Office of Educational Access and Success (OEAS), University System of Georgia

In collaboration with

Center for 21st Century Universities (C21U) and Center for Advanced Communications Policy (CACP),
Georgia Institute of Technology

A Review of State-Level Programs to Enhance Postsecondary STEM Education in the United States

OEAS Working Paper Series #12-02

Atlanta, Georgia
March 2012

OEAS Working Paper Series #12-02

Office of Educational Access and Success (OEAS), University System of Georgia

In collaboration with

Center for 21st Century Universities (C21U) and Center for Advanced Communications Policy (CACP), Georgia Institute of Technology

Atlanta, Georgia
March 2012

A Review of State-Level Programs to Enhance Postsecondary STEM Education in the United States

Executive Summary

Recent research has suggested that students in the United States continue to lag behind other countries in mathematics and science literacy. The current status of STEM education United States has been conceptualized as a "leaky pipeline," wherein students defect from STEM education at various intervals, particularly during the transition from secondary to postsecondary education, as well as between the first semester and graduation from postsecondary education. Students with low levels of mathematics literacy often lack the foundational skills needed for comprehension of other STEM subjects; thus, they are more likely to defect from postsecondary STEM education.

A comprehensive review of the literature and an Internet survey were conducted to gauge the state of STEM education nationwide and revealed that multiple states have, in fact, heeded the warning signs and instituted statewide STEM initiatives. While 29% of states with some form of STEM initiative focus their efforts at the P-12 level, the remaining 71% with an initiative extend those efforts to the P-16 level in order to better prepare a STEM workforce. While the primary focus in STEM education is on decreasing the attrition of STEM majors, there is also a focus on what needs to be done to improve pre-service P-12 teacher preparation and how improved training can have a positive impact on STEM education at the P-12 level. We conclude that college success in STEM is a function of P-12 educator preparation, and likewise, the development of these educators is a function of their success in postsecondary STEM education.

1. Introduction

Despite growing public interest in the improvement of science, technology, engineering, and mathematics (STEM) education in the United States, recent research has suggested that students in the United States continue to lag behind other countries in mathematics and science literacy (28th and 24th, respectively) (Kuenzi 2008). More specifically, American students demonstrate declining levels of mathematics and science proficiency between the 4th and 12th grades, undermining their ability to succeed in postsecondary STEM education and prepare for STEM careers (Kuenzi 2008, Kuenzi 2006, Achieve 2004). The current status of STEM education United States has been conceptualized as a "leaky pipeline," wherein students defect from STEM education at various intervals (Daemfle 2003). In a longitudinal study by Astin (1993), the main "leaks" to the STEM pipeline occur during the transition from secondary to postsecondary education, as well as between the first semester and graduation from postsecondary institutions. A key cause of attrition noted in numerous studies is a conspicuous lack of mathematics competency (Astin 1993, Kuenzi 2006). Students with low levels of mathematics literacy often lack the foundational skills needed for comprehension of other STEM subjects; thus, they are more likely to defect from postsecondary STEM education (Astin 1993, Kuenzi 2006). If the situation is not ameliorated, it has been predicted that the United States will be unable to produce a sufficient number of scientifically literate professionals for its workforce and, consequently, the nation may lose its competitive edge in STEM-related fields (Daemfle 2003).

A comprehensive review of the literature and an Internet survey were conducted to gauge the state of STEM education nationwide and revealed that multiple states have, in fact, heeded the warning signs and instituted statewide STEM initiatives. This assessment of STEM education analyzes STEM educational efforts discussed in the literature and augments that review with findings from an informal Web survey to understand state-level programs to enhance postsecondary STEM education. Among other things, this assessment seeks to identify initiatives comparable to the University System of Georgia (USG) STEM Initiative, examine programmatic efforts of these initiatives, and examine some shortcomings found in these efforts (see Table I).

Table I. Leading State-Level STEM Initiatives, as Determined by Key Indicators

State	STEM Initiative Name	Years of Program	Still Active ?	Number of Schools Involved	Stated Goals	Funding Source	Annual Funding Amount	Program Partners
Georgia	USG STEM Initiative (Higher Education)	2007-Present	Yes	7	Promote K-12 student preparation for and interest in majoring in STEM in college. Increase the success of STEM majors in college. Produce more and better science and mathematics teachers for the schools, which in turn will lead to increased preparation of K-12 students in science and mathematics.	**Board of Regents**	Approx. $2.6 million	Georgia Department of Education
Louisiana	LA-STEM (LSU Students Only)	2006-Present	Yes		Promote the life and diversity of the STEM student body. Provide supportive and motivating environment for students through mentoring, education, and research.	**Louisiana Board of Regents**, NSF, Research Corporation	N/A	N/A

Ohio	Ohio STEM (K-16)	2006-Present	Yes	26 (Postsecondary	Form new skills and sharp minds for a new century. Engage partnerships to accelerate capacity and broaden opportunity. Start and stay small. Make STEM literacy attainable and desirable for all. Drive scalable and sustainable innovations.	Bill & Melinda Gates Foundation, Battelle Center, Ohio Business Roundtable	$50 Million ($12 Million from BMGF in 2008)	Teaching Institute for Excellence in STEM, Ohio STEM, **Ohio Board of Regents**, Ohio Mathematics and Science Coalition
Tennessee	Tennessee Mathematics, Science & Technology Education Center (K-20)		Yes	5 Universities	Provide quality staff development for STEM teachers. Develop undergrad and grad math and science education programs. Influence state policies on STEM education. Develop partnerships with stakeholders. Establish a Math and Science Education Research Group	US Department of Education, TN Department of Education ,**TN Board of Regents**, TN Board of Education, TN Higher Education Commission, NASA, NSF, Texas Instruments, Mind 2 Marketplace	$7 Million awarded for 2008 until 2014	

2. Current Issues in STEM Education

Postsecondary Attrition

The primary focus on enhancing STEM education in postsecondary education has involved improving recruitment and retention of STEM majors within university education. Much of the literature involves case studies that offer the results of programmatic efforts to alleviate STEM attrition. But many of the present programs discussed in the literature share in common the basic principles put forth in two longitudinal studies by Astin (1984 and 1993), which posit student involvement and the impact of environment as keys to persistence in science education..

In his studies, Astin used longitudinal research involving approximately 27,000 postsecondary students to determine the factors affecting postsecondary attrition among students. Astin's student involvement theory (1984) posits that the amount of energy students invest in postsecondary education, both physically (e.g. amount of time studying or amount of time in campus activities) and psychologically (e.g. comprehension of material studied) can be measured quantitatively and qualitatively. Thus, the student's educational performance and likelihood of attrition will depend proportionally upon both the quantitative and qualitative aspects of the student's involvement in his or her education. In this regard, Astin believes that educational systems should pay attention to student engagement and performance as a key factor when designing their curricula. In the theory of student involvement, factors that increase involvement, and accordingly decrease the rate of attrition, may include living on campus, participating in extracurricular activities or sports, having an on-campus job, and taking part in undergraduate research. All of these factors have been found to facilitate positive student interaction with their environment, including faculty and peers.

Conversely, factors that typically do not permit students to have interaction with their campus and other students or faculty—living off campus, having an off-campus job, or only attending school part-time—frequently lead to a diminished sense of involvement and higher attrition rates. Astin suggests that a student's level of involvement correlates inversely with attrition rates. The involvement may take the form of research, social groups, residential halls, or faculty and student relationships. Higher dropout rates correlate with a lack of student involvement and engagement with campus and university related activities. Overall, factors that enhance a student's involvement in educational and campus pursuits offered the student to be better engaged in the college experience and accordingly allowed the student to take a more vested interest in their educational endeavors. In short, Astin concludes that "all institutional policies and practices – those relating to nonacademic as well as academic matters – can be evaluated in terms of the degree to which they increase or reduce student involvement" (Astin 1993, p. 529). Therefore, Astin suggests that restructuring the learning environment to improve active participation may facilitate better student development and lower attrition rates.

Astin's early studies of student involvement are tightly connected to his later study on the impact of college environments on science education (1993). In this study, Astin determined that increased student involvement is tied not only to lower attrition rates, but also competency in science and mathematics. This competency plays a fundamental role in the "leaky pipeline" of STEM students. The longitudinal study demonstrated that students were more likely to persist in or be recruited to STEM majors if there was an increased opportunity for involvement (i.e. learning communities, on campus jobs, undergraduate research, scholarships, and more active learning opportunities) and if the student had a higher mathematical competency. Thus, Astin's recommendations for STEM education include raising mathematics standards among high school students and developing curricula and programmatic interventions that offer more involvement for postsecondary STEM students. However, Astin's study also revealed that, at the time of publication, these types of opportunities were not often available in most institutions. STEM fields often demonstrated a lack of student-centered pedagogy, wherein classes offered minimal faculty and student interaction and furthermore structured classes to lack cooperative or active learning.

The recommendations made in Astin's studies were closely related to those made offered by the contemporaneous Project Kaleidoscope (PKAL) in its *Plan for Strengthening Undergraduate Science and Mathematics* (1991). PKAL's recommendations to improve STEM education addressed as many aspects of the leaky pipeline as possible. Yet, as a project supported by the National Science Foundation (NSF) with a record of success, the project is mainly confined to the issues of attrition in STEM majors and the preparation of pre-service P-12 teachers.

In the case of attrition among STEM majors, the PKAL report (1991) generally supported Astin's (1993) findings and also cited mathematical incompetency as one of the major factors for attrition. In the report, PKAL states that a strong background in mathematics is the "'critical filter' that impedes free flow in our nation's scientific and technological pipeline." Basic mathematics serves as the underlying principle that drives most applications of science and technology; therefore, students must have a grasp on these principles in order to feel confident about their ability in STEM fields. The report then goes on to recommend that programs be developed to aid students in mathematical development either at a P-12 or postsecondary level.

Mathematical Competency

Mathematical competency has been identified as the key factor that determines whether students will succeed in STEM fields, as mathematical principles form the underlying concepts on which other theories of science, technology, and engineering are based (PKAL 1991). PKAL (1991) depicts mathematics as not only the language to describe science and nature but also, "the archetype of reasoning on which our scientific and technological society is based." PKAL's description suggests that a student must comprehend basic mathematic principles so that more complicated and abstract concepts can be introduced and understood. Select literature cites the lack of mathematical competency among students as a problem of deficient mathematical requirements in schools at the primary and secondary educational levels, which is compounded by teachers who lack adequate mathematical knowledge (Achieve 2004, Kuenzi et al. 2006).

In their report, Kuenzi et al. (2006) cited statistics from the National Association of Educational Progress (NAEP) to demonstrate that levels of mathematics proficiency continually decrease from 4^{th} to 12^{th} grade, wherein 36% of 4^{th} graders had achieved a level of "proficient" or above in mathematics, compared to 30% in 8^{th} grade and just 17% in 12^{th} grade.[1] Furthermore, according to a report by Achieve, Inc. (2004), only approximately 32% of high school graduates have completed the necessary coursework to be successful in college. This low level of competency is evidenced by the fact that approximately 22% of students are required to take a math remediation course upon entering college (Kuenzi et al. 2006).

The literature recognizes the problem of college preparedness as a disjointed effort between the P-12 mathematics curriculum and the high concentration of P-12 teachers who lack adequate knowledge needed to teach math (Achieve 2004, Astin 1993). P-12 mathematics curricula historically have been set forth by the local school boards, in which the board forms a curriculum based on national and state standards. The resulting curriculum may or may not require students to complete college preparatory mathematics courses (Achieve 2004; Dossey 2008). Although 42 states define a mathematics curriculum required for high school graduation, most states only require a number of mathematics classes to be completed for graduation and do not require a specific set of courses (Achieve 2004). Furthermore, only three states require students to take the recommended Algebra I-Geometry-Algebra II courses, which are considered the minimum courses required for a student to be prepared for college (Achieve 2004).

