attract and retain the teachers we need.

*Recommendation: Contact hours for STEM teachers should be reduced so that they have time during the day to work with their colleagues on instructional issues they face. Such a reduction will need to be brought about in steps and stages, but the ultimate goal should be to bring contact hours down to a maximum of 4.*

If we are to bring rigorous mathematics and science to significantly more students, and most especially, if we are to raise performance to world-class levels, then our teachers need time to think, plan and learn. Research shows us that this is time that teachers have in countries that outperform us in international comparison studies. We must move in the direction of reducing contact hours. Now, it will be pointed out immediately that this might worsen an already difficult shortage of teachers. This merely means that the efforts to attract more teachers and to reduce contact hours need to be carried out in close coordination with one another and that things will take time. A great deal of what a teacher most know and be able to do is learned, not in a university course, but on the job, through discussions with colleagues. We need to try to create "learning communities" within our schools, the analogue of what the Chinese call "research groups" for teachers. We also need to make more extensive use of instructional assistants, adjunct teachers and other types of specialized teachers, who relieve the principal classroom teacher from standing in front of a class all day long.

*Recommendation: Schools and school systems need to make certain that they provide the administrative support that teachers need in order to do their teaching properly. In each building the principal should devote significant amounts of time to work with teachers on curricular and instructional matters.*

This will require giving principals the support they need in order to be able to spend sufficient time on instructional matters. The life of a principal is such that, without additional help, the time to spend on instructional matters can just ‘slip away.’ In a period such as the one we are entering in STEM education, attention to instructional matters is too important to be allowed to slide.

## **Strengthening Teaching**

One of the most important ways that we support our teachers and keep improving the quality of our education programs is by supporting the on-going professional development of teachers. New and more comprehensive professional development programs for STEM teachers will be needed all across Maryland as we bring rigorous mathematics and science to greater numbers of students and eventually raise all student performance to world-class levels.

*Recommendation: Regional STEM Professional Development Centers should be created across the state as working hubs of the Institute of STEM Education. These regional centers should be linked to school districts and higher education institutions, to support STEM academies and other Raising the Bar initiatives, focusing on the transformation of teaching content knowledge and teaching methods, teacher preparation, and instruction in the science, technology, engineering, and mathematics fields. The work of these centers should be coordinated by the Institute based on in-depth understanding of new STEM initiatives and a comprehensive study of what is already going on in Maryland.*

In some cases, the centers will be Professional Development Academies, analogous to teaching hospitals, and would exemplify best practices, prepare the next generation of teachers, strengthen the STEM content knowledge of existing teachers, and engage K-12 students in rigorous and exciting STEM learning opportunities. In essence, the STEM academies will become satellite “lab schools” of the Institute, places where innovative teaching, research on learning, and industry partnerships can flourish and grow.

Each regional center will assist schools in its geographic area while also developing one or more areas of special expertise (such as elementary school mathematics, middle school science, or an integrated secondary school STEM curriculum) that will be made available to schools in other geographic areas through research reports, new curricula, professional development activities, and distance learning channels.

Examples of specific programs and projects that could be offered at the regional centers include:

- *Professional Development focused on content knowledge* – It is crucial that teachers at all levels have deep and current content knowledge. This is especially true for teachers involved in the world-class mathematics pilot project, but it is true across the teaching force. Regional centers and their higher education partners will offer this content in a number of ways, ranging from lecture series to online coursework to summer courses and institutes and experiences in authentic science research labs. University science, mathematics, and engineering faculty will work with university and school-based educators to develop plans for implementation of content knowledge in K-12 classroom instruction.
- *Certification programs for new and continuing science and mathematics teachers* – Academies and regional centers will partner with teacher preparation programs and academic content specialists to offer high quality, streamlined alternative certification programs for career changers and late deciders with a background in science, mathematics, engineering and other related fields. Middle school

teachers who entered the profession with a K-8 certificate and little content expertise will be put through programs to bolster content knowledge, programs such as the one used with math teachers in the state of Wyoming.

- *Mentoring programs for new teachers of science, mathematics, engineering and technology* – Academies and regional centers will coordinate programs that pair new teachers with experienced teachers or practicing scientists. Academies could also provide training to mentors in how to assist new teachers in developing both their pedagogical and content-related knowledge. Consistent with Maryland Teacher Professional Development Standards, academies could provide in-school coaching services to foster job-embedded professional development. Industry could also provide hands-on experiences and mentoring to further enrich the process.
- *Comprehensive teacher induction programs* – Professional Development Centers and the Institute will work with school districts on development and implementation of comprehensive teacher induction programs. Research shows that such programs for new teachers can significantly improve retention rates if they include mentoring by a veteran teacher in the content area; interaction with an administrator trained in and dedicated to instructional development; common planning time with other teachers; a reduced course load for at least the first year; help from a teacher's aide; and participation in an external network of teachers engaged in professional development – a learning community.
- *Teaching fellow programs* – The Institute will create programs for the best teachers of science, mathematics and technology to come for a summer, a semester or a year to further develop their skills and to share their expertise with university researchers and teachers and to prepare for National Board Certification. Activities will expand their role as expert teachers and enhance their capacity to serve as teacher leaders and mentors supporting mathematics, science and technology curriculum development and teacher enrichment in their schools. At the same time, the teaching fellows will work with university and college STEM faculty to develop and disseminate best practices in pedagogical content knowledge across the K-16 spectrum.
- *Leadership development and Teacher Resource Centers*– Specialized programs will be offered for principals, lead teachers, department heads, and other instructional leaders on how to best support the teaching of science, mathematics and technology, including establishing resource centers with a library of printed and electronically accessible materials and classroom equipment.

The first of these regional Professional Development Centers is being created in 2006, using funding obtained by the State Superintendent of Schools.

*Recommendation: Over the next five years, the state budget should contain sufficient resources to support development of a network of regional STEM Professional Development Centers whose 'reach' covers all school districts in the state.*

*Recommendation: The Institute of STEM Education should enlist the cooperation of Maryland's 24 school districts in developing a comprehensive professional development plan for STEM education. This plan should be part of the guidance system for working with the Professional Development Centers.*

Mathematics and science curricula vary considerably across the districts, so development of such a plan will be an ambitious and complex undertaking. Obviously the effort will succeed only if the districts see it as a service, supporting them in their efforts to strengthen STEM education.

## Plan of Action – *Mobilizing Maryland*

*Recommendation: The Maryland Institute of STEM Education should design and operate a major program of public information/public engagement to: (a) educate students, teachers, parents, policy-makers and others about the issues we in Maryland face and about opportunities created by the new STEM initiatives; and (b) engage these constituent groups in the STEM initiatives being launched.*

This will be one of the Institute’s vital functions, assuring critical awareness of Maryland’s priorities and needs in STEM education, innovation and competitiveness and enlisting the support and participation of many people and groups. The audiences for this public information/public engagement outreach go beyond the traditional stakeholders (schools, school districts, universities and colleges) and engage the many concerned publics. In the same way that Thomas Friedman captured the imagination of the broader public with his thesis that “the world is flat,” the Maryland STEM public information/public engagement effort should energize the broader Maryland community to support investment and innovation in teaching and learning science, mathematics, engineering and technology. It should help mobilize concerned citizens in support of major new STEM initiatives.

The plan for the large public information effort will need to be developed under the guidance of an experienced professional in the field of public information and public engagement, utilizing the content input of Institute leaders and the experience of state leaders in education and business affairs. It must identify key audiences and the messages that need to reach them and it must identify the means of doing so, i.e., the vehicles for communicating. The plan must take into account the fact that each audience is in a more-or-less constant state of change, so that the tasks of communicating most messages are never really finished. Finally, the plan must seek to engage each audience in the process of pursuing bold STEM education goals.

**Audiences and Messages.** Who are these audiences and what are the messages? We will not attempt to lay them all out here, because that is part of the complex planning process that will need to go on. But we will say just enough to make clear why an extensive program of engaging the audiences of education is needed.

This report began, just as did the November 17, 2005 Summit on Mathematics, Science and Technology Education, by referring to the calls to action we have seen in books and the public media – such calls as Thomas Friedman’s Book, “The World is Flat”, and the report, “Rising Above the Gathering Storm”, out of the National Academies. These calls to action note that our nation and our state are in critical situations when it comes to scientific and technical manpower – situations resulting largely from our failure to raise the level of education in STEM fields to world-class levels. Thanks to the books and reports plus various Maryland ‘summits’, including the April, 2006 “Protecting America’s Competitive Edge”, held at University of Maryland, College Park, these messages are now well-understood by leaders in Maryland business and government. But they are not well understood by the ‘general public’. They are not well understood by students in general, or parents in general, or teachers and administrators in general. So, one of the first challenges of the public information/public engagement effort will be to get these messages out to these audiences – get them out in ways that are both meaningful and effective for students, teachers, parents, etc. A particularly challenging part of the effort will be persuading these audiences that we must significantly raise the level of what our young people learn in STEM fields, lest our economic position deteriorate and our young people fail to compete for jobs in today’s economy. But it must not sound like purely negative news. A central part of the message must deal with the good things that will happen for the economy and our young people if we do respond to the challenges before us.

The first step in communicating these messages to the citizens of Maryland must be taken by the Governor, followed by other state leaders. Along with these initial communications must go action plans, which contain within them programs to follow up on the messages and motivate key groups to get behind the

specific components of the action plans. This follow up work will be needed for years and it will need to make use of a wide variety of means of reaching and engaging the key audiences of education.

More specific messages will be involved. We must find new ways to bring the excitement of mathematics, science, technology and engineering to our young people. We must make clear to students what the successful completion of rigorous math and science classes will mean for their futures. We must convey the same messages to parents, helping them to take a little bit longer-range view of what ‘success’ means for their children. We must make clear to teachers why their continuing professional development is so important and why it is vital that we bring rigorous math and science to greater numbers of students. We must convince business leaders to invest more time, energy and resources in lifting up STEM education in Maryland. We must convince college and university faculties to put as much thought and energy into saving STEM majors as they do into weeding them out. We must convince all of these audiences that STEM fields are not for just a few ‘select’ or ‘gifted’ students.

**Teaching Makes Every Other Profession Possible.** *One component of the public information program to be developed by the Maryland Institute of STEM Education should be a statewide campaign to attract STEM teachers. This focus on prospective teachers should describe the opportunities and the rewards of teaching careers, especially in STEM fields. This will need to be a professionally developed component, visible throughout Maryland and beyond and conducted relentlessly over a long period of time. It will need to involve the school districts in design and implementation, making sure that all involved are singing from the same songbook. Industry should be brought into this, both because of their marketing know-how and because of their financial interest in seeing a fully-qualified teacher in every STEM classroom.*

**Engagement.** Meaningful dialogue about messages must be part of the process. The individuals involved in every program that is run to move STEM education forward, whether it is in a school, college, company or museum, must be part of the communication team. A detailed plan is needed to ensure that there is some consistency of messages across all of these education programs. Creative thinking as well as tact and diplomacy will be needed to gain the alignment necessary. It is this needed alignment and the importance of ensuring that all messages are rooted in a deep understanding of STEM issues that argues for having the Institute of STEM Education run the public information/public engagement program. The Advisory Committee feels that it is as important as any component of the STEM education plan recommended here.

### **The Special Role of Industry.**

On the subject of education, industry speaks with a special voice. Maryland’s industrial leaders will be listened to by the public when they speak out about the major issues of STEM education. These leaders must be consulted and listened to at every stage of development of the plan called Mobilizing Maryland. They and their employees, especially those involved in company outreach programs, should be key parts of the public information/public engagement effort. Industry participation will be many-faceted, but the Advisory Committee wants to call attention to two aspects of it.

*Recommendation: The Institute of STEM Education should work with the Governor’s Workforce Investment Board (GWIB) or some of its member companies to create a mechanism for coordinating industry outreach programs and increasing their focus on bringing more young people into mathematics, science, technology and engineering. Industry can provide executives or engineers in residence to increase levels of understanding and interaction with real-world opportunities in the classroom.*

*Recommendation: The State of Maryland should give tax credits to businesses that work to support STEM initiatives consistent with the Action Plan presented here.*

## Plan of Action – *The Maryland Institute of STEM Education*

The Introduction contained one of the Advisory Committee’s key recommendations, to create the Maryland Institute of Science, Technology, Engineering and Mathematics (STEM) Education. Its five major areas of focus were described briefly: Service to school districts and higher education; Advice to government and the public; Research; Public information; and Coordination. Throughout this document we have referred to some specific roles the Institute is intended to play in relation to the initiatives proposed herein. These give some idea of the sort of entity that the Advisory Committee has in mind, but very little has been said thus far about the research focus of the Institute, its structure and its proposed location.

**Research on Teaching and Learning in STEM Education.** At the heart of the Institute will be a research network focused on teaching and learning science, mathematics, engineering and technology. By studying and disseminating research-based knowledge about how people learn and which things work, the Institute will ensure that policy-makers will have the most relevant and useful information for effective and efficient decision-making and students will benefit from the best research-based instruction K-16. The research function will also assure alignment of primary, secondary and post-secondary learning with the STEM needs of the state, and identify, evaluate and pilot world-class STEM curricula.

The Institute will function as an umbrella “network” to connect all the already established research groups or centers at various institutions -- plus individual researchers from all disciplines and policy researchers from government and non-governmental organizations -- into a Maryland Education Research Colloquy or Network. The Colloquy or Network will use all the well-known academic methods to bring Maryland’s researchers together into a strongly interactive learning community: colloquia, seminars, joint projects, joint grants, a Web home, listserv, conferences, and even an online journal. The Network will promote especially research on issues tied to action. Examples of research and evaluation initiatives include:

- *Coordination of a state-wide research agenda in STEM instruction:* The Institute will conduct studies to map the terrain of existing research activities in the state and then evaluate and disseminate research-based best practices in elementary and secondary school science, mathematics, engineering and technology education.
- *Assessment of undergraduate science reform initiatives:* The Institute will conduct studies at colleges and universities to determine the effectiveness of curricular reforms to recruit and retain undergraduate STEM majors.
- *Development and assessment of model curricula* – Currently, several existing professional development schools link their professional development to a particular curriculum. The development of model science, mathematics, engineering and technology curricula will provide a focus for new Professional Development Centers. The focus will be on incorporating deep and current content that reflects state and national expectations with engaging and exciting instruction that “turns students on” to the wonders and joys of STEM fields.

Finally, while the priorities for research and project evaluation will be coordinated by the Council, an explicit premise of the Institute is that it will not undertake any program that can be effected equally well (or better) by some other organization or entity. Among the other organizations that play leadership and coordination roles in education, the Institute will be distinguished by its emphasis on and expertise in issues of mathematical and scientific content.

**Structure.** The STEM Institute Board will be the board of directors of the Institute and will comprise industry leaders, major scientists and community leaders. Selected state officials may also be members, although care must be exercised in this regard because the Institute exists in part to provide objective advice to state government. The Board will maintain the vision of the Institute, set priorities and provide general oversight for all activities of the Institute. Its members must be of sufficiently high stature that the advice of the Institute will be heeded. The STEM Education Coordinating Council will be the operational arm of the Institute. It will translate charges from the Institute Board into specific projects and priorities and coordinate activities and programs of the Institute with those of the key players in STEM education. It will have an Executive Committee that reports to the STEM Advisory Board and is responsible for the agenda and leadership of the Council.

The Coordinating Council will work closely with state agencies, Maryland's K-16 Partnership, the Governor's Workforce Investment Board, and the Maryland Business Roundtable for Education. The membership of the Council will include leaders from business, education and policy who are actively involved in STEM education, bringing to the table the perspectives of state government; public and private higher education; primary and secondary education; private industry; foundations; professional associations; and regional museums, such as the Maryland Science Academy and the National Aquarium. Of particular concern will be linkages to the mathematics and science education associations and the outreach programs of industry and federal laboratories and centers. Council members will not sit as official representatives of other organizations, even though they are selected because of the particular perspectives they bring.

It is expected that the Council may, with Board approval, establish regional and outreach centers in addition to the STEM Professional Development Centers described in the teacher initiative. Some such centers may be in local schools and school districts, if that is felt by the districts to be helpful. The Coordinating Council will function as an operational clearinghouse and build a network that will match the needs of specific schools and school districts to the activities of regional centers in evaluating and disseminating their work. The Coordinating Council will ensure that the professional development, teacher preparation programs and alternative pathways to certification, educational outreach and alignment efforts at each of the Professional Development Centers are grounded in rigorous STEM education and aimed at eventually reaching world-class levels.

**Location.** In deciding where such an Institute should be located, several important factors need to be balanced, of which we mention only a few. First, it needs to have the strong support of the business and education communities. Second, although a great deal of private money will be needed, it will almost surely require state funding for its core operations, at least in the early years -- and so there must be some form of state accountability. In balancing these considerations, a third matter of primary importance is that the Institute must be able to provide objective advice to state government (and the public). The Advisory Committee feels that it should not, therefore, be under the control of any state department or agency. This is said recognizing that the Institute must work very closely with a large number of state agencies and departments. The Advisory Committee recommends, therefore, that the most practical way of balancing the state role is for the Institute of STEM Education to be launched under the umbrella of the University System of Maryland (USM). Discussions that Advisory Committee members have had with a number of state leaders lead them to believe that in this way sufficient autonomy can be achieved while there is still ultimate state accountability.

**Launch.** *It is recommended that resources be included in fiscal '08 budget of the University System of Maryland to launch the Institute, with the intention that this will be renewed annually and that the Governor appoint a small group to develop a proposal to the Board of Regents of the University System of Maryland in time so that the Institute can begin operations in July, 2007.* It is important to note, however, that this will be only the 'core' funding for the Institute. Many of the Institute's programs will require significant amounts of additional foundation and corporate funding. The Advisory Committee has already begun preliminary exploration of potential foundation support for the Institute and the major initiatives of the broader action plan.

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Mrs. Pamela Brown  
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## Appendix 6

### Bowie State University STEM Initiatives

**University:** Bowie State University

**Name of STEM Program:** LS-AMP

**Constituencies Served:** Underrepresented undergraduate students in the STEM fields

**Brief Description:** Provide financial support, research opportunities and academic support to the student scholars.

**University:** Bowie State University

**Name of STEM Program:** P-20 Partnership Program with the University of Maryland School of Medicine

**Constituencies Served:** Underrepresented undergraduate students and junior faculty

**Brief Description:** Provide research training in the area of cancer biology to faculty and students; implement a cancer biology curriculum at Bowie State University; provide research opportunity for students.

**University:** Bowie State University

**Name of STEM Program:** ExxonMobil Bernard Harris Summer Science Camp

**Constituencies Served:** Underrepresented middle school students in Prince George's County, MD

**Brief Description:** Provide a camp-like educational experience for the campers in the areas of science, math, technology, engineering, nutrition and communication

**University:** Bowie State University

**Name of STEM Program:** NSF-MSP Pre-College Summer Science Academy

**Constituencies Served:** Underrepresented 10th and 11th grade students in Prince George's County, MD

**Brief Description:** Provide enhancement courses in math, science and chemistry; with a follow-up summer, participants will be allowed to enroll in one college course for credit

**University:** Bowie State University

**Name of STEM Program:** NSF-MSP Pre-STEM Teacher Training

**Constituencies Served:** Underrepresented undergraduate students in the STEM disciplines at Bowie State University

**Brief Description:** Provide an opportunity for science majors to work with and teach at the middle school level. The Program is a cooperative effort between Bowie State University and Prince George's County Public Schools

## Coppin State University STEM Initiatives

**University:** Coppin State University

**Name of STEM Program:** HBCU-UP Program/ NSF Grant

**Constituencies Served:** Underrepresented undergraduate students in the STEM disciplines

**Brief Description:** Provide financial support, research opportunities and academic support to students and faculty.

**University:** Coppin State University

**Name of STEM Program:** STEM Summer Bridge Program

**Constituencies Served:** High School or Community College graduates who have chosen to major in STEM Disciplines

**Brief Description:** During the summer, the STEM Program offers a 6-week introduction in the University experience to 25 students. Students have the opportunity to earn seven (7) college credits (Chemistry 101—4 credits; and Mathematics 131—3 credits) upon successful completion with a grade of “C” or better. The program provides a stipend and pays for all expenses related to the program.