In regards to teacher knowledge, the literature suggests a complementary problem to that of mathematical competency among students. Mathematics teachers are less likely to have either a major or minor in mathematics at the primary level than they are at the secondary teaching

[1] The National Assessment Governing Board recognizes the level of proficient as what should be reached by all students and describes this level of understanding as one where the student has "demonstrated competency over challenging subject matter."

level. In the 2000 National Survey of Science and Mathematics Education, Weiss et al. (2001) surveyed approximately 5,700 teachers across the United States and found that among P-5 teachers who teach mathematics, less than 2% held a degree in mathematics or mathematics education or had taken the number of courses required for a minor. The percentage increases to 16% for grades 6-8, however. Approximately 63% of teachers at the middle grades level have taken at least 8 semesters of mathematics courses, which generally qualifies as a minor in the subject. For teachers of secondary education, Weiss et al. determined that 80% of mathematics teachers have a degree in mathematics or mathematics education and approximately 95% of teachers have completed the required course work for a minor. Kuenzi et al. (2006) noted that the statistics of math teachers' educational level seem to correlate with student performance, suggesting that the low mathematics proficiency among fourth graders may stem from inadequate instruction by elementary teachers lacking mathematics degrees. Because of the cumulative nature of mathematics comprehension and mastery, students' mathematics competency may conceivably depreciate over time as more advanced concepts are taught, despite having a more qualified teacher. Therefore, students who are not required to take a college preparatory mathematics courses will more likely defect from doing so which leaves only 32% of graduating high school students who have taken the proper high school courses to apply to college (Kuenzi et al. 2006).

3. Overview of Statewide STEM Programs

A Web survey and assessment was conducted to gauge the status of state-level programs to enhance STEM education. Overall, the literature review revealed multiple studies on STEM education at the institutional level and the programmatic efforts utilized to address attrition of STEM majors and enhance education of pre-service P-12 STEM teachers. However, the scholarly literature frequently overlooked STEM education and preparation at the system level (i.e. state level).

An assessment of STEM education at the national level reveals 43 statewide STEM initiatives in 42 states, each with various objectives and scope.[2] The remaining eight states lack any specific initiative pertaining to STEM education. Of the 42 states with initiatives, 12 of them were identified as possessing an initiative that focused solely on P-12 STEM education through the Department of Education, Governor's Office, Department of Higher Education, Board of Regents, or a Non-Profit. The remaining 30 states focused more broadly on P-16 STEM education. For the states possessing an initiative with a postsecondary component, the origin of each initiative depends on the state, but they often receive support from the U.S. Department of Education or their respective governor's offices or university systems. Several also receive support from non-profit entities. (See Table II.)

[2] California has two distinct initiatives.

Table II. Origin of P-16 STEM Initiatives (N=30)

	Depts. of Education	Governor's Office 26.6%	Department of Higher Education 16.6%	Board of Regents 13.5%	Non Profit 13.3%	Other
Arkansas		X				
California					X	
Colorado		X				
Florida					X	
Georgia				X		
Hawaii		X				
Idaho	X					
Illinois						
Indiana	X					
Iowa (New)		X				
Louisiana				X		
Maine						
Maryland			X			
Massachusetts			X			
Michigan					X	
Missouri			X			Chamber of Commerce and Industry
Nebraska	X	X				
New Hampshire						
New York						
Ohio				X		Ohio Business Round Table
Pennsylvania	X	X				
Rhode Island		X				
Tennessee	X		X	X		
Texas						Texas Education Agency
Utah						
Vermont						
Virginia		X				
Washington					X	
West Virginia			X			
Wisconsin						

The most common goals proposed by P-16 STEM initiatives include increasing STEM competency among students, ensuring STEM college and career readiness, increasing the success and diversity of STEM majors in college, producing additional and better prepared P-12 STEM teachers, shaping policy to advocate for STEM education, and building a STEM network to disseminate information. The initiatives that contain a focus on higher education also often utilize one or more of three strategies: 1) utilizing programmatic efforts to institute or develop a set of best practices in STEM among institutions in the state, 2) developing regional STEM centers to coordinate STEM activities, or 3) acting as a clearinghouse for information dissemination. (See Table III.)

Table III. Strategies of P-16 STEM Initiatives

	Best Practices	Regional STEM Centers	Clearinghouse
Arkansas		N/A	
California	X	X	X
Colorado		X	X
Florida			X
Georgia	X		
Hawaii			X
Idaho			X
Illinois	X		
Indiana	X		X
Iowa	X		
Louisiana	X		
Maine	X		X
Maryland	X		
Massachusetts	X	X	
Michigan	X		X
Missouri	X		
Nebraska	X		
New Hampshire	X		
New York	X		
Ohio	X	X	X
Pennsylvania	X	X	
Rhode Island	X		
Tennessee	X		
Texas	X	X	X
Utah	X		
Vermont	X		
Virginia	X		
Washington	X		X
West Virginia			X
Wisconsin	X		X

The use of programmatic efforts in STEM initiatives to determine and implement a set of best practices has been observed as the most prevalent trend among STEM initiatives in higher education. Toward this end, statewide STEM initiatives frequently attempt to improve STEM preparedness for students at the P-12 and postsecondary levels. Among P-12 students, the objective of such programs centers on preparing students for entry into postsecondary STEM education, while efforts directed toward postsecondary students focuses on preparation for STEM careers.

Initiatives focusing on P-12 STEM preparation for college commonly employ programs to bridge P-16 STEM efforts by partnering school systems with postsecondary institutions to raise STEM awareness or enhance education among institutions. One example of a P-16 bridge program includes the 2011 ExxonMobil Bernard Harris Summer Science Camp, sponsored by Texas's T-STEM initiative, which allows students in grades 5-8 to be exposed to various STEM activities at Texas Tech University. Another is Fostering our Community's Understanding of Science (FOCUS), a program originally launched at the University of Georgia to enable STEM majors to assist in teaching K-5 science at local schools. Established as part of the Georgia Partnership for Reform in Science and Mathematics (PRISM) and continued in the USG STEM Initiative, the FOCUS program has since been deployed at a number of colleges and universities at Georgia, demonstrating how an institutional program may be expanded into a statewide effort.

Initiatives focusing on STEM preparedness of postsecondary students often aim to increase fluidity for students into STEM careers or STEM education careers. These initiatives typically commission postsecondary institutions to create an institution-led STEM program that implements a system of best practices and that supports statewide goals either to increase the number of STEM majors or pre-service STEM teachers or to prepare the STEM workforce. These institutional programs are often funded by grants from the state initiative or obtained from external sources. Programs generally focus on the recruitment and retention of STEM majors and pre-service STEM teachers.

An example of an initiative employing programmatic efforts to both increase fluidity in P-16 education can be seen in the University System of Maryland's STEM and Competitiveness Initiative. Under this effort, University System of Maryland (USM) began an initiative to increase the number of pre-service STEM teachers at USM institutions who find employment in Maryland, to enhance the quality of P-12 STEM education, and to utilize higher education to promote business development in STEM areas. With funding from NSF, the USM began an effort to bridge P-16 STEM education by forming partnerships between secondary and postsecondary institutions. This collaborative effort worked to create professional development programs for secondary STEM teachers, begin a dual enrollment program for science courses at select USM universities, and develop the INSPIRES curriculum for teaching engineering in secondary institutions. Other comparable postsecondary STEM initiatives utilize mentor programs, summer bridge programs, STEM workshops, and undergraduate research in an effort to recruit and retain both STEM students and pre-service STEM teachers.

The use of regional centers within state-level STEM initiatives is another approach to enhancing STEM education. In this arrangement, the state initiative is divided into regions, each tailored to the students in the particular region. Universities in the region are able to provide support to surrounding P-12 schools, as well as bridge P-16 STEM education, by offering programs such as professional development for P-12 STEM teachers, STEM-themed camps for P-12 students, and other STEM-related conferences. Initiatives containing regional centers often utilize information dissemination at the statewide level to allow all regional centers a centralized information source for the happenings in STEM education statewide.

The T-STEM initiative in Texas and the Ohio STEM Learning Network (OSLN) are key examples of initiatives utilizing regional centers to coordinate local P-16 STEM practices and provide statewide information dissemination. Both the OSLN and T-STEM initiative are divided into seven regions, each of which coordinates various STEM activities tailored to the students of the region. The T-STEM regional centers are managed by various postsecondary institutions that coordinate with P-12 schools to offer professional development to in-service teachers, STEM summer camps for P-12 students, and information on P-12 STEM opportunities. Within the OSLN, regional centers act as individual organizations that facilitate partnerships between P-12 schools, postsecondary institutions, and surrounding businesses. The focus of the OSLN regional centers mirrors that of the T-STEM regional centers, wherein the partnerships between P-12 and postsecondary institutions are used to coordinate professional development and P-12 STEM education enhancement.

The overall breadth of each statewide program seems to depend on the actual level of funding the program receives, which is obtained from various national, state, and private funding (see Tables IV and IVa). The most common funding sources include NSF, Bill and Melinda Gates Foundation, National Governor's Association (NGA), and various state departments or agencies. Total funding for the various STEM initiatives varies widely, from $500,000 to $250 million. STEM initiatives with relatively smaller amounts of funding, typically between $500,000 and $2 million, frequently demonstrated very little activity, as suggested informally by the apparent lack of updates on project websites. However, initiatives with increased funding were found to be very active, with up-to-date websites that contained large amounts of information about the current activities of the initiative.

Table IV. Funding Information for P-16 STEM Initiatives

State	Funding Amount	Funding Timeframe	Funding Sources
Arkansas*	$2.6 million		AT&T, Dept. of Career Education, Dept. of Education, Dept. Workforce Services, Dept. of Higher Education
California	$2-3 million	Per year	Bill & Melinda Gates Foundation, S.D. Bechtel Jr. Foundation, Corporation for Education Network Initiatives in California
Colorado	$500,000	2007-2009	National Governor's Association
Florida	$759,528 $2.3 million	3 years 5 years	Corporation for National and Community Service (CNCS), Federal TRIO Grant
Georgia			Board of Regents
Hawaii	$500,000	2007-2009	National Governor's Association
Idaho			NSF, Idaho EPSCoR
Illinois			
Indiana			Indiana Dept. of Education, Lumina, Lilly Endowment Inc., BioCrossroads, The Children's Museum
Iowa			

Louisiana			NSF, Louisiana Board of Regents
Maine			NSF, Maine EPSCoR
Maryland			NSF, Department of Education
Massachusetts	$250 million	4 years	Race to the Top
Michigan			
Missouri	$4 million		State and Private funding
Nebraska			NE Governor's Office, NE Department of Education, University of NE, EducationQuest Foundation
New Hampshire			
New York			State Funding
Ohio	$50 million		Bill & Melinda Gates Foundation, Battelle Center, Ohio Business Roundtable
Pennsylvania	$1 million	2007-2009	National Governor’s Association, Dept. of Education, Dept. Labor & Industry, Dept. Community and Econ Development, Wall Street West, Nat’l Girls Collaborative Project, AT&T
Rhode Island	$6 million		State and Federal Funding (to build STEM Learning Center only)
Tennessee	$7 million	2008-2014	US Department of Education, TN Department of Education , Tennessee Board of Regents, TN Board of Education, Tennessee Higher Education Commission, NASA, National Science Foundation, Texas Instruments, Mind 2 Marketplace
Texas	$20 million	2010-2011	Texas Education Agency, Bill & Melinda Gates Foundation, Michael & Susan Dell Foundation, National Instruments, State, Communities of Foundation of Texas
Utah			
Vermont			
Virginia	$500,000	2007-2009	National Governor’s Association
Washington	$10 million	2011-2016	Boeing Company, Bill & Melinda Gates Foundation, Fluke Corporation, JP Morgan Chase, McKinstry, Microsoft, Safeco
West Virginia			NSF, EPSCoR, West Virginia Higher Education Policy Commission
Wisconsin			

Table IVa. Funding Information for P-16 STEM Initiatives Disaggregated[3]

	Public	Total:	Nonprofits	Total:	Private	Total:	Primary Funding
Arkansas	Dept. of Career Education, Dept. of Education, Dept. of Workforce Services, Dept. of Higher Education	4		0	AT&T	1	Public
California		0	Bill and Melinda Gates Foundation, S.D. Bechtel Jr. Foundation,	2	Corporation for Education Network Initiatives in California	1	NGO
Colorado		0	National Governor's Association	1		0	NGO
Florida	Corporation for National and Community Service (CNCS), Federal TRIO Grant	2		0		0	Public
Georgia	Board of Regents	1		0		0	Public
Hawaii			National Governor's Association	1		0	NGO
Idaho	NSF, Idaho EPSCoR	2					Public

[3] The primary funding sources for the P-16 STEM initiatives include public, nonprofit, and private organizations. The public funding sources generated the most funding for the states. In the public arena the National Science Foundation (NSF) contributed to funding in Louisiana, Maine, Maryland, Idaho, Tennessee, and West Virginia. In the nonprofit category the National Governors Association (NGA) and the Bill and Melinda Gates Foundation contributed to the funding of P-16 STEM initiatives. The NGA focused on Colorado, Hawaii, Pennsylvania, and Virginia while the Bill and Melinda Gates Foundation focused on California, Ohio, Texas, and Washington. The public, nonprofit, and private organizations play a pivotal role in sustaining P-12 STEM initiative enhancement.

Illinois		0		0		0	
Indiana	Indiana Dept. of Education	1			Lumina, Lilly Endowment Inc., **BioCrossroads**, **The Children's Museum**	4	Private
Iowa		0		0		0	
Louisiana	NSF, Louisiana Board of Regents	2		0		0	Public
Maine	NSF, Maine EPSCoR	2		0		0	Public
Maryland	NSF, Department of Education	2		0		0	Public
Massachusetts	U.S. Department of Education	1		0		0	Public
Michigan		0		0		0	
Missouri	State and Private funding[4]	1		0	State and Private funding	1	Public and Private
Nebraska	NE Governor's Office, NE Department of Education, University of NE	3	EducationQuest Foundation	1		0	Public
New Hampshire		0		0		0	
New York	State Funding	1		0		0	Public
Ohio	Battelle Center	1	Bill & Melinda Gates Foundation	1	Ohio Business Roundtable	1	Public, NGO, Private
Pennsylvania	Dept. of Education, Dept. Labor & Industry, Dept. Community and Econ Development, Nat'l Girls	3	National Governor's Association, Wall Street West,	2	AT&T	1	Public

[4] At the time of the Web survey, specific funding sources for Missouri's initiative were undisclosed, identified only as state and private funds. Other states (New York, Rhode Island, and Texas) had similar issues.

	Collaborative Project						
Rhode Island	State and Federal Funding	1		0		0	Public
Tennessee	US Department of Education, TN Department of Education , Tennessee Board of Regents, TN Board of Education, Tennessee Higher Education Commission, NASA, National Science Foundation,	7		0	Texas Instruments, Mind 2 Marketplace	2	Public
Texas	Texas Education Agency, State	2	Bill & Melinda Gates Foundation, Michael & Susan Dell Foundation, Communitie s of Foundation of Texas	3	National Instruments	1	NGO
Utah		0		0		0	
Vermont		0		0		0	
Virginia		0	National Governor's Association	1		0	NGO
Washington		0	Bill & Melinda Gates Foundation	1	Boeing Company, Fluke Corporation, JP Morgan Chase, McKinstry, Microsoft, Safeco	6	Private
West Virginia	NSF, EPSCoR,	3		0		0	Public

West Virginia Higher Education Policy Commission			
Wisconsin	0	0	0
Totals	39	13	18
Percentage Totals	**55.7%**	**18.6%**	**25.7%**

4. Programmatic Efforts of Statewide STEM Initiatives

As evidenced in both the literature and complementary survey of statewide STEM initiatives, current efforts to enhance STEM education have focused on decreasing attrition among STEM majors and enhancing the preparation of pre-service P-12 teachers (Daempfle 2003, Eagen et al. 2010, Fones et al. 1999, Gilmer 2007, Seymour 2001). Essentially, observed attempts to reduce the attrition of STEM majors and enhance the education of pre-service teachers focus on the implementation of a set of best practices identified in the literature. While the set of employed programs observed in the survey of statewide STEM programs correlates to those programs seen in the literature, the literature documents the results of STEM programmatic interventions and typically consists of studies which are *small in population size, limited to the results of one school, and do not offer comparative data with other similar programs*. Thus, although statewide STEM efforts might not seem comparable to those smaller institutional efforts observed in the literature, it must be kept in mind that statewide initiatives with a focus on STEM preparedness of postsecondary students and pre-service teachers often commission postsecondary institutions to create institution-run STEM programs, comparable to those seen in the literature.

Common programmatic efforts employed by statewide STEM initiatives includes summer bridge programs, learning communities, peer instruction or tutoring, mentoring, undergraduate research or internships, instructional technology, scholarships, and educator preparation (See Table IV). Essentially this list of programmatic efforts can be classified under two categories: efforts to enhance content knowledge (includes summer bridge programs, peer instruction and tutoring, undergraduate research or internships, instructional technology, scholarships, and educator preparation) and efforts to increase the socialization of students (includes learning communities and mentoring).

In effect both those programs used to bridge content knowledge, as well as those utilized to enhance socialization, align with the theories set forth by Astin in his study of attrition among postsecondary students (1984). In his study of student engagement, wherein a student's educational performance and likelihood of attrition correlates with the qualitative and quantitative aspects of a student's engagement in their education, Astin determined that increased student engagement decreased the likelihood of attrition (1984). In STEM fields, Astin determined that higher levels of mathematics competency in conjunction with increased student engagement caused a reduction of attrition (1993). Essentially all programmatic efforts employed by institutions directly increase the quantitative aspect of student engagement (i.e. amount of time studying or amount of time in campus activities), while the qualitative aspect (i.e.

actual comprehension of material) is typically dependent on the student. Nonetheless, Astin's study demonstrated that students were more likely to persist in or be recruited to STEM majors if there was an increased opportunity for involvement (1984). The results of decreased attrition posed by Astin's student involvement study (1984) were also seen in many of the literature examples, wherein many programs in the literature describe decreased levels of attrition among those STEM majors who participate in programmatic efforts.

In the survey of statewide STEM initiative websites, it was observed that those initiatives which involve postsecondary institutions often call upon those institutions to establish institutional level STEM initiatives. Thus, for many programs the details for which programmatic efforts were being utilized by the initiative had to be gleaned from information provided by each individual institution in the state's STEM initiative. For this reason, wherein STEM initiatives appear to be a compilation of projects established at the institution level, it was considered acceptable to compare the programs instituted by the initiatives with to those seen in the literature. However in the literature, such programs are often portrayed as a collective effort and no distinction can made between the individual programs. For example, summer bridge programs are often tied to learning communities and scholarship opportunities. Nonetheless, the collective programmatic efforts described in the literature is most likely the manner in which programmatic efforts are being employed by postsecondary institutions under statewide STEM initiatives due to the observed use of multiple programmatic efforts by each state STEM initiative (Table V). The following subsections describe the main programmatic efforts seen in the literature and the overall results for these programs.

Table V. Programs Utilized in State STEM Initiatives

State	Summer Bridge	Learning Communities	Peer Instruction/Tutoring	Mentoring	Undergraduate Research	Instructional Technology	Scholarships	Educator Prep
Arkansas				N/A				
California								X
Colorado			X					X
Florida				N/A				
Georgia	X	X	X	X	X	X	X	X
Hawaii	X	X	X		X		X	
Idaho				X	X	X	X	
Illinois					X		X	X
Indiana								X
Iowa	X							
Louisiana	X		X	X	X		X	
Maine					X			
Maryland	X	X	X	X	X		X	X
Massachusetts		X	X	X		X	X	X
Michigan					X			X
Missouri						X		X
Nebraska				N/A				
New Hampshire				N/A				
New York			X	X	X	X	X	
Ohio	X	X	X	X	X		X	X
Pennsylvania				N/A				
Rhode Island							X	X
Tennessee	X		X		X	X	X	X
Texas		X				X		X
Utah								X
Vermont				N/A				
Virginia				N/A				
Washington	X							X
West Virginia					X		X	
Wisconsin					X		X	X

Summer Bridge Programs

When considering programmatic intervention for the retention of STEM students at the postsecondary level, the literature cites the transition between secondary and postsecondary education as a substantial leak in the pipeline. Consequently, multiple programmatic efforts focus on mitigating attrition at this point (Astin 1984, Seymour 2001). The main concern addressed by transition-focused efforts is deficient content knowledge among STEM students. In attempting remediation efforts, many case studies present a combination of programs, such as a summer bridge program and learning communities to both allow for more student involvement while addressing the students' level of mathematical content knowledge (Russomanno et al. 2010). In the literature, summer bridge programs are described as programs where incoming freshmen choose to take a pre-college class, are placed into learning communities, exposed to college coursework in the form of mathematics refresher courses, and are exposed to various STEM subjects through either a series of lectures or STEM-related excursions (Gilmer 2007, Russomanno et al. 2010, Maton et al. 2000). Bridge programs allow students to become oriented with both the college experience and the level of work required in postsecondary education. Bridge programs are often complemented by learning communities, which provide participating students with an increased sense of involvement, both academically and socially, while in a controlled environment (Russomanno et al. 2010). Furthermore, bridge programs are described as allowing students to make valuable personal connections for future active learning endeavors such as undergraduate research, internships, or mentoring opportunities (Gilmer 2007, Russomanno et al 2010, Maton et al. 2000). Another incentive bridge programs often provide are scholarships that are offered to students upon completion of the program. Most scholarships are only offered to students who choose to complete a STEM degree and remain in good standing as a student, which encourages students to remain the STEM field while lowering a school's attrition rates (Gilmer 2007, Maton et al. 2000).

Examples of the implementation of summer bridge programs discussed in the literature include those at Bowling Green State University (BGSU) (Gilmer 2007), the University of Memphis (Russomanno et al. 2010), and the University of Maryland at Baltimore County (UMBC) (Maton et al. 2000). At each of these universities, the summer bridge program is the initial phase of a series of programmatic efforts used to decrease attrition of STEM majors. Coinciding with the summer bridge phase, each university also places students in learning communities to provide a setting where students are able to collaborate scholarly, but also participate in a mentor-led support system to foster student involvement and allow students to become familiar with the STEM environment (Russomanno et al. 2010).

The summer bridge programs including the Academic Investment in Math and Science (AIMS) program at BGSU, the MemphiSTEP program at the University of Memphis, and the Meyerhoff Scholars Program at UMBC are similar in that the bridge program is only the primary phase of the STEM retention effort (Gilmer 2007, Russomanno et al. 2010). All programs include subsequent second freshman/sophomore and third junior/senior phases as continuations of the primary summer bridge effort. In the second and third phases of each program, students are again placed in learning communities, given either a student or faculty mentor, and asked to attend weekly seminars relating to various STEM topics.

These studies are not without their limitations, however. While all programs maintain that their efforts have instigated increased STEM student retention it is difficult to conclude actual results due primarily to the low population size employed in each of the studies. Gilmer's (2007) study of the AIMS program at BGSU only followed the progress of 88 students over five years. Russomanno et al. (2010) used data from 48 students over the course of one year, and data utilized by Maton et al. (2000) followed 128 students over three years. Nonetheless, each study illustrated increased student performance among STEM students in these programs, as well as increased GPA and student satisfaction.

In his study of the AIMS program, Gilmer determined that those students involved in the AIMS summer bridge program often outperformed the control group, wherein approximately 76% of AIMS students were found to have a grade distribution of C or better in their first semester mathematics courses, compared to only 46% of BGSU control students (students with the same academic profiles and demographics as AIMS students; it must also be mentioned that the population size of the control group was never disclosed). However, Gilmer also determined from student interviews that students were better able to prepare for the first semester of STEM education by being involved in a supportive learning community, reviewing basic mathematics, and by being exposed to the type of coursework required in postsecondary education. Overall, the AIMS program was determined to have a positive effect on retention of STEM students at BGSU. Approximately 89% of AIMS students were retained in STEM disciplines after seven semesters compared to that of 72% of the control students (retention for the control group is for BGSU only; no data was collected specifically for STEM).

Due to the fact the study by Russomanno et al. (2010) only presents the findings of the primary year of a five year study, the data from the MemphiSTEP program by was only able to offer outcomes based on the mathematics portion of the summer bridge program as well as student interviews. Thus, the study by Russomanno et al. stated the summer bridge was able to increase students' algebra scores by 15% and trigonometry by 14% based on a pre- and post-boot camp achievement test. Furthermore, based on student interviews, over 75% of students believe that the boot camp not only improved their math skills but also prepared them for college by allowing them to feel more confident about math. Nonetheless, no definitive data was gathered in regards to retention rates among STEM students.