**University:** Coppin State University

**Name of STEM Program:** Facilitated /Structured Tutoring Program

**Constituencies Served:** STEM undergraduate students

**Brief Description:** The purpose of this program is to increase retention rate in STEM disciplines. Many students were either changing their majors or completely dropping out of the university because they were unable to pass certain bottleneck STEM courses. Students participate in groups that consist of a lead facilitator and a staff (faculty or tutor from the tutoring center) and no more than 10 students. Groups meet at least twice weekly and focus on the current class assignments for that week.

**University:** Coppin State University

**Name of STEM Program:** Lecture Series

**Constituencies Served Program:** All students are invited, but lectures are geared toward the development of STEM students.

**Brief Descriptions:** Each semester, several distinguished professors, scientists, and researchers from various universities, institutions and industry are invited to lecture to students and faculty on various topics that relate to STEM interests.

**University:** Coppin State University

**Name of STEM Program:** "Exposure Program" with the National Institutes of Health and Johns Hopkins University School of Medicine

**Constituencies Served:** *Underrepresented undergraduate science students and science faculty*

**Brief Description:** The Purpose of this program is to increase the number of underrepresented minorities in the basic sciences, Coppin State University, John Hopkins University School of Medicine and the National Institute's of Health have joined together to create an enrichment program, "Exposure", designed to broaden the scientific experience of undergraduate science students at Coppin State University. This program offers students bi-weekly scientific lectures from postdoctoral fellows and staff from Johns Hopkins describing the latest concepts in biomedical research. This program is intended to serve as the first of several partnerships with nearby well-established academic institutions, which we

believe will help us better prepare our science students for promising careers in the biomedical and health service industry. Shared resources among public, private, and governmental facilities can assist us with developing a well-rounded student who understands the latest industrial techniques used to solve scientific questions in today's marketplace. By acting upon lessons learned from our pre-undergraduate/ undergraduate (STEM) program, we believe that increasing the scientific exposure of our student body beyond our campus will be of great benefit to not only their immediate career prospects, but also the community at large. As a member of the University System of Maryland, we will continue to meet our promise of challenging students with new opportunities that will enhance their academic experience for many years to come. Our overall goal is to increase the number of scientifically-trained minorities in the Baltimore/ Washington corridor, so that our students can contribute to the scientific pipeline of growth and development in the near future. We believe that a strong effort on our part, like the "Exposure Program," will allow us to fulfill our promise to our students of preparing them for careers in the sciences.

**University:** Coppin State University

**Mini-grant: Increased Capacity of Tegrity/ Blackboard to include off-campus real-time and recorded lectures.**

**Constituencies Served:** undergraduate science students and science faculty

**Brief Description:** While developing the "Exposure Program", one surprising aspect of this process thus far has been the willingness of our community-based colleagues to offer their insightful career-building and academic experiences. However, what must often limit their ability to provide our students with their wealth of knowledge are their over-extended work schedule and the mere distance between their worksite and Coppin State University. We, in the Natural Science Department, believe that this problem actually offer our university an opportunity to expand its educational reach by creatively addressing this problem. To ensure that our science students are adequately exposed to our eager colleagues, we propose to expand the capacity of our present technology-based learning systems (Tegrity/Blackboard) to accommodate real-time and recorded interviews from our surrounding community. We believe that such an expanded system would allow us to delivery notable presenters to our students in a relatively shorter time period while greatly increasing their scientific access to prominent members of our community. As we continue to grow and invest in the infrastructure of our basic science department, we will also continue to use innovative ways to provide our students with the best chance of success in the future. Increasing our communication portal system with the community- at- large will also offer us a unique tool to forester future partnerships with organizations and individuals who once were deemed inaccessible.

**University: Coppin State University**

**Name of STEM Program:** The Long-term Undergraduate Research Experience (LURE)

**Constituencies Served: Undergraduate Mathematics Students**

**Brief Description:** This program, a model for the mathematical sciences, is collaboration between the mathematics facilities at Coppin State University, Central Michigan University, Olin College, and the University of Richmond. The LURE model emphasizes early recruitment of women and minority undergraduates to mathematical research and the cultivation of interest in the mathematical sciences. This program will increase: the number of undergraduates electing mathematic courses beyond

institutional requirements; the number of undergraduates and faculty members engaging in undergraduate research experiences; and the number of undergraduates prepared to pursue graduate work.

**University:** Coppin State University

**Name of STEM Program:** Empowering the Eagles/ National Geospatial-Intelligence Agency Grant

**Constituencies Served:** Underrepresented undergraduate students

**Brief Description:** Provide courses and research opportunities in Geography and Geospatial Technologies, such as GIS, GPS and remote sensing for students in Global Studies.

**University:** Coppin State University

**Name of STEM Program:** Strengthening Capacities in Geographic Teaching and Technologies/ US Department of Education, College Cost Reduction and Access Act

**Constituencies Served:** Underrepresented undergraduate students

**Brief Description:** Create a Geospatial Technologies lab for undergraduate teaching and research, hire contractual lecturer and launch a new BS in Geography.

**University:** Coppin State University

**Name of STEM Program:** Inspiring the Eagles/ NASA Grant

**Constituencies Served:** Underrepresented undergraduate students and students at Rosemont and Coppin Academy

**Brief Description:** Improve K-16 instruction in Geography and Geospatial Technologies by teaming elementary, middle and high school teachers with Coppin faculty-members for curriculum development and teacher training in summer 2009.

**University:** Coppin State University

**Name of STEM Program:** Nanotechnology

**Constituencies Served:** Underrepresented undergraduate students

**Brief Description:** The Department of Natural Sciences initiated a major curriculum review and transformation processes in the use of web enhance technology (Blackboard) and Tegrity in Spring, 2009 in Nanotechnology and general chemistry courses. It was anticipated that the infusion of these computer technologies would enhance the student's ability to learn, improve their grades, which would ultimately lead to higher retention and graduation rates.

This proposal focuses on exploiting science and technology of nanomaterials for future generation. Our works will involve teaching this Nano course in this spring semester, 2009 and do syntheses of various novel nanomaterials, development of experimental techniques for characterization of single nanoparticles, discovery of new phenomena, and searching for new applications. Our focus is not only to achieve excellence in academic world but also to provide some solutions to technological applications in the real world. Recent cutting edge process and characterization techniques provide unprecedented opportunities for forming and investigating nanomaterials that exhibit unusual physical and chemical properties unmatched by their bulk counterparts.

**University:** Coppin State University:

**Name of STEM Program:** Coppin Academy, Rosemont Elementary School Partnership

**Constituencies Served:** K-12

**Brief Description:** This is a K-12 partnership that includes Coppin State University, the Coppin Academy and the Rosemont Elementary School. This partnership involves the development of the appropriate of the curriculum for the sciences, mathematics and history.

**University:** Coppin State University

**Name of STEM Program:** Research Opportunities

**Constituencies Served:** Underserved undergraduate STEM students

**Brief Description:** We aggressively encourage students to conduct research and participate in internship programs. Students are paired with a faculty tutor and/or mentor to conduct research in preparation for presentations at the national research conferences.

## Frostburg State University STEM Initiatives

**University:** Frostburg State University

**Name of STEM Program:** Maryland Summer Center for Future Engineers: Robot Design

**Constituencies Served:** Twenty gifted and talented students entering 9<sup>th</sup> grade and 20 gifted and talented students entering 10<sup>th</sup>-12<sup>th</sup> grades attended.

**Brief Description:** The Department of Physics and Engineering hosted the fifth year of this robotics summer center in 2008. Students learned how to program intelligent robotic systems, practice with robotics simulation software, and program actual robotic arms to solve real life problems. This was funded through the Maryland State Department of Education.

**Weblink:** <http://faculty.frostburg.edu/engn/soysal/robot/>

**University:** Frostburg State University

**Name of STEM Program:** Maryland Summer Center for Mathematics

**Constituencies Served:** 30 students grades 5-9

**Brief Description:** The Department of Mathematics hosted its third mathematics summer institute in 2008 entitled Problem Solving, Data Analysis, Algebra and Geometry with Technology. The two-week program, funded through the Maryland State Department of Education, will serve 30 mathematically-gifted students from around the state, grades 5 through 9. The Math Department hosted two previous summer institutes entitled Mystery + Mastery \* Beauty + Power = Infinity!

**Weblink:** <http://faculty.frostburg.edu/math/lhegde/>

**University:** Frostburg State University

**Name of STEM Program:** Maryland Summer Center for the Physics of Wind and Solar Power

**Constituencies Served:** 24 gifted and talented middle school students (grades 6 through 9)

**Brief Description:** The Department of Physics and Engineering hosted its first wind and solar power summer center in 2008. The program, funded through the Maryland State Department of Education, enrolled 24 gifted and talented middle school students (grades 6 through 9) in Summer 2008. The residential program focused on the mathematical modeling of energy available from the sun and moving air.

**Weblink:** <http://faculty.frostburg.edu/phys/hdeng/>

**University:** Frostburg State University

**Name of STEM Program:** ITQ/TOPPS Physics Teacher Training

**Constituencies Served:** 24 physics teachers from across the state of Maryland

**Brief Description:** FSU is in its second year of a grant from the Maryland Higher Education Commission to offer a three-year summer program providing professional development for physics teachers from across the state. The project supports a cohort of 24 teachers, using curriculum developed by the American Association of Physics Teachers. Teachers attend a six-day workshop each summer and also participate in one-day workshops each semester. The program is designed to help teachers to gain physics content area knowledge, develop their teaching strategies, integrate instructional technology, and attain "Highly Qualified" status. The Project Director will be helping in the development of a similar program on the Eastern Shore modeled after ITQ/TOPPS.

**Weblink:** <http://www.frostburg.edu/topps/>

**University:** Frostburg State University

**Name of STEM Program:** Earth Science Teacher Workshop

**Constituencies Served:** Nine 6<sup>th</sup> and 9<sup>th</sup> grade earth science teachers from Allegany County  
**Brief Description:** During Summer 2007, the College of Education and College of Liberal Arts and Sciences collaborated to offer a one-week workshop for 6<sup>th</sup> and 9<sup>th</sup> grade earth science teachers from Allegany County. Nine teachers worked with FSU faculty to create modules for use in their classrooms.  
**Weblink:** N/A

**University:** Frostburg State University  
**Name of STEM Program:** Gear Up Programs  
**Constituencies Served:** 10<sup>th</sup> graders (2008-2009 school year) from Mountain Ridge High School in Allegany County, Northern and Southern high schools in Garrett County  
**Brief Description:** FSU partners with both the Allegany and Garrett County Boards of Education to bring students to the University as part of Gear Up (Gaining Early Awareness and Readiness for Undergraduate Programs). For the past three summers, FSU has hosted Allegany County school students for a weeklong workshop, with additional field trips planned throughout the semester as well. Sessions presented by FSU faculty include a wide range of topics such as forensic science, graphic design, garage band camp, and physics. FSU has also hosted one-day workshops for the Garrett County Gear Up Program.  
**Weblink:** <http://www.marylandpublicschools.org/MSDE/divisions/leadership/programs/Gearup.htm>

**University:** Frostburg State University  
**Name of STEM Program:** Regional Math and Science Center Programs  
**Constituencies Served:** 8<sup>th</sup>, 9<sup>th</sup>, and 10<sup>th</sup> from Baltimore City and 22 counties of Maryland, Pennsylvania, and West Virginia. Must meet federal income guidelines and/or be a first-generation college student.  
**Brief Description:** Frostburg State University's Regional Math/Science Center is a federally funded Department of Education Upward Bound grant program designed to prepare qualified high school students for successful admission into and completion of post-secondary degree programs that will lead to careers in math or science. The RMSC is funded to serve students from Baltimore City and 22 counties of Maryland, Pennsylvania, and West Virginia. Students participating in the program attend a three- or six-week summer residential program at Frostburg State University and continue to receive support throughout the academic year. Once a student is accepted into the program they are encouraged and expected to continue participating in the program until they graduate from high school.  
**Weblink:** <http://www.frostburg.edu/clife/mscenter/>

**University:** Frostburg State University  
**Name of STEM Program:** STEM Residence Hall  
**Constituencies Served:** FSU freshmen interested in STEM majors  
**Brief Description:** To increase retention we have established a residential learning community for STEM freshmen students. In addition to academic support programming, we endeavor to create opportunities for social networking for STEM students.  
**Weblink:** N/A

**University:** Frostburg State University  
**Name of STEM Program:** Engineering Day  
**Constituencies Served:** 21 students (grades 4-6) and 6 parents from throughout Western MD  
**Brief Description:** The Department of Physics and Engineering hosts an annual half-day workshop targeted toward local 4<sup>th</sup> through 6<sup>th</sup> graders with demonstrations and hands-on activities. The purpose of the program is to promote interest in science among youngsters. The activities are organized by physics/engineering students at FSU, as well as Physics/Engineering professors. They include the study

of motion, solar and wind energy, fuel cell technology, engines, and waves. Twenty-one students participated in Fall 2008.

**Weblink:** N/A

**University:** Frostburg State University

**Name of STEM Program:** Math Symposium

**Constituencies Served:** K-14 students and teachers

**Brief Description:** This is an annual one-day event hosted by the FSU Mathematics Department and funded by FSU and the Maryland Council of Teachers of Mathematics. The focus is teaching, learning, and exploration of mathematics at various levels of mathematics instruction (K - 14). Presentations include topics on mathematics content, teaching methodologies, or connections between mathematics and other subjects.

**Weblink:** <http://www.frostburg.edu/dept/math/symposium/symposium2008.htm>

**University:** Frostburg State University

**Name of STEM Program:** Geospatial Research Group

**Constituencies Served:** FSU students in geography and environmental science majors

**Brief Description:** Originally created in 1992 as part of the Frostburg State University Department of Geography, the Western Maryland Regional GIS Center has historically given students real work experience on GIS projects before leaving college. The Center's projects and research have comprised a varied number of services, including well monitoring, stream flow and quality analysis, GIS development, database construction, thematic mapping, natural resource assessments (coal, limestone, water), mapping, global positioning systems (GPS), and presentation. Services include digitizing, scanning, plotting, graphics, data conversion, mapping, global positioning system (GPS), and presentations.

**Weblink:** N/A

**University:** Frostburg State University

**Name of STEM Program:** Environmental Planning and Land Management Institute

**Constituencies Served:** FSU undergraduate and graduate students in geography and environmental science majors

**Brief Description:** This is a cooperative institute between the FSU Department of Geography and the Maryland Bureau of Mines. The institute provides educational opportunities and assistantships to undergraduate and graduate students in environmental and regional research projects. Focus is on historical and current information on the environment, especially the ecotechnical impact of coal mining to the Western Maryland region and its importance.

**Weblink:** <http://www.frostburg.edu/dept/geog/einstitute/>

**University:** Frostburg State University

**Name of STEM Program:** Student Internship Opportunities

**Constituencies Served:** FSU students in STEM majors

**Brief Description:** The Tawes Incubator, located on the FSU campus, houses eight technology-related businesses and organizations that provide internship opportunities for FSU students. These include the U.S. Geological Survey working on environmental science projects and Leading Edge Design, a provider of system integration products and services to the federal government and intelligence community.

**Weblink:** N/A

## **Student Research Projects**



**University:** Frostburg State University

**Name of STEM Program:** Collection, Preservation and Evaluation of Medicinal Plants in the Appalachian Region

**Constituencies Served:** FSU undergraduate students in chemistry, biology, and geography majors

**Brief Description:** Over three years, the Appalachian Center for Ethnobotanical Studies and the U.S. Department of Agriculture have received a total of \$686,375 in funding for black cohosh research. Two FSU undergraduate students are working on studying the chemical constituents of Black Cohosh to establish and archive chemical fingerprints that can be used to identify populations of Black Cohosh that are rich in active ingredients.

**Weblink:** N/A

**University:** Frostburg State University

**Name of STEM Program:** Wind and Solar Energy (WISE) Project

**Constituencies Served:** FSU undergraduate students in Physics, Engineering, Geography, Math, Computer Science, Biology, and Chemistry

**Brief Description:** This project is motivated by the growing need to find solutions to the energy crisis, as well as global warming. The Wind and Solar Energy (WISE) project exemplifies the commitment of FSU to address these issues. It includes a grid-tied residential scale wind and solar powered system that supplements electrical power to Fuller House. The total rated power is 3.8 kW. The project is sponsored by the Maryland Energy Administration (MEA) to develop a knowledge base for community outreach programs and interdisciplinary courses taught at FSU. The system enables study of the efficiency and feasibility of solar and wind energy in Western Maryland. Examples of interdisciplinary undergraduate projects supporting the WISE project include the following (interdisciplinary collaborations are given in parentheses): Collect, analyze, and interpret wind, solar, and geothermal energy data across different geographic landscapes to assess the most effective combination of renewable energy resources at each specific location (Physics, Engineering, Geography, Mathematics, and Computer Science). Develop energy conversion systems that use renewable energy resources. Typical student projects include (but are not limited to) the following: a wind-powered pump, a solar-powered fan, solar-powered outdoor lighting, etc. (Engineering and Physics). Study biotic and abiotic parameters associated with pre and post construction of commercial and residential wind and hydroelectric power generation (Biology, Physics, and Engineering). Study the visual and geologic impact of commercial and residential wind power generation (Geography and Engineering). Develop fuel cell applications for energy generation and storage (Chemistry, Physics, and Engineering). Investigate biomass applications such as using microorganisms in the artificial production of methane (Chemistry and Biology).

**Weblink:** <http://faculty.frostburg.edu/engn/soysal/Activities/Training.html>

**University:** Frostburg State University

**Name of STEM Program:** Nanotechnology

**Constituencies Served:** FSU undergraduate students in engineering, physics, chemistry, and biology majors; outreach programs for K-16 students and local industry.

**Brief Description:** The Department of Physics and Engineering has received funding from the Appalachian Regional Commission (ARC) to establish a lab facility for providing education and training in nanotechnology. Students will conduct experiments to learn and develop novel methods for synthesis of nanomaterials, characterization of nanomaterials, and integration of these nanomaterials for sensor applications. The facility will be used for electrical engineering, mechanical engineering, physics, chemistry, and biology programs offered at FSU. It will also serve K-16 students through extracurricular activities and local industry for continuing education and training of technical personnel.