The study by Maton et al. (2000) analyzed retention rates of 93 Meyerhoff Scholars compared to those of 35 students who declined to enter the Meyerhoff Scholars Program. Overall the study determined that Meyerhoff Scholars were twice more likely to remain and graduate in a STEM field than that of the control group, with approximately 83% of Meyerhoff Scholars graduating in a STEM discipline compared to only approximately 46% of the control group. Furthermore, students in the Meyerhoff Scholars Program maintained a GPA approximately .27 points higher than the control group in STEM classes. The final measure of success by Maton et al. was portrayed by the data portraying Meyerhoff Scholars being approximately five times as likely to pursue a graduate degree in a STEM field. Multiple student interviews seemed to confirm the program success portrayed by Maton et al. by iterating that the sense of community in the program as well as the summer bridge program was key aspects of academic success. Furthermore, students indicated that the scholarships given to Meyerhoff Scholars acted as a further incentive to succeed by giving students “incentive to pay back the community and to avoid failure.”

Active Learning and Learning Communities

Another key tactic in the literature dealing with retention of STEM students was that of active learning opportunities (Lam et al. 1997, Budny et al. 2010, Yelamarthi et al. 2010). This idea is not particularly novel, as the classic PKAL report (1991) also touted active learning as a possible solution to many of the problems students face in their first and second year at a postsecondary institution. The report by PKAL describes introductory STEM courses as, inaccessible, lacking connection, and a “test of perseverance.” Of particular concern was the emphasis placed on rote memorization of technical details in exam-oriented curricula. Instead, PKAL called for a paradigm shift in STEM education from that of standard passive teaching techniques, such as lecturing and requiring direct memorization, to that of a collaborative learning environment. Furthermore, PKAL recommended that STEM learning be a continual investigation of topics where interdisciplinary connections can be made, and that STEM education reflect the STEM career environment wherein knowledge is “constructed” by classroom investigation is supported by a community. In this sense, the scientific community is described by the PKAL as “a perpetual feedback between the individual scientist and disciplinary community that is connected to the larger community that we call culture.” In the literature, solutions to increase active learning in the classrooms were often presented in three categories: active learning as employed by learning communities, classroom technology, or participation in undergraduate research.

Primarily, the literature focuses on the idea of learning communities as a form of active learning, like those introduced in summer bridge programs. The literature often highlights learning communities as an effort to support collaborative learning and serving the dual function of bridging content knowledge through student collaboration in and out of the classroom while fostering a sense of student involvement by providing a “family-like” environment (Budny et al. 2010, Lam et al. 1997). Learning communities, allow students to actively discuss the material taught in class where learning thus becomes a constructive process as students are able to engage in an open discussion of material in a small and supportive environment that is able to foster investigation (PKAL 1991).

Literature examples demonstrating the employment of learning communities as a programmatic effort against STEM attrition can be seen in the study by Lam et al. (1997) of the IDEAs (Increasing Diversity in Engineering Academics) program at the University of Akron, as well as the study by Yelamarthi et al (2010) of the Computer Science, Engineering, and Mathematics Scholarship (CSEMS) program at Wright State University and the study of freshmen students by Budny et al. (2010) at the University of Pittsburgh. In these studies, learning communities are utilized as an educational measure wherein students are able to become part of a community that fosters peer support and mentorship in learning. Overall, each study cited success measured by either program growth, increased GPA or graduation rates, however like that of summer bridge programs, population sizes of each study were generally small and for certain studies there was no control group to measure results against.

In the review of the IDEAs program, Lam et al. (1997) demonstrate the effect of learning communities among minorities in engineering programs at the University of Akron. The IDEAs program focuses on the minority population due to the general high rate of attrition seen among minorities, especially among STEM disciplines (Lam et al 1997). In the IDEAs program, students are placed in learning communities and also in clustered classes so that students are able to collaboratively study for like assignments (Lam et al 1997). Like that of the CSEMS program and program at the University of Pittsburgh, learning communities were led by an upperclassman mentor so as to demonstrate "success by example" while encouraging a "sense of self efficacy" among students (Lam et al 1997). In the study by Lam et al., success of the IDEAs program was measured by the increased retention of program students. Overall, IDEAs program students increased retention from approximately 31% to 74% over four years, which is noted as a significant improvement by Lam et al considering the national rate of retention among minorities in engineering is approximately 50% (1997).

The study by Yelamarthi et al. of the CSEMS program at Wright State University mirrors that of the study by Lam et al. in that both describe learning communities as a programmatic effort against attrition of minorities in STEM education. The study by Yelamarthi et al. however shows learning communities as a result of extracurricular STEM workshops. Thus the CSEMS program forms learning communities among its participants for the purpose of "encouraging students to help themselves through the development of peer support and study networks" (Yelamarthi 2010). Although the population size of the study was only 39 students, Yelamarthi et al. describe the program as successful due to both the high STEM graduation rate, 75%, of CSEMS students as well as the 90% of undergraduate CSEMS students who achieved a GPA of 2.7 or higher compared to that of 63% of traditional undergraduate students. Although the program is described as a success, it should be noted that when declaring the graduation rate of CSEMS students Yelamarthi did compare the percentage to that of a control group, however there was no mention of whether the group was also comprised of minorities or if the control group were also STEM majors. Additionally, when comparing GPA outcomes, Yelamarthi again compares the CSEMS group to that of a control; however, the students of the control group were only described as a group of 95 students not having participated in the CSEMS program. Equally no time specifications were given for the number of semesters the GPA was measured over.

The study by Budny et al. (2010) describes learning communities in combination with a specific introduction to engineering class. In this program, students are encouraged to utilize the learning community as an opportunity to collaborate with other students and the mentors leading the group on projects and activities assigned specifically in the introduction to engineering class. Success in this program was measured by three main factors: the average GPA of students, the percent of students with honors as well as the percent of students who transfer out of the engineering program. Overall, the data supports the addition of learning communities to the introduction to engineering class as a success due to the decreased average number of students who transfer out of engineering, from 10.3% to 9.89%, the increased average number of honors students, from 20.9% to 33.05%, and the increased average GPA, from 2.59 to 2.98.

Additional approaches seen in the literature to garner active learning in STEM classrooms was the use of classroom technology in the form of the personal response systems

(PRS). This system, not unlike that of engaging learning communities in class, allows professors to pose multiple choice questions to students during class. PRS allows for students to actively engage in lectures by having to answer questions, and often times discuss the questions with other students, instead of only having to passively listen to the lecture (Gauci 2009). Furthermore, professors are able to know what concepts need more attention from response results. Results from Gauci's study reveal that students not only felt "more engaged" in lectures, but that students also improved test results compared to that of previous years (2009).

The final method of active learning discussed in the literature was that of undergraduate research. In the literature, undergraduate research was identified as one of the leading ways for a student in a STEM field to participate in investigative learning, and had the benefit of allowing students to experience the research community (Eagen et al. 2010, PKAL 1991). However, the literature only evaluates undergraduate research as a programmatic effort against STEM attrition in conjunction with other programs (Gilmer 2007, Russomanno 2010, Yelamarthi 2010). Nonetheless, even when bundled with other programs aimed at decreasing attrition, undergraduate research is seen as a vital component to allow not only student engagement by offering mentorship of the student by faculty but also an environment to foster active learning by hands on experience (Astin 1993, Gilmer 2007, Russomanno 2010).

Educator Preparation

According to Astin's (1993) study, the low level of mathematics and science competency among secondary students in the United States is recognized as the foundational source for the leaks in STEM pipeline. The lack of academic competency students possess, primarily at the secondary level of education, accounts for both of the two major leaks in the STEM pipeline, wherein students defect from STEM education following high school graduation and during the first year of postsecondary education due to a lack of academic competency (Astin 1993). It is at this juncture that Astin's findings (1993) coincide with the findings by Weiss et al. (2001) and Kuenzi et al. (2006) wherein the mathematics and science competency levels of primary and secondary students are seen to diminish throughout their educational endeavor. Findings by Weiss et al. (2001) and Kuenzi et al. (2006) also demonstrated a significant lack of STEM teacher knowledge, especially at the primary level of education. From these findings, Kuenzi (2006) extrapolated that low proficiency levels, especially among primary school students correlate directly to the teacher's level of STEM education.

While multiple pieces of literature acknowledge the need for better STEM teacher preparation (Seymour 2001, Astin 1993, Otero 2006, Kuenzi 2008), there are not many examples in literature of measures being taken to improve STEM teacher preparation. Nonetheless, Examples of innovation among education of pre-service STEM teachers can be seen both at Colorado State University and Clemson University.

Colorado State University (CSU) has employed two distinct programs in the effort to better prepare pre-service teachers. The primary effort utilized at CSU is that of the university's engineering education degree (Staff 2007). In order to obtain this degree, pre-service teachers must first earn a bachelor's degree in engineering before obtaining a teaching certificate. Another program employed by the university is that of the Learning Assistants (Otero et al.

2006). In the Learning Assistants Model, STEM students are utilized to help faculty modify classroom environments by making them more interactive. Furthermore, after this experience, learning assistants are recruited to become P-12 STEM teachers (Otero et al. 2006). Although the population size of this program is small, 11 of the 50 employed learning assistants have begun or completed teacher certification programs in biology, physics or astrophysics from 2004 to 2005, thus increasing the original population of three nonparticipating assistant students completing their certifications in the state of Colorado.

The study by Fones et al. (1999) illustrates the measures being taken to increase science knowledge among pre-service early childhood education and special education majors at Clemson University. Prior to the study, early childhood and special education majors were typically seen to complete their science requirements with two semesters of biology and one of either geology or astronomy (Fones et al. 1999). Clemson however recognized that these teachers would be expected to teach topics from other life and physical sciences despite the lack of exposure students of these majors may have (Fones et al. 1999). Science classes for early childhood and special education majors were thus restructured to contain an inquiry based, three semester science course consisting of topics earth, physical, and life sciences (Fones et al 1999). Clemson University then experimented with these classes by offering one section of the class as the traditional lecture/lab course, where the two portions of the course were taught on different days and by different instructors, and the other as an integrated lab plus lecture course, where students explore all material entirely in the lab (Fones et al 1999).

5. Comparative Analysis

Overall, the objective of the University System of Georgia's (USG) STEM initiative is to determine and implement a series of best practices in STEM education with the intent of improving P-16 STEM education by improving student readiness, increasing enrollment in degree programs, and improving STEM degree completion rates and P-12 STEM teacher preparation. The USG STEM Initiative utilizes an array of programs implemented at participating institutions, such as the Academy for Future Teachers, which recruits high school students to pursue careers in STEM teaching; MESA (Mathematics, Engineering, Science Achievement), which offers a comprehensive STEM experience (including learning communities) for students attending participating two-year colleges; and FOCUS (Fostering Our Community's Understanding of Science), a program developed at the University of Georgia and deployed at other colleges and universities in which pre-service STEM teachers aid in teaching science in the surrounding elementary schools. The seven schools in the initiative not only employ the aforementioned programs, but they also have distinct plans to enhance STEM education and education for pre-service STEM teachers, including a comprehensive four-year undergraduate research experience at one institution and targeted mini-grant programs at other participant institutions.

Although an Internet-based survey revealed thirty states with a STEM initiative containing a concentration on P-16 or postsecondary institutions, only eleven initiatives were found to show comparability to USG STEM Initiative. Overall, factors contributing to comparability were: 1) goals of the initiative (e.g. focus on recruitment and retention of STEM majors and pre-service P-12 STEM teachers), 2) activity of initiative (e.g. initiatives appearing to be inactive were not included), and 3) implementation of the initiative (e.g. use of programmatic efforts to determine and implement a set of best practices and range of best practices utilized). (See Table V, Table VI, and Appendix A.) Overall, the survey of statewide STEM initiatives revealed ten initiatives with comparability to the USG initiative, including the initiatives of California, Colorado, Idaho, Maryland, Massachusetts, New York, Ohio, Pennsylvania, Texas, and Washington (for a description of each initiative see Appendix A). Essentially each of these initiatives demonstrates either similar goals or implementation practices to that of the USG initiative and thus an assessment of these efforts is likely to offer practical information.