**Weblink:** N/A

**University:** Frostburg State University

**Name of STEM Program:** Chemical Analysis of Coal and Shale Reserves in Western MD

**Constituencies Served:** FSU undergraduate chemistry and geography majors.

**Brief Description:** The Department of Chemistry is seeking ARC funding to provide chemical analysis of coal and shale reserves in the local region, determine the quality of the coal and shale, catalog this information using spatial mapping technology, and provide this information in a format accessible and useful to industry. It would also include an analysis of mine spoils and fly-ash residue to determine environmentally friendly methods of disposal. FSU will partner with the Maryland Department of Natural Resources and the Maryland Power Plant Research Program (Tawes incubator tenants) on this project. The DNR will initiate a program of collecting coal samples, with the work being performed by the Western Maryland Resource Conservation and Development Council (also in the Tawes incubator). FSU Chemistry Department students and faculty will perform the analysis. The Chemistry Department will provide all of the analyzed information to the Geospatial Research Group for geospatial mapping.

**Weblink:** N/A

**University:** Frostburg State University

**Name of STEM Program:** Biodiesel Fuel Generation

**Constituencies Served:** FSU undergraduate students in STEM majors.

**Brief Description:** FSU has received an ARC grant to conduct research on biodiesel fuel generation. It is possible to produce biodiesel out of raw or processed plant material both safely and cheaply. This program will examine two possible biodiesel sources: a suitable farm crop or a farm crop waste byproduct. Undergraduate students will work with FSU faculty to: Identify local crops that would be optimal sources of biodiesel fuel for this region.

Extract oil from plant material using mechanical oil pressers or oil expellers. These mechanical methods are currently used by European farmers and are much safer than chemical extraction methods.

Convert the plant oil into biodiesel. The chemistry for this reaction is well known, but needs to be modified so it can be performed easily by local farmers using an easy to follow recipe.

Find a suitable filtration method to clean the biodiesel produced by removing contaminants that may damage farm equipment.

Test the quality of the biodiesel fuel with a customized testing kit.

Dispose of the waste products in a cheap, safe, and environmentally friendly manner.

**Weblink:** N/A

## Salisbury University STEM Initiatives

### Salisbury University – A sample of SU's STEM Initiatives

University: Salisbury University

Name of STEM Program: **Early field experience for STEM majors**

Constituencies served: Undergraduate majors in STEM fields

Brief Description: Funding is available for twelve STEM majors to be paid for assisting in local science and mathematics classrooms working with STEM teachers. The experience can either be linked to an introductory education class or be a stand-alone experience. Mentoring from either a math or science education faculty member accompanies the experience

WEB link to more information (if available):

University: Salisbury University

Name of STEM Program: **Eastern Shore Partnership for Real-World Information Technology in Science using Case Studies (ESPRIT Science CS)**

Constituencies Served: Secondary Science Teachers (Somerset, Wicomico, Worcester Counties)

Teachers are supported by university personnel as they engage with area business and agency partners to design inquiry-based case study units to use in science instruction. These case studies make use of real-world and locally relevant data, including on-site data collection by participating teachers. Emphasis is on student engagement, science inquiry and workforce development.

University: Salisbury University

Name of STEM Program: **Eastern Shore Partnership for Real-World Information Technology in Science using Science Visualizations (ESPRIT Science SV)**

Constituencies Served: K-12 Science Teachers (Somerset, Wicomico, Worcester Counties)

Teachers are introduced to science visualizations (SVs), which are important tools in STEM careers, especially in setting where workers from different STEM fields need to integrate their understanding. Teachers will explore the sources of SVs, as well as how to make use of them in inquiry-based science instruction. Area STEM partners that make use of SVs in their work (e.g., local hospital imaging center, NASA) are supporting teacher integration of SVs into instruction.

University: Salisbury University

Name of STEM Program: **Eastern Shore Mathematics Academy**

Constituencies served: Middle School mathematics teachers from across the Eastern Shore, including those from Wicomico, Somerset, Worcester, Dorchester, and Talbot counties.

Brief Description: The Maryland State Department of Education has funded mathematics academy participation for seven cohorts of approximately 30 teachers each. Salisbury University professors from the Education and Mathematics departments have facilitated summer workshops, online discussions, and lesson study for the teachers involved. All of these activities aim to deepen teachers' knowledge of content and pedagogy. The activities also place emphasis upon developing teachers' abilities to engage in critical self-reflection on their current teaching practices.

University: Salisbury University

Name of STEM Program: **STEM Living Learning Community**

Constituencies served: Selected Freshman Students at Salisbury University

Brief Description: SU is creating a STEM Living Learning Community in its Residence Halls, whereby freshman science and math majors will be housed together, will participate in two related courses together (one science and one liberal arts), and will engage in various co-curricular activities together. They will be introduced to STEM teaching through visits to local classrooms and will have the chance to meet local STEM teachers.

WEB link to more information (if available):

University: Salisbury University

Name of STEM Program: **Transitioning from Elementary to Middle School Mathematics**

Constituencies served: A cohort of 20 teachers from Somerset and Worcester County

Brief Description: This project is supported by an MHEC grant to provide professional development in mathematics for a cohort of teachers.

Activities include an online discussion board, the use of educational materials from the Mobius education group, cross-county after school

professional development sessions, lesson plan development, and a one-week summer mathematics institute to serve as the capstone. The grant runs February 2008 - July 2009.

University: Salisbury University

Name of STEM Program: **Eastern Shore High School Math Competition**

Constituencies served: The 25<sup>th</sup> annual HSMC was held in November, 2008. The competition focuses on both individual and cooperative achievement. High Schools from the region may enter teams of up to three students in the competition. The team round presents each school's team with four or five challenging, open-ended problems. The individual round has each student, working independently, answer twenty multiple choice questions. Winners are chosen based on the number of questions answered correctly; there is no penalty for incorrect answers. Subject areas covered by contest questions include: algebra, geometry, functions and functional notation, exponents and logarithms, trigonometry, probability and statistics, logic and set theory, arithmetic sequences, geometric series, and number theory. In addition to the competition, students are invited to participate in a brief workshop on a mathematical topic they probably won't see in high school.

Website: <http://www.salisbury.edu/mathcosc/HSMC/>

University: Salisbury University

Name of STEM Program: **SU Chemistry Outreach Program**

Constituencies served: public school students, undergraduate chemistry majors, and possibly education majors

Brief Description: Several demonstrations and workshops for local K-12 students and the community are held each year including SU Fun Day, Cub Scout and Webelo Workshops, 4H Workshops, Chemical and Lab Safety Workshop for Wicomico County teachers, and Merit Badge College (serving several hundred Boy Scouts).

University: Salisbury University

Name of STEM Program: **Maryland GEAR UP - Closing the Opportunity Gap - Year 8**

Constituencies served: Tenth grade, Somerset County Maryland & a cohort of tenth graders, Wicomico County, Maryland.

Brief Description: SU has and is partnering with Washington High School (152 students), Crisfield High School (85 students) in Somerset County, and Wicomico High School (304) to improve the math skills of tenth graders. Tasks include determining the needs of the students; providing academic enrichment and support activities to address multi-level academic needs; informing and educating students about the

math standards they are expected to master during 11th grade; and establishing a sustainable rapport with students and Gear Up partners. SU will provide academic services that focus on mathematics and succeeding in college.

University: Salisbury University

Name of STEM Program: **Mid-Atlantic Institute for Space and Technology (MIST)**

Constituencies served: Students and faculty of Salisbury University

Brief Description: SU is a partner in the MIST whose goal is to commercialize space flight at NASA's Wallops Island facility. MIST provides internships and employment for students and professional development opportunities for faculty. Moreover, the MIST program has led to the creation of a state-of-the-art Mission Planning Laboratory at Salisbury University which students and faculty are using in their research.

## Towson University STEM Initiatives

**University:** Towson University

**Name of STEM Program:** Hackerman Academy of Mathematics and Science

**Constituencies served:** K-12 students, parents, and teachers

**Brief Description:** The Willard Hackerman Academy of Mathematics and Science was established in 2006 through a generous gift from Willard Hackerman, president and CEO of Whiting-Turner Contracting Co. The academy is housed within the Fisher College of Science and Mathematics on the campus of Towson University. Former NASA astronaut Donald A. Thomas, Ph.D., is director of the academy.

The goals of the Hackerman Academy are to attract more students into STEM (Science, Technology, Engineering, and Mathematics) majors and to prepare teachers who will be energized to teach in area schools in these much needed discipline areas. Additionally this initiative will provide advanced training in math and science to existing teachers in the state of Maryland.

**WEB link to more information:** <http://www.towson.edu/HackermanAcademy/index.asp>

**University:** Towson University

**Name of STEM Program:** Calverton/Towson Project

**Constituencies served:** Middle School Students

**Brief Description:** In June 2008 Towson University began its third year as a partner with Calverton Middle School in Baltimore City Public School System this summer under the Middle Grades Partnership (MGP) umbrella organization. Among the twelve MGP projects that partner local private schools with City public schools, Towson's is unique: It is the only MGP project in which a university is directly involved as a partner-school. MGP's goal is to prepare more Baltimore City public school students to take rigorous mathematics courses in high school and beyond.

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/Calverton/index.asp](http://www.towson.edu/fcsm/community_engagement/Calverton/index.asp)

**University:** Towson University

**Name of STEM Program:** Geomatics Academy

**Constituencies served:** Fairmont Heights High School Students

**Brief Description:** The Geomatics Academy is a partnership between Towson University and Fairmont Heights High School of Prince Georges County Public School System. The Academy is a College Preparation Intervention Program, funded by the Maryland Higher Education Commission. The Academy integrates mathematics, geography, and environmental science in a novel and engaging approach that generates enthusiasm for learning through hands-on, real-life activities and technology. It is designed to:

- strengthen students' understanding of Algebra I and Data Analysis concepts
- promote college awareness, and
- introduce students to a variety of careers within the environmental sciences

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/Geomatics/index.asp](http://www.towson.edu/fcsm/community_engagement/Geomatics/index.asp)

**University:** Towson University

**Name of STEM Program:** Planetarium Shows

**Constituencies served:** K-12 students, parents, and teachers

**Brief Description:** The Watson-King Planetarium is Towson University's primary tool for public outreach

in astronomy. Established in 1965, the Watson-King Planetarium allows us to view the stars at any time of the day or night, in any weather. It has seating for 40 people under its 24 diameter dome. On the third Friday of every month during the academic year, faculty members, students, or friends of the Towson University's Physics, Astronomy, and Geosciences Department give presentations in the Planetarium. Each show usually consists of a tour of the night sky along with a discussion of some topic in astronomy and is open to the public. When weather permits, the planetarium shows are followed by telescope observing using our 14" diameter Ritchey-Chretien reflecting telescope as well as some of our portable 8" Celestron telescopes. Additionally, the department faculty members give shows to individual school and scout groups on an ad hoc basis. We can accommodate groups of students in the campus planetarium, or we may schedule a visit to your school with our inflatable, portable planetarium

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/Planetarium\\_Shows/index.asp](http://www.towson.edu/fcsm/community_engagement/Planetarium_Shows/index.asp)

**University:** Towson University

**Name of STEM Program:** Project ASTRO

**Constituencies served:** K-9 students and teachers

**Brief Description:** Towson University launched a Project ASTRO site for Baltimore in the 2008-2009 academic year. Project ASTRO is a program that has been run by the Astronomical Society of the Pacific (ASP) since 1994 to link professional and amateur astronomers with local K-9 teachers and students to bring inquiry-based astronomy activities to classrooms. Local Project ASTRO networks currently operate in 15 other regions throughout the U.S., but this is the first program serving the Baltimore area, with its high concentration of space science professionals and amateur observers.

As a Project ASTRO site institution, Towson University (TU) is responsible for recruiting educator and astronomer partners and for bringing them together for a workshop, typically held in the fall. At the workshop, partners are provided with materials from the ASP, and they learn how to forge effective collaborations, how to make use of local Astronomy resources, and how to implement hands-on, inquiry-based Astronomy activities in their classrooms. The material supplied by the ASP consists of a notebook of over 85 hands-on astronomy activities that are aligned with National Science Education Standards. The specific goals of the program are to bring direct benefits to both teachers and students by: (1) promoting active learning methods in science classrooms that engage both teachers and students and improve student attitudes towards science; (2) offering role models for students by showing them working examples of who scientists are and what they do; and (3) providing professional development for teachers through workshops, in-service training, and one-to-one partnerships with local content "experts".

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/ProjectASTRO/index.asp](http://www.towson.edu/fcsm/community_engagement/ProjectASTRO/index.asp)

**University:** Towson University

**Name of STEM Program:** Promoting Engineering Education in the Elementary Schools

**Constituencies served:** K-6 students and teachers

**Brief Description:** Dr. Pamela S. Lottero-Perdue, Assistant Professor of Science Education, is putting the "E" in STEM outreach and educational efforts for FCSM. Dr. Lottero-Perdue's PEEESC program involves teaching, enhancing, implementing and researching units of instruction in the Boston Museum of Science's Engineering is Elementary Project. The PEEESC program has two components:

- Harford County Public Schools (HCPS) Elementary Engineering Project
- The Summer Engineering and Science (SEAS) Club at the Havre de Grace Location of the Harford County Boys and Girls Club

**Harford County Public Schools Elementary Engineering Project**

[http://www.towson.edu/fcsm/community\\_engagement/Engineering%20Education/programs/HGPS.asp](http://www.towson.edu/fcsm/community_engagement/Engineering%20Education/programs/HGPS.asp)

This project initiates engineering instruction at the elementary level in Harford County Public Schools (HCPS) by capitalizing on teacher professional development expertise at Towson University. The project team will use funds to purchase materials for and support professional development of teachers in seven elementary – Jarrettsville, Havre de Grace, Halls Crossroads, North Bend, Prospect Mill, Roye-Williams and Darlington schools – who will teach engineering units to students and other teachers. A \$93,634.00 Workforce ONE Maryland Grant supports the first year of a five-year plan to include nine-hour engineering units of instruction in first, second, third, fourth and fifth grades.

**The Summer Engineering and Science Club at the Havre de Grace Location of the Harford County Boys and Girls Club**

[http://www.towson.edu/fcsm/community\\_engagement/Engineering%20Education/programs/SEAS.asp](http://www.towson.edu/fcsm/community_engagement/Engineering%20Education/programs/SEAS.asp)

The Summer Engineering and Science (SEAS) Club was piloted within the 2008 summer program at the Havre de Grace location of the Harford County Boys and Girls Club (BGC). The primary purposes of the club were to extend the science and technology education of elementary children at the BGC, and to study children's thinking and learning about science and technology.

First and second grade SEAS club participants learned about civil engineering and bridge design, while third through fifth grade participants investigated agricultural and mechanical engineering, designing hand pollinators, sailboats, and windmills. The younger club received 12 hours of instructional time over five weeks, while the older club received 26 hours over six weeks. Instructional units were developed by the Engineering is Elementary (EiE) project at the Boston Museum of Science, and trade books were added to these units to enhance students' learning about engineering and technology.

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/Engineering%20Education/index.asp](http://www.towson.edu/fcsm/community_engagement/Engineering%20Education/index.asp)

**University:** Towson University

**Name of STEM Program:** Engineering Content Included in an Elementary Science Methods Course

**Constituencies served:** Elementary Education Majors

**Brief Description:** Dr. Pamela Lottero-Perdue has modified and integrated an Engineering is Elementary geotechnical engineering unit to extend the geology unit in PHSC 303 Earth-Space science, a required science content and methods course for elementary education majors. Students enrolled in her course engage in and learn the value of the engineering design process as an extension of their science learning.

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/Engineering%20Education/programs/PHSC\\_303.asp](http://www.towson.edu/fcsm/community_engagement/Engineering%20Education/programs/PHSC_303.asp)

**University:** Towson University

**Name of STEM Program:** PhysTEC

**Constituencies served:** Elementary Education Majors

**Brief Description:** The Physics Teacher Education Coalition (PhysTEC) project is a nationwide project that has the goal of improving science preparation for K-12 teachers. At each of the PhysTEC sites around the United States, science faculty, education faculty, and a full-time teacher-in-residence (TIR) work together to implement local teaching reforms that emphasize interactive engagement and a student-centered approach to learning science.

The PhysTEC program at Towson is unique within the project in that it supports only elementary science education. Towson graduates about 200 elementary education majors a year (more than any other school in Maryland), and each teacher candidate takes a content course in physical science and



earth-space science, and a field experience course in teaching science. Towson's PhysTEC efforts have focused on reforming the field experience course to inculcate interns (student teachers) with inquiry-based teaching techniques, and provide them with opportunities for mentoring and self-reflection. The Towson PIs have also developed assessment instruments in an attempt to demonstrate the effectiveness of their course reforms on intern teaching methods and attitudes towards science

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/PhysTEC/index.asp](http://www.towson.edu/fcsm/community_engagement/PhysTEC/index.asp)

<http://www.phystec.org/institutions/towson/>

**University:** Towson University

**Name of STEM Program:** STEM Teaching Community Project

**Constituencies served:** Undergraduate students in STEM courses; undergraduate STEM majors

**Brief Description:** the Science, Technology, Engineering, and Mathematics Teaching Community (STEM-TC) project, faculty from the Fisher College of Science and Mathematics collaborate with undergraduate Learning Assistants (LAs) to:

1. improve STEM courses,
2. provide opportunities for the LAs to gain an appreciation and understanding of effective STEM teaching, and
3. make the LAs aware of education-related career options, which might include joining one of the secondary education programs at Towson and choosing high school or middle school teaching as a career.

Through their involvement with STEM-TC, the Learning Assistants develop active-learning instructional skills, practice those skills, and participate in transforming instruction. They do this by engaging in teaching activities, participating in team meetings, and by attending a weekly teaching and learning seminar.

The Learning Assistant teaching activities take different forms, depending on the course(s) and working teams to which the LAs have been assigned. Teaching activities include: leading and facilitating discussions of small groups of students in classes and/or help sessions, providing test review sessions, and tutoring. Typically, the STEM-TC faculty work to transform their introductory classes to encourage more student engagement with the material and with each other. LAs help facilitate this engagement.

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/STEM-TC/index.asp](http://www.towson.edu/fcsm/community_engagement/STEM-TC/index.asp)

**University:** Towson University

**Name of STEM Program:** Project Learning Tree

**Constituencies served:** K-12 students and teachers

**Brief Description:** The Center for Science & Mathematics Education is a state co-sponsor, along with the Maryland Department of Natural Resources, of Maryland Project Learning Tree.

**Teachers:** The Center for Science & Mathematics Education offers Project Learning Tree teacher professional development workshops on your school site. Each participant receives the Project Learning Tree curriculum guide and supplemental resources. We can also come to your classroom to conduct activities with your students.

Project Learning Tree® (PLT) is an award winning, multi-disciplinary environmental education program for educators and students in PreK-grade 12. PLT, a program of the American Forest Foundation, is one of the most widely used environmental education programs in the United States and abroad. PLT continues to set the standard for environmental education excellence.

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/Project\\_LT/index.asp](http://www.towson.edu/fcsm/community_engagement/Project_LT/index.asp)

**University:** Towson University

**Name of STEM Program:** CoSMIC\* Scholars

**Constituencies served:** recruitment and retention of undergraduate students in STEM fields

**Brief Description:** Computing, Sciences, and Mathematics in College\* (CoSMIC\*) is an extension of a previous scholarship program under the NSF S-STEM program. The program has been expanded to include undergraduate students majoring in Computer Science; Computer Information Science; Mathematics; Molecular Biology, Biochemistry, and Bioinformatics (MB3); or Forensic Chemistry; and graduate students majoring in Applied and Industrial Mathematics; Applied Information Technology; Computer Science; Mathematics Education or Forensic Science.