Overall, one of the tactics utilized by certain comparable initiatives, such as Maryland, Ohio and Massachusetts[5], was the use of a committee to research the direction of STEM fields and education in the state. In the reports put forth by Maryland, Ohio and Massachusetts, the research illustrates the current state of STEM students and education in the state, the future drive toward STEM fields in the state's workforce, and recommendations for future efforts in STEM education. The recommendations also provide tangible benchmarks for each state. For example, in the report produced by the Massachusetts Governor's STEM Advisory Council, one of the five goals was to increase student interest in STEM. The report then proposes that this goal can be measured through the use of the SAT (both tests I and II) Registration Questionnaire. Furthermore, the report gives data as to the current levels of interest measured through the SAT Questionnaire and proposes to increase those levels by 35% by 2016 (Massachusetts Governor's STEM Advisory Council 2010). Reports, such as those produced by Maryland and Massachusetts allow the state to assess the initial state of STEM education in the state and allow for a baseline upon which goals and benchmarks can be made.

Of the ten initiatives comparable to that of the USG, The Ohio Stem Learning Network and the Texas T-STEM initiative were determined to be the two most comprehensive. Essentially these initiatives, both of which focus on P-16 STEM education, appear to have the most extensive initiative in terms of programs implemented, schools involved, and overall activity of the initiative. The amount of funding and funding sources for these initiatives is also a key factor of these programs. Both programs receive funding from a variety of sources; however the main initial investors for these projects were nonprofit organizations, notably the Bill and Melinda Gates Foundation provided funds for the inception of both initiatives. Through their investors, the Ohio STEM learning network has secured over $50 million in funding since its inception while the Texas T-STEM initiative has secured over $120 million.

Despite the levels of funding, which provide the Ohio and Texas initiates with multiple resources, a second key successful factor is the organization of the initiatives. Overall, the organization of both initiatives is similar, wherein each initiative employs a set of regional centers that then manage STEM efforts for that area. The statewide STEM initiative then acts as site for information dissemination for all STEM related information, including information provided by the regional centers such as information on best practices or STEM programs. Thus, the regional centers, which normally encompass primary, secondary, and postsecondary STEM programs for a particular area, are then able to more directly affect the surrounding area by catering to the STEM needs for the region, which may be very diverse from other regions. The

[5] Kentucky has also performed an assessment of STEM education and produced a report with recommendations.

STEM initiatives of California, Colorado, Massachusetts, and Pennsylvania also operate with the use of regional centers.

Table VI. Comparability of STEM Initiatives

State	Goals			Activity		Implementation			Comparable?
	Ensure STEM College and Career Readiness	Increase Success of STEM Majors in College	Increase number and quality of P-12 STEM Teachers	Active?	Program Scope Notes	Best Practices	Regional Centers	Clearinghouse	
Arkansas				Recently Announced					
California	X			Active		X	X	X	X
Colorado				Active			X	X	X
Florida				Active				X	
Hawaii				Unknown				X	
Idaho		X		Active				X	X
Illinois			X	Active	UI- Urbana Only	X			
Indiana	X			Active		X		X	
Iowa	X		X	Unknown		X			
Louisiana				Active	LSU Only	X			
Maine		X		Active		X		X	
Maryland	X	X	X	Active		X			X
Massachusetts	X	X		Active		X	X		X
Michigan				Active		X		X	
Missouri	X		X	Active		X			
Nebraska	X	X		Active	Education Initiative, not just STEM	X			
New Hampshire				Not Active		X			
New York		X		Active		X			X
Ohio	X			Active		X	X	X	X
Pennsylvania	X	X	X	Active		X	X		X
Rhode Island			X	Active		X			
Tennessee				Active		X			
Texas	X	X		Active		X	X	X	X
Utah		X	X	Active	Utah State University Only	X			
Vermont				Unknown		X			
Virginia	X			Unknown		X			
Washington	X			Active		X		X	X
West Virginia				Active				X	
Wisconsin				Active		X		X	

6. Challenges

Although numerous states have generated a focus on STEM education by creating initiatives to restore the "leaky" STEM pipeline, all programs seek to meet the state's perceived education needs. An Internet survey revealed that 42 states have started a statewide initiative to improve STEM education (see Appendix B). However, of these 42 states, 12 have limited their initiative to encompass only P-12 education. Furthermore, of the 30 state initiatives with a focus on higher education, many provide only vague details about the actual scope of the initiative or otherwise appear to be inactive. The key barrier to assessing the range and impact of STEM initiatives essentially springs from a lack of information provided by initiative websites. Follow-up telephone interviews or e-mail queries may be deployed next to address this issue by further elaborating on information gathered in this initial Web survey. Thus, a review of STEM initiative websites revealed four essential research gaps among STEM initiatives: 1) level of activity, 2) disclosed details of the program scope, 3) levels of funding, and 4) published results. Essentially, each of the four previously mentioned research gaps: level of activity, disclosed details of the program scope, levels of funding, and published results, are key details needed to help determine whether an initiative has fulfilled its stated objectives or demonstrated some measure of efficacy

In a survey of STEM initiative websites, it was frequently difficult to determine if an initiative is currently active or has gone dormant based on the information provided in the website. Again, telephone interviews will be conducted in the next phase of this research to further address this issue. Essentially, the level of information provided by an initiative as well as the extent of updated information provided served as the basis to determine the level of activity the initiative sustains. Thus, initiative websites with descriptions of STEM initiative goals or plans, recent information on implemented STEM Initiative programs, or even links for recent news updates relating to the initiative, were determined as 'active' initiatives. The websites of the more active initiatives ensure third party observers that STEM resources are being employed properly by giving observers evidence in the form of relevant and recent information. An example of an active STEM website includes that of the Ohio STEM Learning Network (OSLN). The OSLN website is unique among STEM initiatives in that it provides information concerning upcoming events, recent STEM related news stories, and provides regular updates via social media sites such as Facebook and Twitter, further marking it as an exemplar. The only other website comparable to the OSLN in terms of activity is that of the Washington STEM Initiative. Although, Washington's website does not sustain regular news updates, updates are provided in the form of a linked Washington STEM blog which provides information on programs and schools included in the initiative. For those STEM initiative websites that do not sustain regular updates or provide sufficient information concerning the details of the initiative, such as seen in Hawaii, Iowa, Colorado, Maryland, New Hampshire, and Virginia, it is difficult to ascertain if the level of inactivity reflects the completion of the initiative or just a lack of website utilization. The appearance of inactivity on the website reflects poorly on the initiative due to the fact that for many people the website is the only source of information into a state's STEM initiative.

Another problem concerning STEM initiative websites is the level of detail provided. Although some initiatives, such as the Ohio STEM Learning Network, Texas T-STEM Initiative, the New York State CSTEP program and Washington STEM initiative disclose a viable amount of information to adequately describe the direction and scope of the initiative, many initiative websites are vague as to the details, goals, or efforts of the initiative imply that there is a lack of activity or direction for the initiative. Some initiatives, such as Maryland and Massachusetts, are unique and provide a comprehensive report illustrating the state of STEM education and further recommendations for improvement. These reports are detailed and contain data from studies such as student interest in STEM in the state or the number of STEM graduates in the state. However, the corresponding STEM initiatives do not state that the scope of the initiative is based on these benchmarks and recommendations. Therefore it is difficult to ascertain from the website and list of stated goals on the website whether the initiative is actually working to improve STEM education based on the recommendations and benchmarks provided by the initial report or if the initiative has deviated from the provided recommendations.

The majority of initiatives however do not provide a report with baseline information concerning STEM education. Compounding this effort are the often vague goals provided by initiatives. Consider those from the California STEM learning network, which state:

1) Increase interest and competencies among all K-14 California students in STEM disciplines
2) Ensure all California students are college and career ready, without the need for remediation upon graduation from high school, with a greater number of students pursuing STEM-related degrees and careers[6]

They appear to be unquantifiable due to the fact that no benchmark or baseline information has been established for them. Consequently, what determines if the goal has been met? While the goals of the California STEM Learning Network are in line with many other goals put forth by other STEM initiatives; the main question is how these goals will be measured to determine success. Only the Washington STEM Initiative actually provides a ten year benchmark to gauge the progress of their stated goals, which are in line with the California STEM Learning Network's goals. All other initiatives lack information as to the timeline or benchmark for which the goals should be met. Furthermore, some initiatives have instituted programs yet do not have information regarding the implementation. For instance, the California STEM Learning Network states multiple goals for improving the state of STEM education in California through the use of regional alliances, yet the composition of the alliances and programs implemented by the alliances are never mentioned. The lack of information the California STEM Learning Network provides for the use of regional alliances implies that little action has been taken in the actual implementation of this effort. Overall, many initiatives seem to lack a component of measurability for their goals, which is evident in the lack of results STEM initiative websites provide.

Many initiatives lack information as to the details and scope (see Table VII), as well as information about fiscal resources. Our survey found that 17 of the initiatives lack key programmatic details on their websites, while 33 initiatives fail to disclose information about funding (i.e. annual budgets/funding allocations). Although many initiatives provide lists of funding partners, only the Texas T-STEM initiative discloses information as to the total amount funded for the duration of the initiative. All other initiatives only provide partial information as to the amount of funding, funding received by certain investors or the amount of funding

[6] Information obtained from the California STEM Learning Network website http://www.cslnet.org/goals.php

received for instigation of the initiative. The lack of disclosed funding adds to the question of breadth and direction of an initiative. Typically the varying investors in an initiative aid in determining the direction of an initiative. Thus disclosing the levels of funding and funding provided by each investor would allow the public to better understand the initiative.

Table VII. Funding and Programmatic Information for State-Level Initiatives

State	STEM Initiative Name	NOT Provide Fiscal Information[7][8][9]	Lack Program Details[10]
Alabama	Alabama Math, Science and Technology Initiative	1	1
Alabama	none	0	0
Arizona	Arizona STEM Works	1	1
California	California STEM Learning Network	0	0
Colorado	Colorado STEM Network	1	0
Connecticut	none	0	0
Delaware	none	0	0
Florida	Florida Campus Compact STEM Initiative	0	0
Georgia	STEM Initiative	1	0
Hawaii	My STEM Hawaii	0	1
Idaho	Idaho STEM Pipeline	1	0
Illinois	I-STEM	1	0
Indiana	I-STEM	1	0
Iowa	Corridor STEM Initiative	1	0
Kansas	"k-12 only"	1	1
Kentucky	Council of Postsecondary Education had a	1	1

[7] A one indicates a true statement.
[8] A zero indicates a false statement.
[9] Defined as the Annual Funding Amount.
[10] Program Details, for the purpose of this paper, refers to explicitly stated goals.

	STEM Task Force and audited STEM Programs in the state		
Louisiana	LA-STEM	1	0
Maine	Maine STEM Collaborative	1	0
Maryland	USMSTEM and Competitiveness Initiative	1	0
Massachusetts	STEM Pipeline Fund	0	0
Michigan	Initiative Science Outreach	1	0
Minnesota	Minnesota STEM Network	0	0
Mississippi	(7-9 grades only)	1	1
Missouri	Missouri Mathematics and Science Coalition	0	0
Montana	none	1	1
Nebraska	Nebraska's P-16 Initiative	1	0
Nevada	Gathering Genius	1	1
New Hampshire	NH MaST Coalition	1	1
New Jersey	none	1	1
New Mexico	STEM Education Outreach Program	1	1
New York	Collegiate Science and Technology Entry Program	1	0
North Carolina	NC STEM Community	1	1
North Dakota	none	1	1
Ohio	Ohio STEM	0	0
Oklahoma	Oklahoma Career Tech STEM Education	1	1
Oregon	Oregon Pre-Engineering and	1	1

	Applied Science Initiative		
Pennsylvania	PA STEM Initiative	0	0
Rhode Island	Rhode Island STEM Center	0	0
South Carolina	South Carolina's Coalition for Math and Sciences	1	0
South Dakota	None	1	1
Tennessee	Tennessee Mathematics, Science and Technology Education Center	0	0
Texas	T-STEM	0	0
Utah	STEM Education Initiative	1	0
Vermont	Mathematics and Science Grant Program	1	0
Virginia	Governor's STEM Academies	0	0
Washington	Washington STEM	0	0
West Virginia	Science and Research Council	1	0
Wisconsin	WISTEM	1	0
Wyoming	NASA's Summer of Innovation	1	1
Total:		33	17

The critical challenge seen among comparable STEM initiatives is the lack of published results, both on outcomes and efficacy. Many of the comparable STEM initiatives have been in effect for years, yet none have actual published results of their work. Three of the 10 comparable initiatives, the Texas T-STEM Initiative, the Ohio STEM Learning Network, and the New York CSTEP initiative, do mention vague results; however the only actual data illustrates the number of schools funded and the number of students and teachers affected by funded schools[11]. Other results state that Texas students who attend T-STEM high school academies are

[11] Data results were provided by the Ohio STEM Learning Network and the Texas T-STEM Initiative.

more likely to pass the 9th grade Math TAKS assessment and that students in the New York State CSTEP Program are more likely than their peers to graduate and pursue graduate programs.

Overall, a lack of results suggests that initiatives are unsuccessful. Statewide STEM initiatives need to continually evaluate the state of STEM education in regards to the goals provided by the initiatives. This however again leads back to the concern of the lack of baseline data and benchmarks for STEM initiatives. In order to provide results, STEM initiatives need to determine the baseline for the state of STEM education and in turn create benchmarks for which to determine success on the initiative. Without published results the major challenge observed in statewide STEM initiatives appears to be the fact that STEM initiatives are imparting anywhere from \$500,000 to \$250 million but not calculating or disclosing actual results from their efforts. This leaves little justification for funding. Therefore, in order to determine whether statewide STEM initiatives are actually correcting the "leaky" pipeline of STEM education results must be made known.

7. Conclusion and Recommendations

The information produced from an Internet survey of state STEM initiatives brings with it a few recommendations for the EPIR USG STEM Initiative:

1. EPIR should continue to maintain a robust website with current program information, updates and activities. This helps reinforce the idea that the office is actively engaged in STEM activities and helps establish the office as a thought leader nationally.
2. EPIR should contribute to the literature on STEM education by generating articles or trade publication related pieces to convey the range of activities underway in Georgia. Currently, there is a lack of literature relating to statewide STEM efforts, thus publications from EPIR could fill the research gap that exists in this area.
3. EPIR should continually update the results of the USG STEM Initiative. Disclosing the ongoing results of the USG STEM Initiative will again help to establish the office as a leader in STEM education.

Bibliography

Achieve, Inc. (2004). The Expectations Gap: A 50-State Review of High School Graduation Requirements.

Astin, A. W. (1984). Student Involvement: A Developmental Theory for Higher Education. *Journal of College Student Personnel* 25(4), 207-308.

Astin, A. W., Astin, H. S. (1993). Undergraduate science education: The impact of different college environments on the educational pipeline in the sciences. Los Angeles, CA: Higher Education Research Institute, UCLA.

Blickenstaff, J. C. (2005). Women and science careers: leaky pipeline or gender filter? *Gender & Education* 17(4), 369-386.

Budny, D., Paul, C.A., Newborg, B.B. (2010). Impact of Peer Mentoring on Freshmen Engineering Students. *Journal of STEM Education: Innovations & Research* 11(5/6), 9-24.

Daemfle, P. A. (2003). An Analysis of the High Attrition Rates among First Year College Science, Math and Engineering Majors. *Journal of College Student Retention* 5(1), 37-53.

Dossey, J., Halvorsen, K., McCrone, S. (2008) Mathematics Education in the United States 2008: A Capsule Summary Fact Book. Monterrey, Mexico: The National Council of Teachers of Mathematics, Inc.

Eagen Jr., M. K., Sharkness, J., Hurtado, S., Mosqueda, C. M., Chang M. J. (2010) Engaging Undergraduates in Science Research: Not Just About Faculty Willingness. *Research in Higher Education* 52, 151-177.

Fones, S. W., Wagner, J. R., Caldwell, E. R. (1999). Promoting attitude adjustments in science for preservice elementary teachers. *Journal of College Science* 28(4), 231-236.

Gauci, S. A., Dantas, A. M., Williams, D. A., Kemm, R. E. (2009). Promoting student-centered active learning in lectures with a personal response system. *Advances in Physiology Education.* 33(1), 60.

Gilmer, C. T. (2007). An Understanding of the Improved Grades, Retention and Graduation Rates of STEM Majors at the Academic Investment in Math and Science (AIMS) Program of Bowling Green State University (BGSU). *Journal of STEM Education: Innovations & Research* 8(1/2), 11-21.

Kuenzi, J. J. (2008). Science, Technology, Engineering and Mathematics (STEM) Education: Background, Federal Policy, and Legislative Action. *Congressional Research Service Reports*.

Kuenzi, J. J., Matthew, C. M., Mangan B. F. (2006) Science Technology, Engineering and Mathematics (STEM) Education Issues and Legislative Options. *Congressional Research Service Reports*.

Lam P. C., Doverspike D., Mawasha, P. R. (1997). Increasing Diversity in Engineering Academics (IDEAs): Development of a Program for Improving African American Representation. *Journal of Career Development* 24(1) 55-70.

Massachusetts Governor's STEM Advisory Council. (2010). *A Foundation for the Future: Massachusetts' Plan for Excellence in STEM Education.*

Maton, K. I., Hrabowski III, F. A., Schmitt, C. L. (2000). African American College Students Excelling in Sciences: College and Postcollege Outcomes in the Meyerhoff Scholars Program. *Journal of Research in Science Teaching* 37(7) 629-654.

Otero, V., Finkelstein, N., McCray R., Pollock, S. (2006) Who is responsible for preparing science teachers? *Science* 313 445-446.

Project Kaleidoscope. (1991). What Works: Building Natural Science Communities A Plan for Strengthening Undergraduate Mathematics and Sciences.

Russomanno, D., Best, R., Ivey, S., Haddock, J. R., Franceschetti, D., Hairston, R.J. (2010). MemphiSTEP: A STEM Talent Expansion Program at the University of Memphis. *Journal of STEM Education: Innovations & Research* 11(1/2), 69-81.

Seymour, E. (2001). Tracking the Processes of Change in U.S. Undergraduate Education in Science, Mathematics, Engineering, and Technology. *Science Education* 85(6) 79-105.

Staff. (2007). Classroom Success; CSU program prepares next generation of engineering technology teachers. *Colorado Construction* 10(6), 33.

Weiss, I., Banilower E. R., McMahon K. C., Smith P. S. (2001). *Report of the 2000 National Survey of Science and Mathematics Education.* Chapel Hill, N.C.: Horizon Research, Inc. Available at www.horizon-research.com

Yelamarthi, K., Mawasha, P. R. (2010). A Scholarship Model for Student Recruitment and Retention in STEM Disciplines. *Journal of STEM Education: Innovations and Research* 11(5/6) 64-71.

Acknowledgements

This working paper is a publication of the University System of Georgia's (USG) Office of Educational Access and Success (OEAS), in collaboration with the Georgia Institute of Technology's Center for Advanced Communications Policy (CACP) and Center for 21st Century Universities (CACP). Special acknowledgement is given to Ms. Braden Benson, information analyst for CACP, for her contributions to this publication. Ms. Christina McMillian, graduate research assistant and student at Georgia Tech's School of Public Policy, receives additional acknowledgements for her assistance.

For questions or additional information, please contact Dr. Nathan W. Moon, Associate Director for Research, CACP, at nathan.moon@cacp.gatech.edu or Dr. Paul M.A. Baker, Associate Director, C21U, at pbaker@cc.gatech.edu.

Appendix A: Survey of Comparable STEM Initiatives

California STEM Learning Network (2009 – present)

The California STEM Learning Network is a non-profit organization focusing on the college and career preparedness of K-14 students in STEM fields. The network is organized into multiple regional centers (called regional alliances) which are used to build partnerships among stakeholders and engage students in STEM efforts. The California STEM Learning Network thus utilizes a Core Operations Team to gather information from the various regional alliances and determine and scale a system of best practices while tracking STEM progress in the state. Unfortunately, the California STEM Learning Network only provides the overall strategic plan for STEM in the state. While the use of regional alliances seems to be the core strategy of the statewide plan, no information was provided as to the number of regional alliances in the state, whether the alliances were presently active, or what entities compose an alliance

Colorado STEM Network (2006 – Present)

The Colorado STEM Network acts as a center for information dissemination for the eleven regional STEM centers in the network. Each regional center is managed by post-secondary institutions, non-profits, or private companies and acts as a resource to address STEM education locally. Overall, it appears that the Colorado STEM Network does not provide funding for the individual regional centers and that any programs implemented by the regional centers must utilize outside funding. Therefore the Colorado STEM Network only acts an institution to coordinate and disseminate information supplied by each regional center such as events, STEM scholarship opportunities, or STEM educational opportunities.

Idaho STEM Pipeline (unknown – Present)

The Idaho STEM Pipeline is a partnered effort with that of the Idaho Department of Education and the I-STEM Education project (Idaho-Science Technology Engineering and Mathematics) project. The pipeline aims to increase participation and STEM learning opportunities in Idaho by acting as a clearing house for STEM related information in Idaho. The partnership between the Idaho STEM Pipeline and the I-STEM project disseminates STEM related information such as current STEM programs in the state, best practices and curriculum for STEM teachers, and STEM scholarship opportunities.

University System of Maryland STEM and Competitiveness Initiative (2008 – Present)

The University System of Maryland STEM and Competitiveness Initiative was established by the USM Chancellor, who instigated two task forces to research the issues of STEM workforce development and issues of competitiveness in the areas of research and technology based economic growth. The some recommendations made by reports from these task forces were included in Maryland's Race to the Top campaign. Otherwise the initiative appears to be an effort made by the individual institutions in the University System of Maryland, wherein each institution has implemented STEM programs.

Massachusetts STEM Pipeline Fund (2003 – Present)

The STEM Pipeline Fund is a project of the Massachusetts Department of Higher Education and was established to increase the number of Massachusetts students who participate in STEM and the number of pre-service STEM teachers and also improve STEM education in public and private schools. In the past, the fund has provided small grants to different schools or regional STEM centers in order to fund STEM related programs. Recently, in support of the Massachusetts Statewide STEM plan (a product of Race to the Top) the STEM Pipeline Fund has been utilized to provide funds for Scalable STEM projects which are utilized by the Governor's STEM Advisory Council to determine best practices for the state.

New York State Collegiate Science and Technology Entry Program (1986 – Present)

The New York State CSTEP program is designed to increase the number of minorities who both graduate in STEM fields and pursue careers in STEM fields. The program provides students in STEM fields with opportunities for scholarship, undergraduate research, supplemental education, and mentoring. Although the CSTEP program is for minorities, many New York universities have similar programs for non-minorities such as the CPOP (Cornell Professional Opportunities Program) at Cornell or the HEOP (Higher Education Opportunity Program) at Ithaca College and Utica College.

Ohio STEM Learning Network (2006 – Present)

The Ohio STEM Learning Network is divided into seven separate 'hubs,' wherein each hub is described as being the "nucleus of regional STEM activity." The hubs thus facilitate STEM partnerships between K-12, postsecondary and business institutions and provide the regional area with funding for STEM programs as well as information concerning STEM education. The overall statewide initiative disseminates information concerning statewide and national STEM programs and provides direct support for the regional hubs.

Pennsylvania STEM Initiative (2007 – Present)

The Pennsylvania STEM Initiative is described as a partnership between the Team Pennsylvania Foundation and the state of Pennsylvania. The initiative breaks the state into five STEM Regions which work to set regional STEM needs and partnerships. Each regional center was then given seed money to help build establish regional STEM programs.

Texas T-STEM (unknown – Present)

The Texas T-STEM initiative is a set of seven regional STEM centers that provide support for STEM education at the secondary level. The Texas T-STEM initiative is fundamentally directed towards secondary students; however one of the main premises of the program is to partner with universities in order to align secondary and postsecondary education and activities. Each university is either part of or the leader of a T-STEM center. The involved universities also support institutional level STEM programs.