The primary goal of the program is to increase awareness and access to these programs and career opportunities, as well as to increase the probability of retention and persistence in these target areas of science, mathematics, and computing. A secondary goal is to increase the number of students in the programs and who become aware of the interdisciplinary nature of mathematics and computing in the sciences. In addition to the variety of programs offered, we will expect all CoSMiC\* scholars will enroll in one of two one-credit interdisciplinary courses that explore careers and opportunities in science, technology, and mathematics.

**WEB link to more information:**

[http://www.towson.edu/fcsm/community\\_engagement/CoSMiC\\_Scholars/index.asp](http://www.towson.edu/fcsm/community_engagement/CoSMiC_Scholars/index.asp)

**University:** Towson University

**Name of STEM Program:** Towson Opportunities in STEM — TOPS

**Constituencies served:** K-12 students, parents, and teachers

**Brief Description:** Towson **OP**portunities in **STEM** (**S**cience, **T**echnology, **E**ngineering, and **M**athematics)

Towson **OP**portunities in **STEM** (TOPS) is a new program sponsored by a grant of \$2,000,000 from the National Science Foundation that is dedicated to increasing the number of students from the Baltimore area successfully completing a B.S. degree in science or mathematics from Towson University. TOPS provides a suite of support services that assist students to achieve academically. Individuals who are selected to participate in the TOPS program join a community of peers committed to the success of all participants in the program. TOPS participants are further encouraged to become peer tutors and mentors who assist other TOPS students as they pursue their degrees in the sciences or mathematics. TOPS focuses on enhancing academic achievement and career opportunities in STEM by providing financial, academic, professional, and social support for TOPS participants, depending on individual needs.

This program involves a partnership between Towson University's Jess and Mildred Fisher College of Science and Mathematics and the Baltimore City Community College (BCCC). Students can participate in the TOPS program at both institutions. Students enrolled at TU apply to TOPS through TU, while students enrolled at BCCC apply to TOPS through BCCC.

BCCC students continue their education at TU and their participation in TOPS, where they join other TU students who are in the program. At both TU and BCCC, students interact with faculty and peer mentors to enhance their academic success in science and mathematics.

At TU, TOPS activities take place in a dedicated STEM Student Learning Center. Located in Smith Hall, room 304, the center has study spaces and computers that help to create an active learning community.

**WEB link to more information:** <http://www.towson.edu/TOPS/index.asp>

**University:** Towson University

**Name of STEM Program:** ADVANCEment Towards Institutional Transformation at Towson University

**Constituencies served:** Women faculty in STEM

**Brief Description:** The intent of the NSF-sponsored Towson University (TU) IT-Start program is to collect historical and baseline information needed to develop a strategy to proceed with institutional transformation related to women faculty in the Science, Technology, Engineering and Mathematics (STEM) disciplines (either independently or via an ADVANCE IT grant). The overall goal will be to identify roadblocks for female faculty members and major issues involved in their recruitment, retention, and advancement. It is anticipated that the problem will show itself to be some combination of small obstacles related to institutional, career, and family issues and that these issues may differ across important individual and family characteristics. Before an institutional transformation program targeting women faculty in STEM disciplines can be initiated, data must be collected and analyzed, the campus climate determined, and a review of current institutional policies and practices must be performed. The data collected will serve to inform policies and practices affecting the recruitment, selection, retention, scholarship, tenure, promotion and advancement to university leadership positions of female and minority faculty at TU. Data collection will include indicators such as salaries, faculty recruitment and retention, faculty applicant pools, tenure and promotion outcomes; identification of policies and resources for recruitment, review of institutional policies regarding promotion, tenure, and work and life issues, and a climate survey to determine the institution's current environment. The long term goal is to develop a data driven approach to addressing factors that result in the under-representation of women and minorities at all faculty and administrative levels. The PI and Co-PIs combine expertise and experience of faculty from both the Fisher College of Science and Mathematics (FCSM) and the College of Liberal Arts (CLA). The addition of CLA faculty allows us to utilize a social science approach in the development of surveys and interview strategies to establish a baseline of data to create a strategic plan for institutional transformation.

**University:** Towson University

**Name of STEM Program:** Facilitating Seamless Transitions from Community College to Towson University

**Constituencies served:** Underrepresented Minority Community College in STEM Disciplines

**Brief Description:** The long-term goal of the NIH-sponsored Bridges to the Baccalaureate program is to increase the number of underrepresented minorities who successfully complete the transition from Baltimore City Community College (BCCC) or the Community Colleges of Baltimore County (CCBC) to completion of a Baccalaureate degree at Towson University (TU) and who then are competitive to pursue graduate education and/or pursue a career in the area of biomedical research. The specific aims of project are to:

- 1) Effectively recruit qualified students from BCCC and CCBC by increased program awareness and visibility.
- 2) Increase program awareness at TU to create a supportive institutional climate for Bridges students.
- 3) Provide an active and supportive academic program for students, which includes tutoring and peer mentoring, summer research experiences, faculty advising teams for each student, and annual evaluations of the program by a program evaluator.

**University:** Towson University

**Name of STEM Program:** STEM Teach

**Constituencies served:** Freshman STEM majors

**Brief Description:** This grant is being used to develop a U-TEACH-like component to STEM secondary education tracks. The particular components being developed are two one-credit courses that will introduce students to teaching as freshmen (like the U-TEACH Step 1 and Step 2 courses).

**University:** Towson University

**Name of STEM Program:** Women In Science Program

**Constituencies served:** Women STEM Majors and Faculty

**Brief Description:** Our complex world requires the talents of both male and female scientists to help solve the global problems we face now and in the future. We also recognize that we need both talented male and female scientists to design programs of study that are effective, attractive and interesting to our increasingly diverse student body. Leadership in science and mathematics must also draw on both genders in the decision-making processes that will define the future of science in our country. Program goals include the following:

- To create a cooperative and female-friendly learning and working environment for both students and faculty.
- To enhance the enrollment and retention of female students in the experimental sciences.
- To enhance the recruitment, mentoring, retention and visibility of female faculty in the Natural, Social and Health Sciences, particularly in fields where women are underrepresented.
- To develop leadership skills for career development.

**WEB link to more information:** <http://www.towson.edu/wisp/index.asp>

**University:** Towson University

**Name of STEM Program:** Sally Ride Festival

**Constituencies served:** K-12 students and parents

**Brief Description:** Sally Ride Science Festivals bring together hundreds of students for a festive day of science and socializing. Parents and teachers are welcome too! The goal is to engage young women in STEM disciplines. For the third year, Towson University has been selected as the site for a Sally Ride Festival (May 30, 2009). The festival features:

- An inspiring talk by a featured speaker
- Discovery Workshops for students, given by local scientists and engineers (examples include chemists, veterinarians, microbiologists, and others)
- Workshops for parents and teachers on ways to support students' interests in science and math
- A Street Fair with booths, hands-on activities, food, and music

Advance registration is required and is \$15 (includes the featured talk, workshops, lunch, and the Street Fair). The registration fee will be increased to \$20 after May 1, 2009.

**WEB link to more information:** <http://www.sallyridescience.com/festivals>

**University:** Towson University

**Name of STEM Program:** Fisher College of Science and Mathematics Undergraduate Research Grants Program

**Constituencies served:** Undergraduates in STEM disciplines

**Brief Description:** Research experiences have been shown to increase retention of undergraduate students and are an important aspect of a well-rounded undergraduate education in the natural and mathematical sciences. A wide variety of undergraduate research experiences, both at Towson University and nationwide, are available to our students. Faculty members in each of the five departments within the college; Biological Sciences, Chemistry, Computer and Information Sciences, Mathematics and Physics, Astronomy & Geosciences, are actively engaged in research activities with both undergraduate and/or graduate students.

Undergraduate research experiences are supported through the Fisher College of Science and Mathematics Undergraduate Research Grant Program. Established in the Fall of 1999, the college's Undergraduate Research Committee (FCSMUGRC) oversees a competitive process by which funds are made available to undergraduate students to facilitate their research efforts. The committee members award grants based on research proposals written by students and submitted in collaboration with a faculty research mentor. Funds are provided for equipment, supplies, and travel to professional meetings to present research results.

**WEB link to more information:** [http://www.towson.edu/fcsm/undergraduate\\_research/index.asp](http://www.towson.edu/fcsm/undergraduate_research/index.asp)

**University:** Towson University

**Name of STEM Program:** Materials Science Research Experience for Undergraduates

**Constituencies served:** Undergraduates in physical sciences; physical science teachers

**Brief Description:** Research experiences have been shown to increase retention of both undergraduate students and teachers. Towson University has obtained funding from the National Science Foundation to establish a Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET) program during the summer. This combined REU/RET program provides 7 undergraduate students and 7 in-service teachers with hands-on research experiences. The eight-week program will pair one student and one teacher with one of seven experienced research mentors. Participants will work closely with their research mentor on the identification of the project, design and collection of the experiment, analysis of the data, and presentation of the results via publication or oral/poster presentations. As the program progresses, the senior mentor's role will change from teacher to collaborator. Students and teachers will participate in a wide range of research projects in the areas of nanotechnology, thin film and sensor technology, and solid-state chemistry. Through these diverse but related experiences participants will gain an appreciation of the interdisciplinary nature of science.

**WEB link to more information:** <http://pages.towson.edu/schaefer/REU/overview.htm>

**University:** Towson University

**Name of STEM Program:** Science and Technology Day

**Constituencies served:** high school and community college students

**Brief Description:** This program is especially designed for students from High Schools and Community Colleges who have interests in attending four year Universities. A distinguished panel of experts will explore some of the exciting opportunities for Science, Technology, Engineering, and Mathematics (STEM) majors and careers that are available, and why these careers are so important for the future of the Baltimore region and the country. Representatives from academic institutions, companies and the general public are invited to attend. Our goal is to promote cooperation between institutions, attract students into the science fields, and encourage current University students to build their network for potential internships and jobs.

**WEB link to more information:** <http://www.towson.edu/mb3/events.asp>

**University:** Towson University

**Name of STEM Program:** Towson University Undergraduate Research Program

**Constituencies served:** Undergraduate students in all disciplines

**Brief Description:** Research experiences have been shown to increase retention of undergraduate students. Undergraduate research in all disciplines is supported by this competitive grants program. As with the Fisher College grants program, funds are provided for equipment, supplies, and travel to professional meetings to present research results.

**WEB link to more information:** [http://grad.towson.edu/ours/undergraduate\\_research/travelgrants.asp](http://grad.towson.edu/ours/undergraduate_research/travelgrants.asp)

**University:** Towson University

**Name of STEM Program:** Research Opportunities in Urban Environmental Biogeochemistry at Towson University

**Constituencies served:** Undergraduate Students in biology, chemistry, and geology

**Brief Description:** The National Science Foundation continued its support of research in the area of Urban Environmental Biogeochemistry by funding an undergraduate research site at Towson for the summers of 2008 through 2010 (\$212,238). This summer the first cohort of students completed a 10 week research experience working with faculty mentors from the departments of Chemistry, Biological Sciences and Physics, Astronomy and Geosciences. Mentors included Ryan Casey (Director), Susan Gresens, Steven Lev, Clare Muhoro, David Ownby, Joel Snodgrass and Joy Watts. Participating students came from Towson University, Virginia Tech, University of Minnesota, Western Washington University and Colorado State University. The research was highly interdisciplinary and had students working with multiple mentors in different departments. The students finished the program with a poster session in which they presented their work to their peers and the College community. Several students have also presented their work at conferences off-campus and several manuscripts are in preparation for submission to peer-reviewed journals.

**WEB link to more information:** <http://www.towson.edu/chemistry/reu.asp>

**University:** Towson University

**Name of STEM Program:** Research Experience for Undergraduates in Molecular Ecology

**Constituencies served:** Undergraduate biology majors

**Brief Description:** The REU program in Molecular Ecology brings 6 highly qualified undergraduate students to Towson University in alternate years to engage in state-of-the art research integrating the fields of ecology and molecular biology. Successful applicants will work in one of three lab groups, consisting of students with interest in ecology, molecular biology/genetics, or both, and a pair of faculty mentors. Each group will use molecular approaches to address ecological questions pertaining to the biology of plants and animals. Students will live in Towson University residence halls and receive financial support in the form of a stipend, funds for housing, a basic meal plan and travel. The program is 10 weeks long (June 1 - August 7) with the option for a second summer of support. Students will participate in a class designed to prepare them for the Graduate Records Examination (GRE). In addition, all participants are expected to publish the results of their studies. Students with limited opportunities at their home institution or from groups under-represented in science are especially encouraged to apply.

**WEB link to more information:** <http://www.towson.edu/biology/REU%20program%202007.htm>

**University:** Towson University

**Name of STEM Program:** Student Affiliates of the American Chemical Society

**Constituencies served:** Undergraduate STEM majors

**Brief Description:** This student organization provides students with opportunities to develop study groups focused on chemistry, to apply for scholarship support, and to participate in a variety of activities that include recreation and community service. All of these facets of club participation enhance retention of students in STEM disciplines.

**WEB link to more information:** <http://www.towson.edu/saacs/>

**University:** Towson University

**Name of STEM Program:** *Beta Beta Beta*

**Constituencies served:** Undergraduate Biology Majors

**Brief Description:** *Beta Beta Beta* is a national honors society for students dedicated to improving the understanding and appreciation of biological study and extending boundaries of human knowledge through scientific research. By providing students with opportunities to develop study groups focused on chemistry and to participate in a variety of activities that include recreation and community service, Beta Beta Beta club participation enhances retention of students in STEM disciplines.

**WEB link to more information:** <http://www.towson.edu/betabetabeta/>

**University:** Towson University

**Name of STEM Program:** Students for the Advancement of Information Technology

**Constituencies served:** Undergraduate Computer and Information Sciences majors

**Brief Description:** Students for the Advancement of IT provides a community environment where students, faculty, and industry professionals can connect and share their thoughts on information technology. SAIT participation enhances retention of students and provides them with opportunities to interact with industry professionals who may provide internships and employment.

**WEB link to more information:** <http://sait.phyrenet.com/>

**University:** Towson University

**Name of STEM Program:** Society of Physics Students

**Constituencies served:** Undergraduate Physics majors

**Brief Description:** The Society of Physics Students is a professional physics association explicitly designed for students. Membership is open to anyone interested in physics. The Society provides each student the opportunity of participating in the physics community on a professional basis. For \$13 per year, members of SPS receive *Physics Today*, *The Journal of Undergraduate Research in Physics*, and the *SPS Newsletter*, which covers local, regional, and national SPS activities and includes the latest job information. Also available are scholarships and reduced rates on journals published by the American Institute of Physics.

The Towson Chapter of SPS also sponsors activities during the school year. Recent activities include three picnics, trips to NASA's Goddard Space Flight Centre and the Space Telescope Science Institute, and several bagel sales. The chapter also co-sponsors the bimonthly department seminars. Plans for the future include trips to Aberdeen Proving Grounds and, in conjunction with the Chemistry club, to NIST.

**WEB link to more information:** <http://www.towson.edu/physics/physics/SPS.asp>

**University:** Towson University

**Name of STEM Program:** Molecular Biology, Biochemistry, and Bioinformatics Club

**Constituencies served:** Undergraduate Chemistry and Biology majors

**Brief Description:** The goal of the MB3 Club is to highlight the fields of Molecular Biology, Biochemistry, and Bioinformatics by a series of one hour luncheon talks with leading scientist in these fields. Molecular biology, biochemistry, and bioinformatics are dynamic, rapidly expanding, modern areas of study that have enormous significance on the way we live our lives today, and on the ways our lives will change in the coming years. Combining the three areas enables us to better understand diseases, develop new drugs and therapies, develop new, more efficient crops, and soon biological fuels. Find out about the latest research in the field and how it can benefit us.

Club activities include organization of the Science and Technology Day activities that are designed to recruit high school and community college students into STEM disciplines.

**WEB link to more information:** <http://mb3club.org/about.aspx>

**University:** Towson University



**Name of STEM Program:** Minority Science and Technology Club

**Constituencies served:** Undergraduate STEM majors

**Brief Description:** MSTC is dedicated to increasing the participation of minority students in STEM disciplines at the undergraduate and graduate level. It further promotes awareness of workforce opportunities for student members.

**WEB link to more information:** <http://www.towson.edu/MSTC/>

**University:** Towson University

**Name of STEM Program:** Women in Information Technology @ Towson

**Constituencies served:** Women students and Faculty in CS and CIS

**Brief Description:** National Center for Women and Information Technology (NCWIT) has named Towson University as an Academic Alliance Partner. The Department of Computer and Information Technology has received grant funding from Microsoft Research to increase and retain women in CS and CIS fields.

**WEB link to more information:** <http://www.towson.edu/cosc/cosclabs/labnews/NCWIT/index.html>

**University:** Towson University

**Name of STEM Program:** A Second Generation Faculty Development Program

**Constituencies served:** Higher Education Faculty

**Brief Description:** Towson University was awarded a \$299,963 grant from the National Science Foundation to support the project "*A Second Generation Faculty Development Program*". This project focuses on better preparing faculty from a consortium of Maryland colleges and universities to teach and do research in the area of computer security, thereby enhancing the preparation of students for the workforce.

**WEB link to more information:** <http://www.towson.edu/cosc/research.asp>

**University:** Towson University

**Name of STEM Program:** Building Security In: Injecting Security throughout the Undergraduate Computing Curriculum

**Constituencies served:** Undergraduate CS and CIS students

**Brief Description:** Towson University was awarded \$399,511 from the National Science Foundation for support of the project entitled "Building Security In: Injecting Security throughout the Undergraduate Computing Curriculum." This work involves developing modules for teaching computer security concepts and disseminating the materials to a variety of schools, including Bowie State, HCCC, AACC, and CCBC. Eventually, we will work to introduce these materials at all 15 educational institutions in the Maryland Alliance for Information Security Assurance. This work will improve student retention, as well as enhance the transfer pathway from three community colleges into Towson University's CS and CIS programs.

**WEB link to more information:** <http://www.towson.edu/cosc/research.asp>

**University:** Towson University

**Name of STEM Program:** Integrating Usability and Accessibility in Information Assurance Education

**Constituencies served:** CS and CIS majors and faculty members

**Brief Description:** Towson University and Bowie State University have received a National Science Foundation grant totaled \$299,832. This grant will support a series of teaching and research activities that integrate usability and accessibility concepts and methods in information assurance education. This



grant further strengthens Towson University's long-standing excellence in information assurance education, preparing outstanding CIS and CS professionals for the workforce.

**WEB link to more information:** <http://www.towson.edu/cosc/research.asp>

**University:** Towson University

**Name of STEM Program:** College Preparation Intervention Program (CPIP) for Students and Teachers of Dundalk Area Schools

**Constituencies served:** K-12 students and teachers

**Brief Description:** Towson University has received funding from the Maryland Higher Education Commission for the College Preparation Intervention Program (CPIP) in support of Maryland Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP) has been accepted. The purpose of the program is to make the students aware of college opportunities and requirements. Their grant is to continue their work with mathematics teachers of the Dundalk area schools through on-going professional development and professional observations performed by the three professors. Additionally, tenth grade students at Dundalk High School will be invited to the Towson University campus five times throughout the spring term. During that time the students will receive mathematical enrichment in Algebra 1, Algebra 2 and Geometry, and they will be exposed to the university atmosphere.

**University:** Towson University

**Name of STEM Program:** Culturally Relevant Ecology, Learning Progressions and Environmental Literacy

**Constituencies served:** Grades 6-12 students and teachers

**Brief Description:** Towson University is a sub-contractor on a National Science Foundation award to Colorado State University. The targeted partnership focuses on the critical education juncture of middle school through high school (grades 6-12). The project is developing a program of teacher professional development in science and mathematics driven by an environmental science literacy framework around the learning progressions of core science and mathematics concepts complemented with citizenship. The project connects the research prowess in the environmental sciences and education of our partner universities and sites within the NSF-funded Long Term Ecological Research (LTER) Network with K-12 teacher professional development in science and mathematics of our partner schools.

**University:** Towson University

**Name of STEM Program:** MS degree in Applied Information Technology in Harford County

**Constituencies served:** IT graduate students

**Brief Description:** Towson University was awarded a BRAC Workforce ONE Maryland grant, for \$90,990, to expand the MS degree program in Applied Information Technology to Harford County. This will provide convenient advanced educational opportunities for military and civilian personnel at APG. This program includes well-established graduate-level certifications in Software Engineering, Information Security and Assurance, Network Technology, and Information Systems Management in line with the current and future needs of APG.

**University:** Towson University

**Name of STEM Program:** Math Readiness and Test Preparation Tutoring and Mentor Program – Baltimore City Digital Harbor HS

**Constituencies served:** K-12 students

**Brief Description:** The Mid-Atlantic CIO Forum supported via a grant to DECO's Extended Education and Online Learning and TU's Academic Achievement Center \$5,000 to support a project with Digital Harbor High School in Baltimore City. Mike Schroder and Terrie Massie-Burrell worked with Digital Harbor High

School to identify tutoring and mentor/coaching needs. Ninth-Grade and Tenth-Grade students were identified needing assistance in 9<sup>th</sup> Grade Math classes. A TU student was identified to conduct tutoring, test preparation and mentoring to over 40 students at Digital Harbor HS in 2008.

**WEB link to more information (if available):**

**University:** Towson University

**Name of STEM Program:** Math Readiness and Test Preparation Tutoring and Mentor Program – Baltimore City MERV HS

**Constituencies served:** K-12 students

**Brief Description:** The Mid-Atlantic CIO Forum supported via a grant to DECO's Extended Education and Online Learning and TU's Academic Achievement Center \$5,000 to support a project with MERV High School in Baltimore City. Mike Schroder and Terrie Massie-Burrell worked with MERV High School to identify tutoring and mentor/coaching needs. Ninth-Grade and Tenth-Grade students were identified needing assistance in 9<sup>th</sup> Grade Math classes. A TU student was identified to conduct tutoring, test preparation and mentoring to over 50 students at Digital Harbor HS in 2008. An additional TU student (recent graduate from MERV HS), joined the project team to assist with the tutoring and added a component of college readiness and discussion groups for students.

**WEB link to more information (if available):**

**University:** Towson University

**Name of STEM Program:** BRAC Information Sessions and Recruitment

**Constituencies served:** TU students

**Brief Description:** DECO's Extended Education and Online Learning coordinated 4 BRAC information sessions for students in 2008. Two organizations (DISA – Defense Information Systems Agency and C4ISR Army Team). Information sessions were held for both organizations in 2008 (once for DISA and 3 times for CRISR). Information sessions gave students overview on security clearance process, job opportunities within both organizations and details on their BRAC moves to MD. Each session had an average of 80 students in attendance. Exact data is not available, but approx. 12 TU students have been offered jobs. Ms. Allie Pyzik and Mike Schroder with assistance from Guy Davis in the TU Career Center coordinate the project.

**WEB link to more information (if available):**

## University Maryland, Baltimore County STEM Initiatives

### UMBC

#### Chancellor's STEM Task Force

#### STEM Programs

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** NSF/DRK12

**Constituencies served:** 45 in service secondary technology education teachers in Maryland and secondary technology education students nationally

**Brief Description (including funding source):** This program is funded by a 2.2 million dollar grant from NSF, and is a collaborative effort between two faculty in Chemical Engineering, two in Education and one from the University of Maryland School of Medicine. The project is focused on building capacity for the STEM workforce through the development of novel hands-on inquiry based curricula for secondary technology education. The focus within the Education Department is to develop an effective framework for professional development to enable the delivery of the new curricula.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** UMBC Noyce Master Teacher Preparation Program

**Constituencies served:** 20 graduates of the STEM MAT (funded through original NSF grant) interested in becoming teacher/leaders in STEM curriculum and instruction

**Brief Description (including funding source):** This program is funded at \$600,000.00 from NSF/Noyce and is coordinated by one faculty member in Engineering and one in Education. This is a follow-up grant to the large NSF grant that funded five years of MAT/MAE participation. This phase of the project is focused on providing induction support to early career STEM elementary and secondary teachers in Baltimore County Public Schools produced through the earlier STEM project; the intention is to continue to develop these teachers as leaders within their schools.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Noyce Undergraduate Scholarship program

**Constituencies served:** 15 future STEM teachers per year; cohorts of 15-30 middle/high school students per year through the summer program

**Brief Description (including funding source):** This \$750,000.00 grant is coordinated by one faculty member in Education and one in Mathematics. The program will provide scholarships and customized learning experiences to undergraduate students who are becoming secondary science teachers as well as induction support after graduation via the MAE program. Additionally, students at Meade Middle School and Meade High School will benefit through summer science instruction conducted at their school sites by the NOYCE candidates.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** UMBC STEPT for ELLS Program

**Constituencies served:** Inservice teachers of STEM areas in local counties

**Brief Description (including funding source):** This one million dollar grant, administered through our English Language Center and Education, provides professional development for teachers of science and

math (and social studies) in order to facilitate their ability to teach STEM content to English language learners.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** UMBC Developing and Sustaining New Pathways in STEM Education

**Constituencies served:** Future secondary math and biology, and future elementary and early childhood teachers interested in having an integrated, interdisciplinary STEM major

**Brief Description (including funding source):** This project will allow UMBC to develop clearer pathways to certification in biology and mathematics, to develop an interdisciplinary STEM major for elementary certification seekers, and will provide for creation of new recruitment materials for new and transfer students. The project is funded through USM.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** SMART – Students Modeling A Research Topic

**Constituencies served:** Selected area high school students as an extracurricular activity; students (identified by a trained teacher) work in teams and are matched with a UMBC researcher.

**Brief Description (including funding source):** In the SMART program, high school students work in teams to explore the molecular world by partnering with a researcher to understand and model the structure-function relationship of a protein. After designing and building a model of the protein using Rapid Prototyping technology, SMART teams create an oral presentation explaining their work to a lay audience and a poster which is presented to a scientific audience. The SMART program originated at the Milwaukee School of Engineering and has recently been funded by HHMI to include remote sites, of which UMBC is one of seven. Julie Wolf coordinates the SMART project at UMBC in which she connects high school students with researchers engaged in physical modeling of proteins.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Sherman STEM Teacher Education Scholars Program

**Constituencies served:** High achieving Undergraduate and Graduate students from STEM disciplines who are preparing for a teaching career

**Brief Description (including funding source):** The Sherman Scholars Program supports the content and pedagogical studies and supplements the professional development of our scholars with the aim of exposing them in meaningful ways to Baltimore’s communities, schools, families, and youth. We expect that our scholars will teach in Baltimore-area high-needs math and science classrooms.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Bridging the Watershed

**Constituencies served:** Future secondary STEM pre-service teachers

**Brief Description (including funding source):** UMBC in collaboration with the National Capital Region park service has submitted an application to the PARK Teacher Program funded by the US National Parks Service. This program will develop and implement plans for supporting secondary STEM pre-service teachers to effectively integrate the various resources available at local National Parks.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** *NSF - SSTEM (Scholarships in STEM)* (this is the NSF program, and my project is SITE) *SITE (Scholarships in IT and Engineering)*

**Constituencies served:** Undergraduate Engineering and IT Majors

**Brief Description (including funding source):** The *Scholarships in IT and Engineering (SITE)* program provides scholarships and supplemental academic and student support services for twenty (20) low-

income, academically talented, full-time students enrolled at UMBC in bachelor's degree programs in General Engineering, Chemical Engineering, Mechanical Engineering, Computer Engineering, Computer Science, and Information Systems. This \$500,000 NSF grant is led by a faculty member in Chemical Engineering and CWIT.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** UMBC-BCPS STEM Project

**Constituencies served:** Teachers and students in elementary, middle and high school in the Woodlawn cluster of Baltimore County Public Schools

**Brief Description:** The UMBC-BCPS STEM partnership of the Baltimore County Public Schools (BCPS) and the University of Maryland, Baltimore County (UMBC) is an innovative project that will facilitate the implementation, testing, refinement and dissemination of promising practices for improving STEM student achievement as well as teacher quality/retention in selected high-needs elementary, middle and high schools in Baltimore County Public Schools. Centered on creating and evaluating performance-based preservice teacher education (interns) programs and sustainable professional development programs for teachers and administrators, the project is designed to increase P-12 student achievement in the areas of science, technology, engineering, and mathematics by increasing intern/teacher and administrator knowledge and confidence related to these areas.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Project Lead the Way Pre-engineering Program

**Constituencies served:** Teachers, counselors and students in middle and high school in Allegany, Anne Arundel, Baltimore, Caroline, Carroll, Cecil, Charles, Frederick, Garrett, Harford, Howard, Kent, Montgomery, Prince George, Queen Anne, Talbot, Washington and Worcester Counties as well as Baltimore City

**Brief Description:** Project Lead The Way® has created a special series of courses that are incorporated into the middle school and high school years. These courses complement math and science college preparatory programs to establish a solid background in engineering and technology. Both teachers and counselors are trained at UMBC. Schools are certified to offer college credit for courses and a certification visit is conducted by MSDE and UMBC staff.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** FIRST LEGO League

**Constituencies served:** Students ages 9-14 throughout Maryland

**Brief Description:** FIRST LEGO League (FLL) is an exciting and fun global robotics program that ignites an enthusiasm for discovery, science, and technology in kids ages 9 to 14. Each year FLL teams embark on an adventurous Challenge based on current, real-world issues. Guided by a team coach and assisted by mentors, the kids research and solve a real-world problem based on the Challenge theme, present their research and solutions and build an autonomous robot using engineering concepts.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** CNMS Community College Student Transfer Excellence Program (CCCSTEP) at UMBC (2007 – ongoing)

**Constituencies served:** Select community college transfer students

**Brief Description:** CCCSTEP is a pilot program of comprehensive academic support for invited community college transfer students at UMBC funded by the College of Natural and Mathematical

Sciences. This scholarship program is dedicated to the retention and success of talented, full-time transfer students majoring in the disciplines of the four CNMS departments: Biological Sciences, Chemistry and Biochemistry, Mathematics and Statistics, and Physics. CCCSTEP Scholars receive \$500 scholarships for the fall and spring semesters through Spring 2009. CCCSTEP Scholars are required to participate in monthly activities and 'Short and Sweet' seminars' geared to enhance their academic success at UMBC. CCCSTEP Scholars are involved in educational planning activities and participate in proactive academic monitoring and guidance. In addition to being recognized as CCCSTEP Scholars on campus, participants receive support from the CNMS Dean's Office and are matched with a department academic advisor with knowledge of transfer student issues. CCCSTEP is designed to serve as a basis for future programs with expanded participation through increased extramural funding support. Interim Dean Philip Rous, Assistant Dean Kathy Lee Sutphin and Life Science Advisor Michelle Bulger guide the program as key members of the CCCSTEP Advisory Board.

URL: <http://www.umbc.edu/CCCSTEP/>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** CNMS Summer Undergraduate Research Fest (1997 – ongoing)

**Constituencies served:** Summer undergraduate researchers from UMBC and undergraduates from other institutions who are conducting research at UMBC and/or through UMBC programs

**Brief Description:** The Annual Summer Undergraduate Research Fest is held each August at the Albin O. Kuhn Library and features oral presentations and poster presentations given by budding scientists. Presenters participate in summer research opportunities supported by UMBC and/or with UMBC faculty research mentors. The annual Summer Mentor Award for Outstanding Support and Service to UMBC Research Programs is presented at this student-focused symposium, which is hosted by the College of Natural Mathematical Sciences. The 2008 SURF at UMBC marked the eleventh anniversary of the event and featured four oral and over 40 poster presentations by student researchers. Programs with participants and the College of Natural and Mathematical Sciences provide funding and other support.

URL: <http://www.umbc.edu/SummerResearchFest/>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Annual Undergraduate Research Symposium in the Chemical and Biological Sciences (1997 – ongoing)

**Constituencies served:** Undergraduate researchers from UMBC and other institutions apply to participate

**Brief Description:** The annual Undergraduate Research Symposium in the Chemical and Biological Sciences has been hosted each fall by the UMBC Departments of Chemistry and Biochemistry and Biological Sciences and is sponsored, by the National Institute of General Medical Sciences (NIGMS) at the National Institute of Health (NIH). Undergraduates from near and far have participated in this juried symposium with first and second place awards made in multiple categories in the chemical, biological, and biochemistry and molecular biology sciences. The October 11, 2008 event was the largest ever with over 400 attendees from ten states and the District of Columbia and marked the eleventh anniversary of the popular event.

URL: <http://asp1.umbc.edu/newmedia/cbe/registration.html>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** 'A Look Ahead,' UMBC's Annual Life Science Symposium (1996 – ongoing)

**Constituencies served:** The UMBC research community and biotechnology business leaders

**Brief Description:** Generous donations from a cadre of corporate sponsors support *A Look Ahead*, UMBC's Life Science Symposium, which is held each fall. The gala event features a research poster

session by UMBC's talented undergraduate and graduate student researchers and lectures by two keynote speakers. One of the speakers gives the annual Janice Antoine Lumpkin Memorial Lecture. The free symposium provides many opportunities for networking and attracts hundreds of scientists, educators, and biotechnology business leaders in addition to members of the UMBC community focused on life science research.

URL: <http://www.umbc.edu/lookahead/>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Chemistry Discovery Center (2005 – ongoing)

**Constituencies served:** Students enrolled in Introductory Chemistry classes at UMBC

**Brief Description:** This problem-based, high-tech cooperative learning lab was established to complement the introductory chemistry instruction as a replacement for weekly recitation classes. The Chemistry Discover Center uses a Process Oriented Guided Inquiry Learning (POGIL) environment to ensure that participants actively work together with rotating roles to solve problems and master course material. The success of the center has been demonstrated by increased pass rates for Chemistry 101, fewer repeat course enrollments, and overall improvement in all grade levels. The center was started through a combined effort between UMBC's Department of Chemistry and Biochemistry, the Office of Undergraduate Education and the Shriver Center with funding from UMBC's Continuing and Professional Studies. National Science Foundation funding supported the second year of operation and the center has become a laboratory model for other STEM instruction. For more information, contact Dr. William LaCourse, Chair of the UMBC Department of Chemistry and Biochemistry.

URL: <http://www.umbc.edu/window/chem101.html>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Physics Discussion Sessions (2007 – ongoing)

**Constituencies served:** UMBC Students enrolled in introductory, calculus-based Physics

**Brief Description:** The UMBC Department of Physics dedicated a classroom and invested funds for new equipment and teaching support to reinforce instruction in introductory, calculus-based Physics (PHYS 121 and 122) beginning Fall 2007. Inquiry-based pedagogy is implemented along with cooperative learning to reward the use of systematic approaches to problem solving based on the application of relevant conceptual understandings. For more information, contact Dr. Eric Anderson, Department of Physics.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Physics Learning Assistant Development Program (2007 – ongoing)

**Constituencies served:** Students taking introductory Physics classes at UMBC and the Learning Assistants trained through this program

**Brief Description:** The UMBC Department of Physics received start up funding from a NSF VIP sub-grant through UMBC's Shriver Center to establish a Learning Assistant Development Program in 2007. Undergraduate learning assistants (LAs) join with graduate teaching assistants (TAs) to assist groups of students in weekly discussion sessions in introductory, calculus-based physics. Each semester, new LAs participate in a two-day seminar on the theory and practice of learning by inquiry and cooperative learning. All LAs and TAs meet two hours each week with the course instructor to discuss content and methods. For more information, contact Dr. Eric Anderson, Department of Physics.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Chemistry Tutorial Center (1969 – ongoing)

**Constituencies served:** Students taking introductory Chemistry classes at UMBC

**Brief Description:** The Chemistry Tutorial Center was established many years ago to provide a comprehensive venue of tutorial assistance that was supported by department faculty, coordinated by a center director, and given by trained peer student tutors. It has grown and continues to be a unique asset for chemistry and biochemistry instruction that is staffed by a Ph.D. Chemist who tutors and oversees the scheduled and walk-in tutoring by advanced undergraduates and graduate students. The center, which is located in Room 145 of the Meyerhoff Chemistry Building, offers both day and evening hours with focused support of instruction in introductory chemistry courses. For more information, contact Dr. Tiffany Gierasch.

URL: <http://www.umbc.edu/chem/facilities/tutorial.html>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Biology Tutorial Center (2000 - ongoing)

**Constituencies served:** Students taking introductory Biology classes at UMBC

**Brief Description:** The Department of Biological Sciences established a tutorial center in 2000 after the completion of the Biological Sciences Building's comprehensive modernization, which provided space both for the center in Room BS 011 and networked computer equipment for student workstations. The center, which is located near the department's key teaching labs, is directed by a senior lecturer in the Department. The Director coordinates the peer tutors, who provide both walk-in and scheduled tutorial assistance for key courses in the biological sciences. For more information, contact Mr. James Sandoz.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Physics Tutorial Center (ongoing)

**Constituencies served:** Students taking Physics classes at UMBC

**Brief Description:** The Department of Physics offers a schedule of walk-in tutoring in Room 226 of the Physics Building each academic semester. For information, contact Dr. Lili Cui.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Pre-Medical and Pre-Dental Advising Office (2007 – ongoing)

**Constituencies served:** Current students and alumni planning to apply to professional schools to earn medical, dental, veterinary, optometry, and podiatry degrees.

**Brief Description:** The College of Natural and Mathematical Sciences established a new position in the Dean's Office in Spring 2007 to provide dedicated assistance to UMBC students and alumni planning to apply to professional schools to earn various medical degrees. Christy Botdorf, the Pre-Medical and Pre-Dental Advising Coordinator, helps to ensure student preparedness and success by 1) providing walk-in advising hours for individual students, 2) conducting informational meetings about the application process, 3) working closely with several student pre-health professions organizations and 4) helping to coordinate meetings of the UMBC Health Professions Evaluation Committee. In addition to helping students as they prepare and submit their medical, dental, veterinary, optometry and podiatry school applications, Ms. Botdorf provides support to students as they consider a variety of career options. Students pay a modest fee when requesting the services of the Health Professions Evaluation Committee to help defray associated costs. Please note: Students interested in other allied health careers receive support through UMBC's Office of Academic Services.