Washington STEM (2009 – Present)

The Washington STEM Initiative is a statewide P-16 initiative to enhance STEM education in hopes of providing a STEM ready workforce. The initiative is seemingly divided into two components, which include grants for the enhancement of STEM education and regional learning networks. The grants are provided to educators and thought leaders to allow for innovation projects in STEM teaching. The regional learning networks are utilized to implement collaboration in STEM and determine best practices in STEM education. The Washington STEM website is a site for information dissemination for regional and statewide STEM programs.

Appendix B: STEM Initiative Catalog: Program Demographics

	PROGRAM DEMOGRAPHICS								
State	**STEM Initiative Name**	**Website**	**Years of Program**	**Still Active?**	**Number of Schools Involved**	**Stated Goals**	**Funding Source**	**Annual Funding Amount**	**Program Partners**
Alabama	Alabama Math, Science and Technology Initiative (AMSTI) (K-12 Only)	http://www.amsti.org/							
Alaska	None								
Arizona	Arizona STEM Network (K-12 & Industry)	http://www.sfaz.org/live/page/stem-network							
Arkansas	Arkansas STEM Works (Announced 8/15/11) (9-16)	http://m.arktimes.com/ArkansasBlog/archives/2011/08/16/beebe-announces-technical-education-project	Announced 8/15/11	Yes			AT&T, Dept of Career Education, Dept of Education, Dept Workforce Services, Dept of Higher Education	$2.6 million	
California	California STEM Learning Network (K-14)	http://www.cslnet.org/index.php	2009-Present	Yes		1. Increase K-14 STEM competency 2. Ensure STEM college and career readiness 3. Build a network to enhance STEM teaching and learning	Bill & Melinda Gates Foundation, S.D. Bechtel Jr. Foundation, Corporation for Education Network Initiatives in California	Operating Budget listed as 2-3 million	California Polytechnic State University, California Council on Science & Technology

	PROGRAM DEMOGRAPHICS								
State	**STEM Initiative Name**	**Website**	**Years of Program**	**Still Active?**	**Number of Schools Involved**	**Stated Goals**	**Funding Source**	**Annual Funding Amount**	**Program Partners**
California	California STEM Service-Learning Initiative (K-16)	http://www.calstem.org/		Yes		1. Increase the number of women and minorities in STEM Careers 2. Implement STEM based service learning 3. Identify and collaborate with like minded partners in service learning projects 4. Develop a cadre of STEM service learning trainers	Corporation for National and Community Service, Learn and Serve America	Not Given	Yolo County Office of Education, CA Dept of Education, CalServe Initiative
Colorado	Colorado STEM Network (K-higher education)	www.coloradostemeducation.com	2006-Present	Yes	10 Regional Centers	Create partnerships with key stake holders - business, education, govt - for developing Colorado's 21st century workforce	National Governor's Association		
Connecticut	None								
Delaware	None								
Florida	Florida Campus Compact STEM Initiative (Higher Education)	http://www.stem.floridacompact.org/		Yes		1. Contribute to the development of a knowledge economy in FL comprised of STEM professionals 2. Encourage changes in behavior that will create a more sustainable future 3. Contribute to the institutionalization of service learning in STEM	Corporation for National and Community Service (CNCS), Federal TRIO grant	$759,528 over 3 years Also received part of a 2.3 million grant over 5 years	

State	STEM Initiative Name	Website	Years of Program	Still Active?	Number of Schools Involved	Stated Goals	Funding Source	Annual Funding Amount	Program Partners
Georgia	STEM Initiative (Higher Education)	http://www.usg.edu/educator_prep/preparation/stem/	2007-Present	Yes	7	1. Promote K-12 student preparation for and interest in majoring in STEM in college. 2. Increase the success of STEM majors in college. 3. Produce more and better science and mathematics teachers for the schools, which in turn will lead to increased preparation of K-12 students in science and mathematics.	Board of Regents		
Hawaii	My STEM Hawaii (K-16)	http://www.mystemhawaii.com/Pages/Home.aspx	2008-Present	Last updated July 2010			National Governors Association for Best Practices	$500,000 grant in 2007	
Idaho	Idaho STEM Pipeline (K-16)	http://www.idahostem.org/				Increase statewide participation in Idaho STEM by providing coordinated information and educational "pipeline" opportunities. Increase access to STEM learning opportunities within Idaho for all students, including women and those from underrepresented groups such as Native-American, Hispanic-American, Asian/Pacific Islander, and African-American populations. Provide a statewide clearinghouse of STEM pipeline programs available to K-12 students and teachers, undergraduate, and graduate students in the State of Idaho. Provide a statewide clearinghouse of STEM pipeline programs available to Idaho community members.	NSF, Idaho EPSCoR		

	PROGRAM DEMOGRAPHICS								
State	**STEM Initiative Name**	**Website**	**Years of Program**	**Still Active?**	**Number of Schools Involved**	**Stated Goals**	**Funding Source**	**Annual Funding Amount**	**Program Partners**
Illinois	I-STEM (University of Illinois Urbana Only)	http://www.istem.illinois.edu/about/aboutus.html	2009-Present	Yes		1. Facilitate P-16 STEM partnerships to engage students in STEM experiences 2. Improve STEM Teacher Training and Professional Development 3.Foster Undergrad and Grad STEM Education Reform 4. Shape Policy and Advocate for STEM Education			
Indiana	I-STEM (K- Higher Education)	https://www.istemnetwork.org/index.cfm		Yes		1. Mobilization of expertise and leveraging of resources that reach all K-12 children in Indiana 2. Promotion of STEM education and literacy so high school graduates are prepared for post-secondary education 3.Research, develop and disseminate info on the state of STEM K-12 education to policymakers and the media 4. Coordination with regional partners to develop an interactive network that allows for a fluid flow of information	Indiana Dept of Education, Lumina, Lilly Endowment Inc., BioCrossroads, The Children's Museum		
Iowa	Corridor STEM Initiative (K-16) *Iowa has recently (July 2011) started a new STEM Advisory Council in the Governor's Office	http://www.corridorstem.org/index.php?id=1	2007-Present	Site updated 2010		1. Plan initiative to increase awareness and recognition of the need for STEM learners in Iowa 2. Increase knowledge that the workforce must possess in STEM 3. Cultivate quantity and quality of STEM teachers			
Kansas	K-12 Only								
Kentucky	In 2007 the Council of Post Secondary Education had a STEM Task Force and audited STEM programs in the state	http://cpe.ky.gov/news/reports/cpe_reports/stem.htm	2006-2007	No					

	PROGRAM DEMOGRAPHICS								
State	**STEM Initiative Name**	**Website**	**Years of Program**	**Still Active?**	**Number of Schools Involved**	**Stated Goals**	**Funding Source**	**Annual Funding Amount**	**Program Partners**
Louisiana	LA-STEM (LSU Students only)	http://www.lsu.edu/lastem/about%20us/index.html	2006-Present	Yes		1. Promote the life and diversity of the STEM student body 2. Provide supportive and motivating environment for students through mentoring, education, and research	NSF, Research Corporation, Louisiana Board of Regents		
Maine	Maine STEM Collaborative (K-20)	http://www.mainestem.org/STEMInitiative.asp	2007-Present	Yes		Increase Maine's overall student STEM participation by 10% by 2014 through a strong, coherent, consistent, and integrated STEM education system	NSF, Maine EPSCoR		
Maryland	USM STEM and Competitiveness Initiative (P-20)	http://www.usmd.edu/usm/STEM/	2008-Present	Site updated 2009	12	1. Increase the number of STEM teachers graduating from USM institutions and pursuing teaching careers in the state 2. Preparing more of today's students for STEM career opportunities and improving K-12 education 3. Utilizing resources of higher education to foster innovation and business development in STEM areas	NSF, Department of Education		
Massachusetts	STEM Pipeline Fund (K-16)	http://www.mass.edu/forinstitutions/prek16/pipeline.asp	2003-Present	Yes		1. Increase student interest in STEM 2. Increase STEM achievement among PreK-12 students 3. Increase the percentage of students who demonstrate readiness for college-level study in STEM fields 4. Increase the number of students who graduate from a post-secondary institution with a degree in a STEM field 5. Increase the number/percentage of PreK-16 STEM classes led by effective educators.	Race to the Top	$250 million over 4 years	Department of Higher Education

	PROGRAM DEMOGRAPHICS								
State	**STEM Initiative Name**	**Website**	**Years of Program**	**Still Active?**	**Number of Schools Involved**	**Stated Goals**	**Funding Source**	**Annual Funding Amount**	**Program Partners**
Michigan	Initiative Science Outreach (K-16)	http://www.initiativescience.org/Outreach/Home.html	2005-Present	Yes		To initiate Scientific, Technological, Environmental and Mathematical inquiry via holistic, interactive learning strategies, for the purpose of engaging the minds of America's youth	Privately held conglomerate		
Minnesota	Minnesota STEM Network (K-12)	http://www.scimathmn.org/mnstemnet.htm	2010-Present	Yes		1. Connect across sectors leveraging common interests in STEM 2. Increase The pace of innovation in STEM education and workforce development by collaboration 3. Increase participation by business and industry 4. Increase the number of students selecting STEM as a career opportunity	Boston Scientific, 3M, SciMath, Medtronic, H.B. Fuller, Cargill State of MN	$12 million (5 years)	University of Minnesota, Minnesota State Colleges and Universities,
Mississippi	(7-9 grades only)	http://www.acteonline.org/profile_ms.aspx#STEM							
Missouri	Missouri Mathematics and Science Coalition (K-20)	http://www.momathandscience.com/mx/hm.asp?id=home				1. Improve performance of all P-20 students 2. Expand pool of students motivated to pursue STEM careers 3. Expand pool of quality STEM educators 4. Establish technology plan to support STEM efforts 5. Increase public awareness of STEM	Missouri Chamber of Commerce and Industry	$4 million (state and private)	Missouri Department of Higher Education
Montana	None (Only Montana Math & Science Teacher Initiative to recruit K-12 STEM Teachers)								

State	PROGRAM DEMOGRAPHICS STEM Initiative Name	Website	Years of Program	Still Active?	Number of Schools Involved	Stated Goals	Funding Source	Annual Funding Amount	Program Partners
Nebraska	Nebraska's P-16 Initiative	https://p16.nebraska.edu/	1998-Present	Yes		1. Adopt a college and career prep core curriculum 2. Eliminate the academic achievement gap 3.Develop a longitudinal data system for info on the P-20 degree attainment 4. Attain HS grad rate over 90% 5. Improve Nebraska's college-going rank to top 10 tier nationally 6. Provide affordable access for NE students to attend college 7. Improve time to degree completion and increase grad rate of college 8. Provide all students with STEM skills needed for workforce and increase the number and diversity of students who pursue STEM careers	NE Governor's Office, NE Department of Education, University of NE, EducationQuest Foundation		
Nevada	Gathering Genius (K-12)								
New Hampshire	NH MaST Coalition	http://nhmast.us/index.php	1988-Present	last updated 2007		1. Encourage and facilitate dialogue among NH STEM stakeholders 2. Promote and foster STEM education projects 3. Disseminate info for those interested in improving STEM education 4. Convene meetings of orgs and individuals interested in improving STEM education			
New Jersey	None								
New Mexico	STEM Education Outreach Program (K-12)								
New York	Collegiate Science and Technology Entry Program (CSTEP) (Higher Education)	http://www.highered.nysed.gov/kiap/colldev/CollegiateScienceandTechnologyEntryProgram.htm	1986-Present	Yes	51	Increase the number of students from under-represented groups who are pursuing professional licensure and careers in STEM and health related fields.	State Funding		