URL: <http://www.umbc.edu/CNMS/pre-med.html>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Graduate Assistance in Areas of National Need (GAANN) Programs at UMBC (2003 – ongoing)

**Constituencies served:** Select graduate students participating in funded programs



**Brief Description:** The Graduate Assistance in Areas of National Need (GAANN) Programs at UMBC represent comprehensive programs of graduate support offered through the U.S. Department of Education and the University of Maryland, Baltimore County. Support includes need-based stipends for select doctoral students who receive a variety of training in research and pedagogy. Most GAANN Fellows at UMBC are working in STEM areas. GAANN support provides fellowships to Ph.D. students with excellent records who demonstrate financial need. GAANN fellowships are limited to U.S. citizens, permanent residents, or those who demonstrate the intention to become permanent residents. Women and students from traditionally underrepresented backgrounds are especially encouraged to apply. GAANN Programs at UMBC started in 2003, with three awards made by the U.S. Department of Education to the Departments of Biological Sciences, Mechanical Engineering, and Mathematics and Statistics. In 2004, two additional GAANN programs at UMBC were funded in the Departments of Physics and Information Systems. Two of these inaugural programs have been renewed to date by the U.S. Department of Education and continue to support UMBC graduate students: Department of Biological Sciences (PI Dr. Lasse Lindahl - 2006) & Department of Mechanical Engineering (PI Dr. Tim Topoleski - 2007).

Biological Sciences URL: <http://www.umbc.edu/biosci/grad/gaann.php>

Mechanical Engineering URL: <http://www.umbc.edu/engineering/me/graduate.htm>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** CNMS Graduate Teaching Assistant (GTA) Training Program (Being piloted Spring 2009)

**Constituencies served:** Select College of Natural and Mathematical Sciences graduate students and undergraduates they will instruct

**Brief Description:** Developed in 2007 through an NSF VIP sub-grant through the UMBC Shriver Center, a training course was designed to standardize, enhance and expand the pedagogical instruction provided to graduate-level teaching assistants in the College of Natural and Mathematical Sciences. The course is being piloted as comprehensive seminar series with two introductory sessions held before Spring 2009 classes begin followed by six evening sessions throughout the semester. Participants successfully completing the instruction will be recognized as Master CNMS Graduate Teaching Assistants. For more information, contact Kathy Lee Sutphin.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Summer Biomedical Training Program (1999 – ongoing)

**Constituencies served:** Select undergraduate students from UMBC and other institutions

**Brief Description:** The Summer Biomedical Training Program (SBTP) is funded by multiple sources including the Federation of American Societies for Experimental Biology (FASEB), The Leadership Alliance and UMBC. SBTP provides biomedical research experiences for undergraduates, particularly those underrepresented in the field, who are interested in earning research doctorates in biomedicine. Students from across the nation complete ten-week, comprehensive research summer experiences with faculty mentors at UMBC while living on campus. The following cross-disciplinary research areas of student interest are currently supported: biochemistry, biological sciences, chemistry, chemistry/biology interface, molecular and cell biology, psychology and three areas of engineering: chemical, electrical and mechanical. Approximately ten students from UMBC and across the nation are supported annually, depending on the availability of funds. Dr. Michael Summers is the PI and Justine Johnson serves as the Program's Assistant Director.

URL: <http://www.umbc.edu/meyerhoff/Undergrad/summer/>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Meyerhoff Scholarship Program (1988 - ongoing)

**Constituencies served:** Select UMBC undergraduate and graduate students

**Brief Description:** This highly competitive scholarship program enrolls primarily high-achieving minority students in the sciences and related fields to nurture their pursuit of research doctorates. These comprehensive programs support undergraduate and graduate students. The undergraduate program, which started in 1988, has served as a model, on the UMBC campus and off, for highly successful mentoring and leadership experiences. The undergraduate program emphasizes excellence and requires summer research of its participants, which often continues into the academic year if students also participate in the MARC or HHMI Programs. Approximately 65 new students enter the undergraduate program as freshmen at UMBC each year. The graduate program, the Meyerhoff Fellows Program, was started in 1996 to promote cultural diversity in the biomedical sciences at the graduate level. It is funded by a Minority Biomedical Research Support (MBRS) Initiative for Maximizing Student Diversity (IMSD) grant from the National Institutes of Health (NIH). In 2008, the Meyerhoff family was more than 800 strong, with 557 graduates across the nation and 267 undergraduates and graduate fellows enrolled at UMBC with the number of students and their accomplishments growing each year. A gala 20<sup>th</sup> anniversary research symposium and celebration of the Mr. and Mrs. Meyerhoff's founding gift was held April 2008.

URL: <http://www.umbc.edu/meyerhoff/>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** STEP-UP (formerly the Biomedical Summer Undergraduate Research Experience) Program (2004 – ongoing)

**Constituencies served:** Select undergraduate from UMBC and other institutions

**Brief Description:** The STEP UP Program is a comprehensive summer research program funded by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) targeting undergraduates from groups underrepresented in the biomedical sciences. Participants conduct independent research projects in faculty laboratories near and far and present their research at the annual NIDDK Summer Research Conferences. Prior to Summer 2007, the program was residential and supported seven students each year but new funding received in 2007 expanded the program to support ten students at UMBC and an additional 15 students at other institutions with preparatory and concluding activities held at the NIDDK in Bethesda, Maryland. Dr. Charles Bieberich is the PI from UMBC.

URL: <http://www.umbc.edu/bsure/>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Minority Access to Research Careers/ Undergraduate Student Training in Academic Research ([MARC U\\*STAR](#)) (1997- ongoing)

**Constituencies served:** Select junior and senior undergraduates from UMBC who are majoring in disciplines related to biomedicine and/or mathematics

**Brief Description:** This scholarship program offers comprehensive academic support to UMBC undergraduates who plan to pursue doctoral degrees and careers in the biomedical sciences. Participants, who must demonstrate an interest in increasing the numbers of students from underrepresented groups in the sciences and mathematics, are required to conduct sustained research projects related to the biomedical sciences. It is part of the national MARC Program funded by the National Institute of General Medical Sciences (NIGMS) of the National Institutes of Health (NIH). The program supports an average of 34 UMBC juniors and seniors each year. An additional ten to fifteen sophomores conduct research as Pre-MARC scholars. In 2008, 27 MARC alumni have earned their research doctorates, four alumni completed their MD/PhD, and an additional 22 alumni have completed

their medical degrees. Dr. Lasse Lindahl serves as the Program Director and Taifa Hibbert is the MARC Coordinator.

URL: <http://www.umbc.edu/MARC/>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Joint Center for Earth Systems Technology (JCET) Summer Internship Program (2005 – ongoing)

**Constituencies served:** Select undergraduates from UMBC and other institutions in appropriate disciplines

**Brief Description:** The JCET Summer Internship Program is a ten-week opportunity for Earth science and atmospheric physics research that pairs students with research mentors from NASA Goddard Space Flight Center and/or UMBC. Students are engaged in a current (or real) specific Earth Science research project such as hurricane and volcano research, observation of carbon monoxide using remote sensing, precipitation measurement and data analysis, sea ice properties, global modeling, planetary atmospheres, and studies of aerosol particles from Biomass burning, to name a few, or a specific project that a student and mentor create together. Students work in close collaboration with the NASA/UMBC mentor for the 10-week program. Often, students continue their collaboration with the mentor afterwards and some continue into graduate school with the research they have performed during their internships. During the program, students can take part in a variety of activities at NASA Goddard and UMBC such as lectures and workshops aimed at current popular Earth sciences. To complete the program, students produce final presentations on their summer research activities. Students are primarily undergraduate level but graduate level students have been included in the past. Students are local and non-local, both UMBC and non-UMBC students. Other students participating were affiliated with institutions such as Morgan State University, University of Maryland College Park, Susquehanna University, and Johns Hopkins University. Approximately 5 students per year are accepted and fully funded by JCET of UMBC. Funding includes stipend for 10 weeks, housing if non-local, and roundtrip transportation. Valerie Casasanto is the Program Coordinator.

URL: <http://jcet.umbc.edu>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Center for Research and Exploration in Space Science & Technology (CRESST) Summer Internship Programs (2006 – ongoing)

**Constituencies served:** Select undergraduates from UMBC and other institutions in appropriate disciplines

**Brief Description:** The Center for Research and Exploration in Space Science & Technology (CRESST) Summer Internship Programs recruits undergraduate and graduate students who are interested in astrophysics to participate in internships of approximately ten weeks under the guidance of mentors at NASA Goddard Space Flight Center. Dr. Ian George is the CRESST Program Associate Director.

URL: <http://cresst.umd.edu/epo/>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** McNair Scholars Program (1992 - ongoing)

**Constituencies served:** Select undergraduates from UMBC in appropriate disciplines

**Brief Description:** The Ronald E. McNair Post Baccalaureate Achievement Program at UMBC is a comprehensive program that provides academic, professional, and personal experiences that prepare students for graduate education. It is designed to prepare first generation, low-income, and minority UMBC undergraduate students for doctoral study through involvement in

research, mentoring, and other scholarly activities. The program provides annual support to about 26 students. In addition to the academic year program, these McNair Scholars write research proposals to compete for limited opportunities to participate in the eight-week annual Summer Research Institute at UMBC as McNair Fellows. McNair Fellows complete research projects with their UMBC mentors, prepare research papers, present their research findings at national conferences, and in some cases, publish their research. The program supports up to 13 McNair Fellows each summer. Cynthia Hill is the Program Director and Dr. April L. Householder is the Assistant Director.

URL: <http://www.umbc.edu/mcnair/index.htm>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Howard Hughes Medical Institute (HHMI) Scholars Program (2002 – ongoing)

**Constituencies served:** Select undergraduates from UMBC in appropriate disciplines

**Brief Description:** The goal of the HHMI Scholars Program at UMBC is to increase the number of minority students that matriculate to Ph.D. or M.D./Ph.D. biomedical programs. HHMI grant funding for this prestigious Undergraduate Biological Sciences Program emphasizes extended research experiences and the comprehensive student support it provides includes travel, housing, regular program meetings, multiple opportunities for research presentations, and salaries for working in research laboratories. After participating in a rigorous application and interview process, an average of seven freshmen majoring in biomedical fields are selected for the four-year program of support each year. HHMI Scholars participate in various research experiences beginning as freshmen and continue academic year scientific research as sophomores, juniors and seniors. Students participate in summer research experiences with highly productive off-campus researchers, many of who are HHMI Investigators, and have the opportunity to be exchange students and research assistants at their host institutions during their junior years. Keith Harmon is the Program Coordinator.

URL: <http://www.hhmi.umbc.edu/hhmischolars/>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Teacher Quality in Biology (TQB) (2003 – ongoing)

**Constituencies served:** Select secondary science teachers from Maryland public and private schools

**Brief Description:** Teacher Quality in Biology (TQB) is a comprehensive professional development program in modern biology offering instruction on a variety of topics, including molecular and cell biology, genetics, biochemistry, evolutionary theory, and laboratory skill development. The TQB Program follows the model of the successful series of “Hands-On” Biotechnology Professional Development Program for Maryland High School Biology and Science Teachers. Participants who successfully complete the program will earn three graduate credits in biology and each participant's tuition costs are paid by grant support. The Program targets high school science teachers who teach in high-need districts and/or those not currently meeting the criteria to be considered “highly qualified” are particularly encouraged to apply. It will help high school teachers become “highly qualified” in modern biology through face-to-face and on-line instruction with UMBC faculty. The program requires about one year to complete. The Program is provided in four phases. Phase 1 consists of eleven three-hour sessions during the spring college semester. Phase 2 consists of a nine-day hands-on laboratory training experience scheduled for the end of June. Phase 3 is one three-hour afternoon seminar session scheduled for mid-October. Phase 4, the final phase, is a gala “Share Our Success Seminar and Poster Session” held with participants in the TQC Program at UMBC and hosted by the College of Natural and

Mathematical Sciences. This final activity allows participants to update their knowledge and share lesson plans based on program content.

The Maryland Higher Education Commission (MHEC) funded the TQB Program for a total of six program years from 2003 to 2010 through Improving Teacher Quality State Grants. Participants receive course textbooks and notebooks/manuals to support laboratory exercises. Participants are eligible for attendance-based stipends of \$150 per each full day and may apply for free summer housing during the summer program if they live more than 40 miles from UMBC. The TQB Program Coordinator is Cynthia Hollis in the UMBC Department of Biological Sciences.

URL: <http://www.umbc.edu/TQB>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Teacher Quality in Chemistry (TQC) (2007 – ongoing)

**Constituencies served:** Secondary science teachers from Maryland public and private schools

**Brief Description:** Teacher Quality in Chemistry (TQC) is comprehensive professional development program follows the model of the TQB Program at UMBC to fortify and expand the learning base of its participants in the core learning goals for chemistry. The program consists of four steps, including the hands-on summer course, which will give participants the opportunity to apply the concepts of general chemistry to the resolution of realistic forensic chemistry questions with an emphasis on laboratory techniques. The Program targets secondary school chemistry teachers who currently are teaching out of field or who do not meet criteria for "highly qualified." Teachers who teach in high need districts or schools are particularly encouraged to apply. The program has a targeted enrollment of 20 Teacher Scholars for each program. Each participant's tuition costs are paid by grant support and the program requires about one year to complete. The Program is provided in four phases: Phase 1 consists of several three-hour sessions during the Spring college semester, Phase 2 consists of a nine-day hands-on laboratory training experience scheduled for the end of June, Phase 3 is a three-hour afternoon seminar session scheduled for mid-October and Phase 4, the final phase is a gala "Share Our Success Seminar and Poster Session" held with participants in the TQB Program at UMBC and hosted by the College of Natural and Mathematical Sciences. This final activity enables participants to update their knowledge and share lesson plans based on program content.

The Maryland Higher Education Commission (MHEC) has funded the TQC Program for a total of three program years from 2007 to 2010 through Improving Teacher Quality State Grants. Participants receive course textbooks and notebooks/manuals to support laboratory exercises. Participants are eligible for attendance-based stipends of \$150 per each full day and may apply for free summer housing during the summer program if they live more than 40 miles from UMBC. The TQC Program Coordinator is Kathy Lee Sutphin in the UMBC College of Natural and Mathematical Sciences.

URL: <http://www.umbc.edu/TQC>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** The Center for Interdisciplinary Research and Consulting – CIRC (2003 – ongoing)

**Constituencies served:** Faculty, student, and community researchers on and off the UMBC Campus, CIRC workshop participants, and UMBC graduates students taking MATH/STAT 750

**Brief Description:** The Center for Interdisciplinary Research and Consulting (CIRC) is a consulting service on mathematics and statistics provided by the Department of Mathematics and Statistics at UMBC to the campus community and the public. Established in 2003, CIRC is dedicated to supporting interdisciplinary research on and off campus, by providing a full range of consulting services from free

initial consulting to long-term support for research programs. Free initial consulting of up to two hours is available in the CIRC office where CIRC Research Assistants field questions on Mathematics and Statistics and provide quick answers to small projects. Hands-on workshops on mathematical and statistical software packages, including MATLAB, FEMLAB, SAS, SPSS, and S-Plus, are offered by the CIRC during the regular semester. The workshops are taught interactively in an instructional computer lab at UMBC accompanied by tutorial handouts. Also, CIRC offers a unique opportunity to access mathematical and statistical consulting free of charge through MATH/STAT 750, *Introduction to Interdisciplinary Consulting*. Students enrolled in this course devote their talents to actual real-world projects under the guidance of department faculty. Consulting projects of larger magnitudes or long-term support for a variety of research programs can be arranged for on campus as well as off campus organizations both during and outside of regular UMBC semesters. For more information, contact Director Dr. Nagaraj K. Neerchal or Associate Director Dr. Matthias Gobbert.

URL: <http://www.math.umbc.edu/circ>

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Master of Arts in Education / Post-Baccalaureate Certificate with emphasis on Mathematics and Science.

**Constituencies served:** Experienced teachers in the following public school systems: Anne Arundel County, Baltimore County, Charles County, Howard County, and Queen Anne's County  
Current (AY 2008-09) headcount enrollment = 189

**Brief Description:** The Masters of Arts in Education offers both on-campus and off campus programs for certified, experienced teachers. On-campus and off-campus programs share six core education courses (18 semester hours) in professional education. Off-campus or "Cohort" programs are collaboratively designed with school districts to meet both the standards of the university and the goals of the school system. Examples of these programs are listed below in the areas of mathematics, science, S.T.E.M., and ESOL. Other programs have been developed through discussions among faculty members, school administration and teachers. On-campus programs are collaboratively designed with individuals to meet both the standards of the university and the goals of the experienced teacher.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** The Future Engineers in Dynamic Systems (FEDS)

**Constituencies served:** Approximately ten rising high school juniors and seniors with an interest in pursuing an engineering degree

**Brief Description:** A unique two-week summer education program out of UMBC's Department of Mechanical Engineering and supported by The Shriver Center for junior and senior high school students in the Baltimore region. It focuses on dynamics, vibration, acoustics, and system control in the mechanical engineering discipline. This program is supported through a CAREER award from the National Science Foundation. FEDS has served approximately 50 students since summer 2004.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Friendship Academy of Science and Technology (FAST) Classroom Fellows

**Constituencies served:** 6<sup>th</sup>, 8<sup>th</sup>, and 9<sup>th</sup> graders in Baltimore City (in three years, it will be 6<sup>th</sup>-12<sup>th</sup> grade with the addition of a new 6<sup>th</sup> grade class each year)

**Brief Description:** Scheduled to begin in spring 2009, FAST Classroom Fellows is based on a successful model utilized by The Shriver Center through previous programs (Teaching Enhancement Partnership Project and the Vertically Integrated Partnerships K-16). Classroom Fellows will spend 7-8 hours in classroom working with FAST students and their teachers to support STEM instruction and learning.



These Classroom Fellows will be recruited by The Shriver Center across STEM majors. **Pending funding availability**, stipends of \$1000 will be offered to up to ten Classroom Fellows.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** The National Academy Foundation (NAF) High School Coaches

**Constituencies served:** 9<sup>th</sup>-12<sup>th</sup> graders in Baltimore City across three academies: Finance, Information Technology, and Hospitality & Tourism

**Brief Description:** “Coaches” work in either one-on-one or small group settings with NAF students to prepare for the Algebra, English, Biology, and Government High School Assessment (HSA). These students have not met expectations required to pass the HSA and in turn may not be able to graduate from high school. The Shriver Center recruits UMBC volunteers, especially for the Biology HSA to coach NAF students in remedial support to be successful. Small stipends are available to UMBC students for their participation, which assists to cover transportation to the school. Approximately 200 youth have been served since fall 2006.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Maryland Academy of Health & Technology Sciences (MATHS) Tutors

**Constituencies served:** Currently 6<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, and 10<sup>th</sup> graders from Baltimore City (in two years, which will become 6<sup>th</sup>-12<sup>th</sup> graders with the addition of a new 6<sup>th</sup> grade class each year)

**Brief Description:** MATHS’ mission is to “provide an intellectually rigorous, personalized and supportive college-prep education to 6<sup>th</sup>-12<sup>th</sup> grade students, with an emphasis on the biotechnology, health science and bioengineering fields. Our vision is to cultivate academically-driven, principled students that mature into leaders and contributors of their respective communities. Students with a keen interest in the sciences and attending college will benefit from our challenging and structured program. We demand strong parental/family participation to achieve our mission.” The Shriver Center recruits UMBC students to volunteer at MATHS to support their mission both in and out of the classroom. Lori Hardesty, the Program Coordinator of K-16 Partnerships at The Shriver Center, currently serves on the Board of Directors for MATHS. Approximately 125 youth have been impacted since spring 2007.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Elkton Middle School, Cecil County

**Constituencies served:** 8<sup>th</sup> graders

**Brief Description:** This unique opportunity began in fall 2006, initially intended for all 8<sup>th</sup> grade Math students at this Cecil County Middle School to visit UMBC and experience STEM at UMBC through a “Question and Answer” panel of current UMBC students, presentations by UMBC STEM Faculty tailored to this group, and a tour of campus. This visit initially took place during UMBC’s Reading Day in December 2006, the day before finals started. It has since grown into the entire 8<sup>th</sup> grade participating (200+ students). In addition to December 2006, the Service-Learning Program Coordinator of K-16 Partnerships has coordinated this visit in December 2007 and 2008, with plans for December 2009. Over 600 students have visited UMBC since December 2006.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Vertically Integrated Partnerships (VIP) K-16 Symposium

**Constituencies served:** 9<sup>th</sup>-12<sup>th</sup> graders in Montgomery County Public High Schools

**Brief Description:** The VIP K-16 Project, an NSF MSP, was lead by the University System of Maryland and engaged several partners including the Montgomery County Public Schools (MCPS), Montgomery College, UMCP, UMBC, UMBI, and Towson University. UMBC’s program had several components,

including experiences for undergraduate STEM majors. Funding for the program concluded September 2007. However, a two-year extension was granted for additional assessment of the five-year project. This symposium set for April 21<sup>st</sup>-22<sup>nd</sup>, 2009 will also feature the Langenberg Lecture, bringing together STEM experts on a local and national level to highlight lessons learned from the VIP K-16 Project. An estimated 1,150 students have been impacted by this project since fall 2005.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** NASA's BEST Students (Beginning Engineering, Science and Technology)

**Constituencies served:** 300 students in 23 schools in Anne Arundel County (K-8)

**Brief Description:** Support for professional development and the implementation of after-school clubs (NASA STEM Clubs) was provided to 23 schools in Anne Arundel County. The educators and two parents from each school participated in face-to-face professional development that was augmented with online support for the duration of the 12-week clubs in the Spring of 2008. This effort was funded by NASA's Exploration Systems Mission Directorate.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** Maryland Summer Center for Lunar Robotics

**Constituencies served:** Twenty gifted and talented students entering 8<sup>th</sup> grade

**Brief Description:** The UMBC Goddard Earth Science and Technology Center (GEST) hosted this two-week summer center in 2008. Students learned how to design, develop and deploy robots to conduct a simulated mission to the Moon to search for lunar ice. This was funded through the Maryland State Department of Education and was co-located with the NASA's BEST Students Summer Bridge in Lunar Robotics.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** NASA's BEST Students Summer Bridge in Lunar Robotics

**Constituencies served:** Twenty students entering 9<sup>th</sup> grade in the new STEM Magnet High School in Anne Arundel County

**Brief Description:** The UMBC Goddard Earth Science and Technology Center (GEST) hosted this two-week summer bridge in 2008. Students learned how to design, develop and deploy robots to conduct a simulated mission to the Moon to search for lunar ice. This was funded through NASA's Exploration Systems Mission Directorate and was co-located with the Maryland Summer Center in Lunar Robotics.

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**University:** University of Maryland, Baltimore County

**Name of STEM Program:** NASA-UMBC STEM Expo

**Constituencies served:** 149 participants (parents and students) from Windsor Mill Middle School, Baltimore County

**Brief Description:** This event was held on Nov 15, 2008, in celebration of NASA's 50<sup>th</sup> Anniversary. The event was started with a presentation by former astronaut, Don Thomas, following which the attendees participated in a potpourri of hands-on STEM activities excerpted from the NASA's BEST Students club activities, and augmented with five different types of rocket building and launching activities. This effort was funded by NASA's Exploration Systems Mission Directorate.



## University Maryland, Biotechnology Institute STEM Initiatives

**University:** UMBI

**Name of STEM Program:** Maryland Loaner Lab

**Constituencies served:** 5,500 students (grades 9 – 12)

**Brief Description:** The Maryland Loaner Lab (MDLL) is a resource for Maryland high school science teachers that brings a variety of investigations to the classroom. These [activities](#) are aligned with the Maryland State Department of Education's Core Learning Goals and provide teachers with the information and resources (curriculum, equipment and reagents) necessary for teaching core concepts and conducting hands-on experiments in biotechnology. This program is offered free of charge to all Maryland high school teachers. Equipment loans are available year round. For more information please go to [www.umbi.umd.edu/education-outreach/](http://www.umbi.umd.edu/education-outreach/).

**University:** UMBI

**Name of STEM Program:** Science and Technology Laboratory (SciTech)

**Constituencies served:** 700 + students (grades 6 – 12)

**Brief Description:** [SciTech](#) offers students the opportunity to experience biotechnology first-hand in a dedicated student laboratory led by an expert instructor. Each of the six laboratory activities are designed to teach core concepts while introducing students to the world of biotechnology. Located at UMBI's Center for Marine Biotechnology in Baltimore's Inner Harbor, SciTech has served over 25,000 students since its inception. All of UMBI's curricula are aligned with Maryland's Voluntary State Curriculum. Reservations are accepted year round. For more information please go to [www.umbi.umd.edu/education-outreach/](http://www.umbi.umd.edu/education-outreach/).

**University:** UMBI

**Name of STEM Program:** Teacher Professional Development in Bioscience

**Constituencies served:** 30 + teachers (middle and high school)

**Brief Description:** Throughout the school year, teachers are trained to incorporate biotechnology activities into their classroom curricula. A variety of training sessions are offered either at UMBI or delivered on-site at Maryland schools. Training sessions focus on use of specialized equipment (available through the Maryland Loaner Lab) in the classroom, current biotechnology topics, and biotechnology careers. Training sessions are offered year round. For more information please go to [www.umbi.umd.edu/education-outreach/](http://www.umbi.umd.edu/education-outreach/).

**University:** UMBI

**Name of STEM Program:** ExPERT (Extended Professional Experiences in Research for Teachers)

**Constituencies served:** 22 high school teachers from Prince George's County.

**Brief Description:** ExPERT is a professional development program designed to help high school science teachers transition into inquiry-based teaching. Though a 4-week placement in a research lab, workshops and year-long learning community teachers experience inquiry as the single most important everyday activity that scientists conduct. This program is part of an NSF Math and Science Partnership Award to Bowie State University, USM, UMBI, Prince George's Community College, Prince George's County Public School System and UMCP. Participation is open to any Prince George's County public high school science teacher. Please contact Mary Stapleton at 410.385.6318 for more information.

**University:** UMBI

**Name of STEM Program:** LMRCSC Intern Program

**Constituencies served:** 12 high school and college students

**Brief Description:** The ten-week long internship is part of the Living Marine Resources Cooperative Education Center (LMRCSC). The program offers minority students the opportunity to be mentored by world-class scientists. One of the main goals of the program is to prepare and advance the training of students and collaborative research in NOAA related sciences. LMRCSC was established in 2001 by a cooperative agreement with the National Oceanic and Atmospheric Association's (NOAA) educational partnership program with the University of Maryland Eastern Shore. LMRCSC is funded by NOAA in collaboration with UMBI's Center of Marine Biology (COMB).

# University of Maryland, College Park STEM Initiatives

## I. STEM Programs in Engineering: A. James Clark School of Engineering

### **Producing Engineering Degrees and Teachers of Engineering:**

University: University of Maryland, College Park

Name of STEM Program: Training Teachers of Engineering in the High Schools:

Constituencies served: Prospective high school engineering teachers.

Brief Description: The A. James Clark School would work with the College of Education to provide an academic program that enhances training in teaching of engineering at the high school level. The Clark School would develop a curriculum that will prepare teachers in engineering. Teacher participants will include present engineering and other science (as relevant) instructors in targeted high schools in the area, as a pilot program. The goal is to establish a Master's Degree in Education for Teachers with a certificate in engineering. The School will seek funds from the State of Maryland.

WEB link to more information: none

University: University of Maryland, College Park

Name of STEM Program: FLEXUS: Dr. Marilyn Berman Pollans WIE Living & Learning Community

Constituencies served: Incoming first year students that self-select into the program.

Brief Description: The Women in Engineering program supports incoming first and second year students in the FLEXUS program by providing opportunities for networking, professional development and leadership experiences. Participants are also clustered in introductory math, chemistry and engineering design courses. A 1-credit seminar required each semester includes participation in engineering outreach programs. Participants reside in Ellicott Hall and participate in various community activities such as group studying or movie nights. Program costs are covered in part by an endowment.

WEB link to more information (if available): <http://www.wie.umd.edu/undergrad/wiecommunity.html>

University: University of Maryland, College Park

Name of STEM Program: Bridge Program for Scientists and Engineers

Constituencies Served: 20 students entering their freshman year at the University of Maryland (9 engineering students; 9 CMPS students; and 2 students in Letters and Sciences)

Brief Description: Students began their freshman year with a five-week summer program that offers them the opportunity to get a head start in their Math courses. During the academic year students receive mandatory advising and participate in special activities designed to enhance their retention, promote academic excellence and expose them to internship and undergraduate research opportunities. This program is funded by the National Science Foundation. NSF funding is matched by funds from the University of Maryland.

University: University of Maryland, College Park

Name of STEM Program: Annual Winter Student Leadership Retreat

Constituencies Served: Undergraduate engineering students and corporate representatives

Brief Description: In this setting, undergraduates have an opportunity to engage with corporate representatives to receive valuable information on professional development as well as tips on improving the overall effectiveness of the respective student societies that they represent. In the past both local chapters of the National Society of Black Engineers and the Society of Hispanic Professional Engineers have been represented. Universities that have attended include the University of Maryland,

College Park, the University of Maryland-Baltimore County, Morgan State University, and Howard University. Funding for this event comes from corporate sponsors.

University: University of Maryland, College Park

Name of STEM Program: Undergraduate Research Program

Constituencies Served: Undergraduate engineering students

Brief Description: Undergraduate students work with faculty and/or graduate students for one or more semesters in a laboratory. At the end of the academic year, students present their work in a research symposium that is attended by staff and their research mentors. Funding for this program comes from the National Science Foundation.

University: University of Maryland, College Park

Name of STEM Program: Undergraduate Research Program

Constituencies Served: Graduate students

Brief Description: Graduate students receive a financial award for two years to assist them in the pursuit of the Ph.D. in a STEM area. This program is a shared project between the University of Maryland, College Park, the University of Maryland-Baltimore County, and the University of Maryland-Eastern Shore. Funding for this program comes from the National Science Foundation.

#### **Pre-College Outreach and Student Recruitment**

University: University of Maryland, College Park

Name of STEM Program: Information Technology for Girls (ITG)

Constituencies served: 30 to 60 Rising 6<sup>th</sup> to 8<sup>th</sup> middle school students

Brief Description: The Clark School would provide 1 to 2 week summer camp learning sessions to a group of middle school girls to expose them to information technology including, computers, software, internet, electronic devices. The goal is to build the future workforce in this critical technology area. Program would be funded by ManTech International Corporation and would be run by our Women in Engineering Program.

WEB link to more information: none

University: University of Maryland, College Park

Name of STEM Program: Terp Engineers Summer Camp

Constituencies served: 30 Rising 9th and 10th grade high school students

Brief Description: The Clark School's Undergraduate Recruitment & Special Programs Office offers this one-week commuter camp for young men and women who are interested in science and engineering to work on a variety of challenging and hands-on engineering activities.

WEB link to more information: <http://www.ursp.umd.edu/summer/terp-engineers.html>

#### **USM STEM Initiative**

University: University of Maryland, College Park

Name of STEM Program: Discovering Engineering Summer Camp

Constituencies served: 60 Rising 11th and 12th grade high school students

Brief Description: Find out if engineering is right for you! Meet faculty, tour one-of-a-kind labs and facilities, and learn about the various engineering disciplines offered at the University of Maryland. You will live on campus and participate in a variety of activities including laboratory work and demonstrations, lectures, discussions, computer instruction and team design projects.

WEB link to more information: <http://www.ursp.umd.edu/summer/discovering-engineering.html>

University: University of Maryland, College Park

Name of STEM Program: Engineers WithIn Borders (EWIB)

Constituencies served: 30 High School Students

Brief Description: The Clark School's would work with local high schools to coordinate activities of STEM students to participate in regional activities that add value from an engineering perspective to the community. Examples include Habitat for Humanity and disaster assistance like Katrina. Program funding would come initially from the School and later from a possible donor.

WEB link to more information:

### **Center for Minorities in Science and Engineering: Pre-College Outreach**

University: University of Maryland, College Park

Name of STEM Program: Engineering Day

Constituencies Served: Middle and high school students and parents

Brief Description: Students and parents attended an outreach and recruitment day hosted by the Center for Minorities in Science and Engineering in which participants interacted with staff and undergraduate students. Participants took part in hands-on engineering activities, tours, and listened to panel discussions. Funding for the program came from the Center's state budget.

University: University of Maryland, College Park

Name of STEM Program: Up, Up and Away

Constituencies served: Twenty-two students entering grades 6-8 attended.

Brief Description: Students learned about the science of flight through exciting hands-on activities, demonstrations, field trips and guest speakers. Topics discussed include the compression and expansion of air, the history of flight, flight patterns, aerodynamic forces and rocketry. Activities included constructing hot air balloons, balsa wood gliders and model rockets, and two field trips taken by students, staff and parents. Funding for the program came from the Maryland Mathematics, Engineering, Science Achievement (MESA) program, as well as from registration fees.

University: University of Maryland, College Park

Name of STEM Program: "Spring into the Future"

Constituencies served: 30 students entering grades 10-12

Brief Description: Students designed and built a trebuchet for one week. The program culminated with students attending the Mathematics, Engineering, Science Achievement (MESA) National Engineering Design Competition that was held at the University of Maryland, College Park on June 21, 2008.

Students also met with University of Maryland faculty and staff to learn more about attending the School of Engineering at the University of Maryland. Funding for the program came from registration fees and corporate donations.

University: University of Maryland, College Park

Name of STEM Program: Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP) College Awareness and Mathematics Preparation (CAMP)

Constituencies served: A cohort of 430 high school students currently in the tenth grade.

Brief Description: The Center for Minorities in Science and Engineering, through funding from the Maryland Higher Education Commission (MHEC) serves as the college partner to Central High School's GEAR UP program. Central High School is one of two schools that have a GEAR UP program in Prince George's County. The program has implemented an after-school MESA program, an in-school class that uses robotics to teach algebra, a Saturday program that focuses on life strategies, mathematics, and the

FIRST Tech Challenge, and summer enrichment activities that in 2009 will include a Pre-Calculus class and an Algebra class.

University: University of Maryland, College Park

Name of STEM Program: Collaborative program between Mechanical Engineering Department (University of Maryland), Prince George's County Public Schools, and the Center for Minorities in Science and Engineering

Constituencies served: 20 students entering grades 6-8

Brief Description: Students participated in hands-on engineering activities, while working with undergraduate engineering students and teachers from the Prince George's County Public Schools system. Students also participated in tours of Engineering facilities at the University of Maryland. The program was funded by the Department of Mechanical Engineering and the Prince George's County Public Schools System.

University: University of Maryland, College Park

Name of STEM Program: Prince George's County Mathematics, Engineering, Science Achievement Program

Constituencies served: 75 students at 10 schools in Prince George's County

Brief Description: The Center for Minorities in Science and Engineering serves as the Prince George's County center for Maryland MESA. The Center supports ten MESA programs in the county at elementary, middle and high schools. Additionally, the Center supported the efforts of Maryland MESA in co-hosting the National MESA Engineering Design Challenge in 2007 and 2008. Funding for the program comes from the Center's state budget and Maryland MESA.

University: University of Maryland, College Park

Name of STEM Program: LEGO Robotics Program

Constituencies served: 50 students in elementary and middle school

Brief Description: Students designed, constructed, and programmed LEGO Mindstorms robots with instruction from graduate and undergraduate engineering students. Students presented their work at a special symposium at the end of the program in which they demonstrated the knowledge that they gained. Participants worked in small teams using motors and sensors, explored gears and pulleys, built and controlled a line drawing robot, and used computers to test their programming skills. Funding for the program came from registration fees

University: University of Maryland, College Park

Name of STEM Program: Engineering, Science and Technology to Energize and Expand Young Minds (ESTEEM)

Constituencies served: 8 students entering twelfth grade in Prince George's County

Brief Description: Students participated in a two-week program in the summer in which they explored engineering research by attending lectures, lab demonstrations, and developed a research proposal and engaged in a literature search and review for a research presentation. Students returned for an academic year-long independent project with a faculty member. This will lead to a final paper and participation in a research symposium in the spring of 2009. Funding for the program comes from a grant from the Provost's office.

### **Clark School's Women in Engineering Program (FLEXUS): Pre-College Outreach**

University: University of Maryland, College Park

Name of STEM Program: Exploring Engineering at the University of Maryland (E<sup>2</sup>@UMD)

Constituencies served: 64 rising high school junior and senior women attend from across the United States and abroad.

Brief Description: The Women in Engineering program hosts two one-week sessions of E<sup>2</sup>@UMD on campus. Participants interact with faculty from each Clark School department, current students and professional engineers. Participants also take tours of engineering labs and live in a residence hall. Participants work in small teams on a week long engineering project that is presented to their parents at the end of the program. Applicants must exhibit strong academic performance, and provide a personal statement of interest and a STEM teacher recommendation. Program cost is partially supported by one donor with the balance paid by the participants.

WEB link to more information (if available): <http://www.wie.umd.edu/precollege/e2umd.html>

University: University of Maryland, College Park

Name of STEM Program: WIE DREAM Conference

Constituencies served: 400 students, parents and teachers

Brief Description: The Women in Engineering program hosts an annual one day conference on engineering that includes professional panel discussions, engineering application seminars, financial aid workshops, engineering student panels, and information fair. Prominent keynote speakers are featured throughout the conference. As part of the conference, student attendees that apply and are admitted to the Clark School are eligible to apply for a DREAM Scholarship. This program is free for all participants. Program costs are covered by corporate sponsorships and donations.

WEB link to more information (if available): <http://www.wie.umd.edu/dream/index.html>

University: University of Maryland, College Park

Name of STEM Program: WIE LEAD Academies

Constituencies served: Varies (max of 25 per academy) high school students

Brief Description: The Women in Engineering program works with Clark School faculty to plan and coordinate one day academies related to specific engineering majors. Participants get a team based, hands-on experience working with faculty on relevant research topics. Program cost is covered in full by participants.

WEB link to more information (if available): <http://www.wie.umd.edu/precollege/lead.html>

University: University of Maryland, College Park

Name of STEM Program: SPICE Program (Students with Potential and Interest Considering Engineering)

Constituencies served: Pilot Program expected to serve 20 rising high school freshmen and sophomore women from underrepresented populations in summer 2009.

Brief Description: The Center for Minorities in Science and Engineering and the Women in Engineering program will co-host area students on the University of Maryland campus. Participants work on a variety of hands on, relevant engineering projects, interact with faculty and student speakers and take a tour of an engineering facility off campus. Program cost is covered in full by participants.

WEB link to more information (if available): N/A

University: University of Maryland, College Park

Name of STEM Program: Stepping Stones to Your Future (SSTYF)

Constituencies served: 60-64 rising 7<sup>th</sup> and 8<sup>th</sup> grade students.