	PROGRAM DEMOGRAPHICS								
State	**STEM Initiative Name**	**Website**	**Years of Program**	**Still Active?**	**Number of Schools Involved**	**Stated Goals**	**Funding Source**	**Annual Funding Amount**	**Program Partners**
North Carolina	NC STEM Community Collaborative (K-12)	https://www.ncstem.org/							
North Dakota	None								
Ohio	Ohio STEM (K-16)	http://www.osln.org/	2006-Present	Yes	26 (post secondary)	1. Form new skills and sharp minds for a new century 2. Engage partnerships to accelerate capacity and broaden opportunity 3. Start and Stay small 4. Make STEM literacy attainable and desirable for all 5. Drive scalable and sustainable innovations	Bill & Melinda Gates Foundation, Battelle Center, Ohio Business Roundtable	$50 million ($12 million from BMGF in 2008)	Teaching Institute for Excellence in STEM, Ohio STEM, Ohio Board of Regents, Ohio Mathematics and Science Coalition
Oklahoma	Oklahoma CareerTech STEM Education (K-12)	http://www.okcareertech.org/STEM/gateway.htm							
Oregon	Oregon Pre-Engineering and Applied Science Initiative (K-12)	http://opas.ous.edu/index.php	2010-Present						
Pennsylvania	PA STEM Initiative (K-20)	http://teampa.com/impact/education-workforce-development/past-programs/pa-stem-initiative/	2007 - Present	Yes		By 2018: 1. Increase the number and diversity of Pennsylvanians with high quality post-secondary STEM education and training. 2. Ensure that all graduates from Pennsylvania's high schools are proficient in STEM 3. Increase the number and diversity of teachers well-prepared in STEM content in PA 4. Increase public support for STEM education	NGA, Dept of Education, Dept Labor & Industry, Dept Community and Econ Development, Wall Street West, Natl Girls Collaborative Project, AT&T	Began with $1 million	

	PROGRAM DEMOGRAPHICS								
State	**STEM Initiative Name**	**Website**	**Years of Program**	**Still Active?**	**Number of Schools Involved**	**Stated Goals**	**Funding Source**	**Annual Funding Amount**	**Program Partners**
Rhode Island	Rhode Island STEM Center (P-20)	http://www.trworkbench.com/stem/	2009 - Present	Yes		1. Engage in recruitment, continuous and rigorous preparation, and professional development of high quality STEM teachers and other STEM professionals 2. Develop new initiatives to increase STEM awareness, interest and motivation at all educational levels	Mix of federal and state sources, Governors office	$6 million for building and STEM Learning centers on RI College campus	
South Carolina	South Carolina's Coalition for Math and Sciences (K-12?)	http://www.sccoalition.org/	1993 - Present	Yes		Their mission is to be an advocate/catalyst for constancy and quality in STEM in SC	SC Dept of Education, Dupont, Michelin, Progress Energy, BMW		
South Dakota	None								
Tennessee	Tennessee Mathematics, Science & Technology Education Center (K-20)	http://frank.mtsu.edu/~mscenter/mission.shtml		Yes	5 universities	1. Provide quality staff development for STEM teachers 2. Develop undergrad and grad math and science education programs 3. Influence state policies on STEM education 4. Develop partnerships with stakeholders 5. Est. a Math and Science Education Research Group	US Department of Education, TN Department of Education , Tennessee Board of Regents, TN Board of Education, Tennessee Higher Education Commission, NASA , National Science Foundation, Texas Instruments, Mind 2 Marketplace,	$7 million awarded for 2008 until 2014	

	PROGRAM DEMOGRAPHICS								
State	**STEM Initiative Name**	**Website**	**Years of Program**	**Still Active?**	**Number of Schools Involved**	**Stated Goals**	**Funding Source**	**Annual Funding Amount**	**Program Partners**
Texas	T-STEM (K-16)	http://tstem.thsp.org/index.htm		Yes	51 high schools, 7 T-STEM centers (run by universities)	To increase student performance and career awareness in the area of STEM by linking schools, universities, centers, organizations and businesses with valuable resources and tools associated with best practices in STEM education.	Texas Education Agency, Bill & Melinda Gates Foundation, Michael & Susan Dell Foundation, National Instruments, State, Communities of Foundation of Texas	$20 million *Current funding (10-11) is provided by the state, overall the program has had around $120 million in funding	
Utah	STEM Education Initiative (Utah State University only)	http://stemed.usu.edu/				1. Increase the number and quality of STEM Educators and STEM professionals in the region and country, 2. Conduct research and development on computing and communication tech in STEM Education 3. Increase the number of students entering and continuing through STEM career pathways 4. Study and report on new knowledge about STEM Education 5. Develop and Implement institutional partnerships that support practices and policies in STEM Education			Cache County School District, Teton Science Schools, Stokes Nature Center
Vermont	Mathematics and Science Grant Program (9-16)	http://education.vermont.gov/new/html/pgm_curriculum/mathematics/initiatives.html							
Virginia	VT-STEM (K-12 outreach initiative by VA Tech)	http://www.stem.vt.edu/index.html							

State	PROGRAM DEMOGRAPHICS								
	STEM Initiative Name	**Website**	**Years of Program**	**Still Active?**	**Number of Schools Involved**	**Stated Goals**	**Funding Source**	**Annual Funding Amount**	**Program Partners**
Virginia	Governor's STEM Academies (9-16)	http://www.doe.virginia.gov/instruction/career_technical/gov_academies/index.shtml	2008-Present	No updates since 2009		1. Maximize opportunities in preparing students for targeted careers by linking high school and post secondary education and training 2. Raise student aspirations and recruit post secondary STEM majors and preservice teachers 3. Provide well trained workers to support the recruitment of the workforce	National Governors Association	$500,000 awarded in 2007	
Washington	Washington STEM (K-16)	http://www.washingtonstem.org/	2009-Present	Yes		Mobilize educational, business, civic and community leaders to support and implement improvements in STEM education	Boeing Company, Bill & Melinda Gates Foundation, Fluke Corporation, JP Morgan Chase, McKinstry, Microsoft, Safeco	$10 million (from BMGF for 4 years and 10 months starting 02/11) and $6 million from Microsoft over 3 years	
West Virginia	Science and Research Council (Higher Education)	http://www.wvresearch.org/index.php?option=com_frontpage&Itemid=1	2009-Present	Yes		Invest in research to help WV create jobs, attract additional public and private investment, improve education and steer at-risk youth toward careers in STEM	NSF (EPSCoR), WV Higher Education Policy Commission		West Virginia University, West Virginia State University
Wisconsin	WISTEM (K-16)	www.wistem.org				Provide valuable resources to young people and adults interested in pursuing STEM careers			WISTEM lists over 50 partners including Wisconsin Science Network, GE,Connect a Million Minds (Time Warner), and Eaton
Wyoming	NASA's Summer of Innovation (grades 4-9)	http://www.nasa.gov/offices/education/programs/national/summer/home/Wyoming_SG_SoI.html							

Appendix C. STEM Initiative Catalog: Programmatic Components

		PROGRAMMATIC COMPONENTS									
State	STEM Initiative Name	Mini-grants program?	Service-learning?	Peer Instruction/ Tutoring?	Learning Communities?	Undergrad Research/Internships?	Instructional Technology?	Educator Preparation?	Summer Bridge Programs?	Scholarships for STEM Students?	Mentoring?
Alabama	Alabama Math, Science and Technology Initiative (AMSTI) (K-12 Only)										
Alaska	None										
Arizona	Arizona STEM Network (K-12 & Industry)										
Arkansas	Arkansas STEM Works						Yes	Yes (Uteach)			
California	California STEM Learning Network (K-14)							Yes			
California	California STEM Service-Learning Initiative (K-16)		Yes								
Colorado	Colorado STEM Network (K-higher education)			Yes				Yes			
Connecticut	None										
Delaware	None										
Florida	Florida Campus Compact STEM Initiative (Higher Education)	Yes STEM Service Learning Fellows	Yes								
Georgia	STEM Initiative (Higher Education)	Yes	Yes (FOCUS)	Yes	Yes	Yes	Yes	Yes (Summer Academy for Future teachers)	Yes (STEP at Armstrong, UWG)	Yes	Yes

		PROGRAMMATIC COMPONENTS									
State	STEM Initiative Name	Mini-grants program?	Service-learning?	Peer Instruction/ Tutoring?	Learning Communities?	Undergrad Research/Internships?	Instructional Technology?	Educator Preparation?	Summer Bridge Programs?	Scholarships for STEM Students?	Mentoring?
Hawaii	My STEM Hawaii (K-16)			Yes	Yes (Part of the Keaholoa STEM Program plan)	Yes			Yes	Yes	
Idaho	Idaho STEM Pipeline (K-16)				Yes (Idaho STEP Program)	Yes			Yes	Yes	
Illinois	I-STEM (University of Illinois Urbana Only)		Yes			Yes		Yes		Yes	
Indiana	I-STEM (K- Higher Education)							Yes			
Iowa	Corridor STEM Initiative (K-16)								Yes		
Kansas	K-12 Only										
Kentucky	None										
Louisiana	LA-STEM (LSU Students only)			Yes		Yes			Yes	Yes	Yes
Maine	Maine STEM Collaborative (K-20)					Yes (Maine INBRE)					
Maryland	USM STEM and Competitiveness Initiative (P-20)			Yes	Yes (Special housing)	Yes		Yes	Yes	Yes	Yes (S-STEM)
Massachusetts	STEM Pipeline Fund (K-16)	Yes		Yes	Yes		Yes (Mass Bay Community College's SolidWorks Workshops)	Yes (also professional development)		Yes	Yes

		PROGRAMMATIC COMPONENTS									
State	STEM Initiative Name	Mini-grants program?	Service-learning?	Peer Instruction/ Tutoring?	Learning Communities?	Undergrad Research/Internships?	Instructional Technology?	Educator Preparation?	Summer Bridge Programs?	Scholarships for STEM Students?	Mentoring?
Michigan	Initiative Science Outreach (K-16)					Yes		Yes			
Minnesota	Minnesota STEM Network (K-12)						Yes	Yes			
Mississippi	(7-9 grades only)										
Missouri	Missouri Mathematics and Science Coalition						Yes	Yes (alternative certification			
Montana	None (Only Montana Math & Science Teacher										
Nebraska	Nebraska's P-16 Initiative										
Nevada	Gathering Genius (K-12)										
New Hampshire	NH MaST Coalition										
New Jersey	None										
New Mexico	STEM Education Outreach Program (K-12)										
New York	Collegiate Science and Technology Entry Program			Yes		Yes	Yes (Laptop Loans)			Yes	Yes (also career advising)
North Carolina	NC STEM Community Collaborative (K-12)										

		PROGRAMMATIC COMPONENTS									
State	STEM Initiative Name	Mini-grants program?	Service-learning?	Peer Instruction/ Tutoring?	Learning Communities?	Undergrad Research/Internships?	Instructional Technology?	Educator Preparation?	Summer Bridge Programs?	Scholarships for STEM Students?	Mentoring?
North Dakota	None										
Ohio	Ohio STEM (K-16)			Yes	Yes	Yes		Yes	Yes	Yes	Yes
Oklahoma	Oklahoma CareerTech STEM Education (K-12)										
Oregon	Oregon Pre-Engineering and Applied Science Initiative (K-12)										
Pennsylvania	PA STEM Initiative (K-20)										
Rhode Island	Rhode Island STEM Center (P-20)							Yes (also Professional Development)		Yes	
South Carolina	South Carolina's Coalition for Math and Sciences (K-12)			Yes							
South Dakota	None										
Tennessee	Tennessee Mathematics, Science & Technology Education Center (K-20)			Yes			Yes	Yes	Yes	Yes	Yes

		PROGRAMMATIC COMPONENTS									
State	STEM Initiative Name	Mini-grants program?	Service-learning?	Peer Instruction/ Tutoring?	Learning Communities?	Undergrad Research/Internships?	Instructional Technology?	Educator Preparation?	Summer Bridge Programs?	Scholarships for STEM Students?	Mentoring?
Texas	T-STEM (K-16)		Yes "Shake Hands" Camp		Yes		Yes (LabVIEW and Virtual Instruments, Smart Board, TI Navigator, PRS)	Yes, including professional development for in-service teachers			
Utah	STEM Education Initiative (Utah State University only)							Yes (Utah Mathematics Endorsement Project)			
Vermont	Mathematics and Science Grant Program (9-16)	Yes to foster partnerships between institutions									
Virginia	VT-STEM (K-12 outreach initiative by VA Tech)										
Virginia	Governor's STEM Academies (9-16)										
Washington	Washington STEM (K-16)							Yes	Yes		
West Virginia	Science and Research Council (Higher Education)	Offers grants for scientific research				Yes				Yes	
Wisconsin	WISTEM (K-16)					Yes		Yes (STEM education Co-op)		Yes	
Wyoming	NASA's Summer of Innovation (grades 4-9)										