Brief Description: The Women in Engineering program hosts two one-week sessions of SSTYF (30-32 students each week) on the University of Maryland campus. Participants work on a variety of hands on engineering related projects and design challenges. Participants work in small teams on an extended

project that is presented to their parents at the end of the program. Program cost is covered in full by participants.

WEB link to more information (if available): <http://www.wie.umd.edu/precollege/stepstone.html>

University: University of Maryland, College Park

Name of STEM Program: KEYS to Empowering Youth (KEYs)

Constituencies served: 40-60 young women between 11-13 years of age per program.

A similar program is offered to 40-60 girl scouts, cadets and seniors.

Brief Description: The Women in Engineering program hosts two one-day programs (fall and spring) of KEYS on the University of Maryland campus. Participants rotate through different engineering experiences. Participants also learn about engineering through a professional engineering speaker. Program cost is covered in full by participants.

WEB link to more information (if available): <http://www.wie.umd.edu/precollege/keys.html>

## **II. STEM Teacher Education: College of Education and Partner Colleges.**

University: University of Maryland, College Park

Name of STEM Program: Paid Teacher Education Internship

Constituencies served: Teacher Candidates in Montgomery and Prince George's County: Targeting Science and Mathematics Teachers

Brief Description: The College of Education offers a paid-internship option in the Master's Certification (M-Cert) secondary program with Montgomery County Public Schools and has begun a similar arrangement with Prince George's County. In this program, students teach part time in the districts with school-based and university support while taking courses at the University. With the newly designed curriculum, added financial support for interns, and enhanced recruitment, the M-Cert secondary program has grown from 16 students in 2004-05 to 75 for 2007-08. We are projecting that numbers will increase to 100 for 2008-09, including increased enrollment in mathematics, with increased financial support.

Web link to more information: <http://www.education.umd.edu/EDCI/info/mmcp/mc-secinfo.html>

University: University of Maryland, College Park

Name of STEM Program: Transition from Laboratory to Classroom

Constituencies served: Scientist from NIH and Montgomery County Schools

Brief Description: In 2005-06, the college piloted a partnership with Montgomery County public schools and NIH to start the Transition from Laboratory to Classroom initiative, which provides the opportunity for scientists from NIH to complete a one-year focused program that leads to certification in secondary science (5 of the 7 candidates completed the program and are teaching in MCPS in full time positions). Each of these people has an advanced science background and is bringing this expertise into the classroom. The science unit faculty believes that the students in the TLC program are among the best teacher candidates they have, and plans are underway to renew this grant. We are currently seeking funding to reactivate this initiative for 08-09 with MCPS and NIH and are exploring a parallel initiative in PGCPs.

Web link to more information: <http://www.education.umd.edu/EDCI/info/tlc.htm>

University: University of Maryland, College Park

Name of STEM Program: Middle School Teaching and Learning: Mathematics option

Constituencies served: Montgomery and Prince George's County public schools.



Description: The College of Education offers a Middle School Teaching and Learning: Mathematics option, which is preparing teachers certified in elementary education to be highly qualified as teachers of mathematics at the middle school level. Seventeen candidates enrolled in the first cohort, and a second cohort of 25 candidates began in April, 2007. This research-based program involves coursework in mathematics content, mathematics education and curriculum-based integrated content and pedagogy courses, as well as an action research course. School based components to the program include support for teachers visiting each other's classrooms and support for mathematics enrichment activities in schools. Supported by two Improving Teacher Quality grants from the Maryland Higher Education Commission, this degree program has been offered to three cohorts. The first MCPS cohort graduated in Spring, 2007, and a number of these graduates are now instructional team leaders in their schools. A second MCPS cohort of 23 practicing teachers is starting its second year. A PGCPs cohort of 18 teachers began in the spring of 2008.

Web link to more information: [http://www.education.umd.edu/EDCI/info/math\\_med.html](http://www.education.umd.edu/EDCI/info/math_med.html)

University: University of Maryland, College Park

Name of STEM Program: Middle School Teaching and Learning: Science Option

Constituencies served: Elementary certified teachers who teach science at the elementary and middle school level.

Brief Description: This program enhances teacher candidates' content knowledge and supports their abilities to effectively teach science at the elementary and middle school levels. Faculty from the Science Teaching Center in the School of Education have partnered with MCPS, the College of Chemical and Life Sciences, and the Department of Physics to develop an M.Ed. pathway with an emphasis on Middle School Science Teaching and Learning. This program is expected to receive University approval shortly. The College anticipates expanding the program in future years to serve teachers from other surrounding districts.

University: University of Maryland, College Park

Name of STEM Program: Enhancing the mathematics preparation of elementary teachers

Constituencies served: Future elementary teachers

Brief Description: Collaborations between Education and Mathematics faculty focus on enhancing the mathematics preparation of elementary education majors. Working in consultation with the faculty from the Department of Curriculum and Instruction, the mathematics department is creating three new mathematics courses, which will be specifically designed for students who want to teach upper-level elementary grades mathematics. In its June 2008 study examining the mathematics preparation of America's elementary teachers (*No Common Denominator: The Preparation of Elementary Teachers in Mathematics*), the National Council on Teacher Quality (NCTQ) identified the College of Education at the University of Maryland as one of only ten schools in the sample of 77 which rose to the top in terms of overall quality of preparation in mathematics for elementary education majors.

University: University of Maryland, College Park

Name of STEM Program: Preparing Pedagogical Experts in Educational Technologies (PEETS).

Constituencies served: High school science teachers

Brief Description: Preparing Pedagogical Experts in Educational Technologies for Teaching Science (PEETS) project offers a professional development program that supports science teachers' developing expertise in designing and implementing novel educational technologies in Maryland high schools. As part of the program, teachers learn to use computer visualization software as a central component of learning activities in chemistry classrooms beyond simple visual aids. Participating teachers become members of a network of Maryland teachers using educational technology in science and develop novel

lesson plans using self-generated computer-based visualization. Currently, there are 23 teachers from PGCPs participating in this project.

University: University of Maryland, College Park

Name of STEM Program: Project NEXUS, the Maryland Upper Elementary/Middle School Science Teacher Professional Continuum Model

Constituencies served: Upper elementary and middle level specialist science teachers

Brief Description: Priority is placed on the recruitment and professional development of a diverse teaching force. The project is testing a model of active recruitment and support of specialist upper elementary/middle teacher education majors (particularly minority teacher interns) with academic background in content who can fulfill State and Federal certification guidelines for high quality teachers. Project NEXUS teachers benefit from a baccalaureate program that features connecting transformative undergraduate science content and method courses; supported internship experiences with adolescent students in informal education contexts; field placements in urban professional development schools and ongoing innovative educational experiences addressing the needs of minority and urban students; and, continuous university, public school district, and informal education support during their induction years. Participants in the 5-year National Science Foundation project include 150 new specialist science teachers and 40 practicing mentor teachers (formal and informal science education domains).

Collaborating partners include the University of Maryland, College Park; Coppin State University; Hands-on Science Outreach, Inc.; and, PGCPs.

Web link to more information: <http://www.projectnexus.umd.edu/>

University: University of Maryland, College Park

Name of STEM Program: Minority Student Pipeline Math Science Partnership – MSP-Squared (MSP-Squared):

Constituencies served: Prince George’s County teachers in grades 4-8

Brief Description: The Science Education Center in the College of Education is collaborating with Bowie State University (BSU), Prince George’s Community College (PGCC), the University of Maryland Biotechnology Institute (UMBI), PGCPs, and the University System of Maryland (USM) to expand the minority student pipeline in STEM fields in higher education, will include:

- Professional development programs created by UM and PGCC for teachers in grades 4-8 designed around principles of teaching and learning through inquiry science;
- Summer research experiences for PGCPs high school science teachers with BSU, UMBI, and UM faculty; and,
- Mentored teaching experiences for 100 undergraduate underrepresented minority students coordinated by UM and 50 undergraduate research experiences through BSU.

Web link to more information: <http://www.umsa.umd.edu/newsroom/news/598>

University: University of Maryland, College Park

Name of STEM program: Funded Research Project: Women’s Adjustment to STEM Majors

Constituencies served: Women and other underrepresented group in undergraduate STEM programs

Brief Description: The project builds on prior research on how students, and women in particular, adapt to STEM-related academic environments. This project will test, using a longitudinal design, a model of academic satisfaction and adjustment, focusing on the interaction of social and cognitive variables during women’s and men’s transition in their first two years in a STEM college program. The project uses a large sample of students at two predominantly White and two historically Black universities in Maryland, Virginia, and DC. Participants’ responses to complex queries will be used to explore in depth how they experience the academic environment and what strategies they use to cope with their

transition as STEM majors. The University of Maryland, College Park, Morgan State University, Virginia Tech, and Howard University have agreed to participate in this study.

University: University of Maryland, College Park

Name of STEM program: Funded Graduate Programs: Mid-Atlantic Center for Mathematics, Teaching and Learning (MAC-MTL)

Constituencies served: Future mathematics education researchers and teacher educators

Brief Description: In 2001, in conjunction with colleagues at The Pennsylvania State University and the University of Delaware, the Mathematics Center in the College of Education was awarded one of the first two NSF-funded Centers for Teaching and Learning to create the Mid-Atlantic Center for Mathematics Teaching and Learning (MAC-MTL). In 2005, MAC-MTL was the only Center to receive a five-year renewal. Total funding for the initial and renewal grant exceeds twenty million dollars. This grant provides doctoral student fellowships, as well as funding to redesign and grow the doctoral programs at these three institutions and to enlarge the scope of their activities. Over the last three years, Maryland's College of Education has graduated four-five MAC-MTL fellows at the doctoral level each year. Graduates have taken mathematics teacher education positions in Maryland (e.g., Towson University, Morgan State University) and in other states.

Web link to more information: <http://www.education.umd.edu/mac-mtl/>

University: University of Maryland, College Park

Name of STEM program: Maryland Mathematics Institute (MMI)

Constituencies served: Current high school teachers

Brief description: An intensive summer one-week all-day set of presentations from several UMD Mathematics and Mathematics Education faculty. 2 credits. The first MMI (2008) was largely funded by PG County and largely attended by their teachers (about 20). The Institute also provides four summer courses (algebra, geometry, statistics, calculus). 3 credits each, 5-6 weeks long. These courses are designed to strengthen high school teachers' mathematical understanding for better teaching.

WEB link: <http://www.math.umd.edu/highschool/mmi>

### **III. STEM Majors in the Sciences.**

University: University of Maryland, College Park

Name of STEM Program: Computer Science Education Degree Program

Constituencies served: Middle and High School students

Brief Description: The College of Computer Science, Mathematics and the Physical Sciences in collaboration with the College of Education is conducting workshops (during Spring 2009) on computer science education in Maryland. The workshops include stakeholders in the state and are focused on identifying educational and programmatic goals, regulatory and administrative constraints or obligations, and research directions in education in computer science. Goals of this project include first steps at defining the content of computer science education and developing a path forward to initiate a degree program in computer science education in the State. Agreed-upon standards for such education and the definition of appropriate credentialing for graduates would promote increased training of computer science teachers in the State.

University: University of Maryland, College Park

Name of STEM Program: Passport Program

Constituencies served: Middle and High School students

Brief Description: The Passport Program is a program for middle and high school students interested in Math and Computer Science. The program includes an emphasis on encouraging females, African-Americans, and Latinos to the fields of Math and Computer Science. This program is offered at no cost to the student (students are only responsible for any transportation arrangements). Students learn about Java and computer programming in a short course form classes taught on the UMCP campus.

WEB link to more information: <http://www.cs.umd.edu/projects/passport/webPage/>

University: University of Maryland, College Park

Name of STEM Program: Research on Learning and Teaching Physics.

Constituencies served: Students and Teachers in Physics, K-18.

Brief Description: The Physics Education Research, an interdisciplinary research team from the Department of Physics and the Department of Curriculum and Instruction in the School of Education conduct research on the learning and teaching of physics at all levels. Research on how students reason and learn and relevant teaching techniques includes applications (and their evaluation) in courses at the University of Maryland. NSF grants have supported these studies.

WEB link to more information: <http://www.physics.umd.edu/perg/>

University: University of Maryland, College Park, College of Chemical and Life Sciences

Name of STEM Program: Bridge to Success from Community College to Research University

Constituencies served: Students at community college enrolled in basic biology courses who intend to transfer to UMCP

Brief Description: Attrition rates for STEM transfer students from community colleges are typically higher than for first year admits. Faculty at UMCP and Montgomery College (MC) are participating in a pilot program in Spring, 2009 to examine how teacher-student class interactions affect student outcomes. A discussion course has been designed in which MC students will write answers to questions typically posed by UMCP faculty and will be given feedback and practice on their work. The study objective is to assess those skills most critical to success and how students can be assisted in developing and using these skills early in their programs.

WEB link to more information (if available):

University: University of Maryland, College Park, College of Chemical and Life Sciences

Name of STEM Program: Summer Biology Institute

Constituencies served: High School Life Science Teachers

Brief Description: The College of Chemical and Life Sciences proposed to run a Summer Biology Institute that will bring high school biology teachers in Maryland to UMCP for a four week intensive learning experience. Each morning will be devoted to intensive lectures in content knowledge. Each afternoon teachers conduct lab exercises as they are done at UMCP. At the end of the experience teachers will be required to develop their own high school lab exercises. This program is a modified version of a successful program run several years earlier but which ended when funding was no longer available.

WEB link to more information (if available):

## University of Maryland Eastern Shore STEM Initiatives

University: University of Maryland Eastern Shore

Name of STEM Program: Hazel Scholarships

Constituencies Served: Graduate undergraduate teachers and counselor education candidates

Brief Description: To support teacher education candidates at graduate and undergraduate levels with priority going to critical shortage areas.

Weblink: N/A

University: University of Maryland Eastern Shore

Name of STEM Program: UMES Departmental/ Unit Scholarships

Constituencies Served: Graduate undergraduate teachers education candidates

Brief Description: To support teacher education candidates at graduate and undergraduate levels with priority going to critical shortage areas.

Weblink: N/A

University: University of Maryland Eastern Shore

Name of STEM Program: UMES Graduate Scholarships

Constituencies Served: Teacher education candidates at graduate and undergraduate levels

Brief Description: To support Teacher education candidates at the graduate and undergraduate levels with priority going to MAT Program Fields of STEM and Math Education in Career and Technology Education (CTED).

Weblink: N/A

University: University of Maryland Eastern Shore

Name of STEM Program: Linkages with Community Colleges

Constituencies Served: Teacher Candidates at Wor-Wic and Eastern Shore Community Colleges.

Brief Description: Increase number of teacher candidates in UMES Teacher Education Program especially in critical shortage areas. Targeting Associate of Arts in Teaching (AAT) Students in Community Colleges, Streamline process of transfer from 2 year colleges to UMES.

Weblink: N/A

University: University of Maryland Eastern Shore

Name of STEM Program: Geospatial Information technologies (GIT) A Water Quality Management Internship Program

Constituencies Served: 20 High School Students

Brief Description: Introduced High School students to Geospatial technologies and teaching applications in these technologies. Technologies include (GIS, GPS & Remote Sensing).

Weblink: N/A

University: University of Maryland Eastern Shore

Name of STEM Program: Technology Education and Community Universal, Partnership (TEACHUP)

Constituencies Served: Undergraduate STEM Majors at UMES

Brief Description: To recruit, select, enroll, support, retain and graduate and place local students in local Engineering and Information Technology oriented enterprises, fill the STEM pipeline gap and strengthen the social, economic and intellectual fabric of the community.

Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: Professional Education Programs in STEM Areas  
Constituencies Served: Undergraduate teacher students and MAT graduate students  
Brief Description: UMES undergraduate teacher education programs in the STEM and related areas. Master's of Arts in Teaching (MAT).  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: University of Maryland Eastern Shore-Somerset County Teacher Education project (USTEP)  
Constituencies Served: STEM Teachers and uncertified teachers in Somerset County Public schools.  
Brief Description: UMES in partnership with Somerset County Public School in focusing on preparing highly qualified teachers with emphasis on critical areas such as STEM. Involves; training for PRAXIS I and II, developing individual professional development plans for teacher and staff interested in becoming teachers. On-line course development to entrance skill of teacher.  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: Project TEAM (Teacher's Equipment And Material)  
Constituencies Served: Elementary, middle, and high school teachers in Maryland.  
Brief Description: Provide Support for Elementary, Middle and High School teachers (Primarily in Maryland) for instructional materials for Math Teaching.  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: Living Marine Resources Cooperative Center - LMRCSC - Geoscience  
Constituencies Served: 42 undergraduates, 16 master's students, and 7 doctoral students  
Brief Description: To conduct research congruent with the interests of NOAA fisheries; current themes include: fisheries stock assessment, essential fish habitat, fisheries socioeconomics, and aquaculture. A collaborative program.  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: University of Maryland partnership in cancer research and outreach.  
Constituencies Served: Department of Natural Science Student and faculty and University of MD School of Medicine/Greenbaum Cancer Center (UMSOM?UMGCC)  
Brief Description: To reduce cancer disparities in Baltimore City and the Eastern Shore of Maryland through research and outreach.  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: Department of Natural Sciences and Uninformed Services University for the Health Sciences (USUHS) Bethesda, MD, Partnership in Health Disparities.  
Constituencies Served: Undergraduate and faculty  
Brief Description: Extramural research and partial support of biomedical research in the Department of Natural Sciences.  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: UMES Minority Biomedical Research Support Research Improvement for Scientific Enhancement. (MBRS RISE) program, National Institute of General Medical Sciences (NIGMS)  
Constituencies Served: 6 members of faculty and 10 students  
Brief Description: Enhance infrastructure, skills and competitiveness of student and faculty in the Department of Natural Sciences in biomedical research  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: UMES minority access to research careers undergraduate student training and research (UMES MARC U \* STAR) program.  
Constituencies Served: 10 high achieving honor students  
Brief Description: Increase number of underrepresented UMES minority students who earn doctoral degrees in the biomedical sciences by enhancing and preserving student's interests for research careers in the biomedical services  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: New STEM course development EDTE 488F and current STEM course offerings  
Constituencies Served: Pre-service STEM K-12 Teachers with emphasis on minority populations  
Brief Description: Increase quantity, quality and diversity of mathematics, science and technology teachers at the elementary and secondary school levels nationally.  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: MARS Camp (Math and Related Sciences) SMART Camp (Science, Math, and Recent Technologies): CMST (Center for Mathematics, Science and technology).  
Constituencies Served: Student from U.S.  
Brief Description: MARS Camp (Math and Related Sciences) for the past 16 years.  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: Project HOME (Here is an Opportunity for mathematical Exploration)  
Constituencies Served: High and middle school students and teachers  
Brief Description: Weekend course for middle and high school students in Somerset County designed to increase awareness and interest in math.  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: Project GEAR UP (Gaining Early Awareness and Readiness for Undergraduate Programs)  
Constituencies Served: Focuses on middle school students from Wicomico and Somerset Counties  
Brief Description: UMES' focus is on a summer academy targeted at increased interest in STEM areas.  
Weblink: N/A

University: University of Maryland Eastern Shore  
Name of STEM Program: New STEM course development EDTE 488F and current STEM course offerings

Constituencies Served: Students who are STEM Teachers

Brief Description: The new course CEDTE 488F - foundation of technology under the career and Technology Education master's program is primarily for students who are STEM teachers.

Weblink: N/A