North Carolina's Science, Technology, Engineering, and Mathematics (STEM) Education Strategic Plan

Public Schools of North Carolina
State Board of Education | Department of Public Instruction

Executive Summary

North Carolina has arguably the finest business climate in America. However, the state is undergoing a critical economic transformation, moving rapidly from a low-skill, low-wage economy to a high-skill, knowledge-based economy driven by technology and innovation. These changes demand an adaptable workforce - one with the science, technology, engineering and mathematics (STEM) skills embedded within the critical 21st Century skills required for successful citizenship. To maintain North Carolina's supremacy, future workers must have the STEM skills leading companies demand and the citizenship the 21st Century now requires for success.

Fortunately, North Carolina can boast a high number of statewide and local STEM education initiatives, as well as strong education standards and public and private organizations promoting education innovation in their communities and regions. No matter their geographic, political, or economic disposition, North Carolina's leaders agree that **a coordinated, statewide STEM Education Strategic Plan** with clear direction, support and goals is needed to ensure a workforce that is prepared for the high-skill, high-wage and high-demand jobs of a knowledge-based and innovation economy.[1] The plan must be built on a shared vision that leverages public and private resources in the most effective and efficient manner possible, moving North Carolina further and faster toward a world-class workforce and sustained economic growth and development in a global market.

North Carolina is poised to lead the nation with vibrant STEM-based education and economic systems. It is time for North Carolina to connect the many "islands of excellence" across the state into a bright future for all its citizens and communities. To build and maintain the world-class workforce needed to ensure economic prosperity in a global market, North Carolina must focus on the following three priorities and measure our progress against these strategies:

Priority 1: Increasing our student, educator and institutional STEM Achievement

Strategy: Adopt a set of attributes for STEM schools and programs, aligned with 21st Century Skills, to assist public and private organizations to align, coordinate and advance STEM skills for all students.

Strategy: Measure a set of student achievement indicators along the education-to-workforce continuum to guide the current and future implementation of the STEM Strategy.

Strategy: Implement a designation for STEM Schools and Programs, aligned with the STEM Attributes, to drive the goals and measures outlined within this STEM Strategic Plan.

Strategy: Identify high-quality tools and supports – such as rubrics, self-assessments – to enable schools, programs and businesses to advance consistent understanding and application of the adopted STEM Attributes.

Priority 2: Gaining and sustaining broader community understanding and support for education innovations that support our economic needs

Strategy: Coordinate a public awareness campaign to 100 counties utilizing public/private partnerships, to inspire and engage North Carolina citizens in this economic challenge.

Strategy: Identify and convene leading programs, partners and schools to advance and highlight best practices to every county

Strategy: Provide a one-stop action-oriented resource for students, educators, parents, and businesses to get involved in the STEM initiative.

Priority 3: Connecting, leveraging & increasing STEM Resources across public and private sectors to improve our citizens and their economic future

Strategy: Invest public and private funds over the next ten years to scale effective STEM programs, policies and practices throughout every economic development region of North Carolina

Strategy: Identify and fund a public/private partner that coordinates, evaluates and monitors STEM Education programs and initiatives

Strategy: Incentivize collaborations based on evidence-based policies, programs and practice that greatly increases the number of students gaining STEM skills and continuing in STEM fields of work.

Strategy: Establish a STEM Council to facilitate and coordinate the implementation of North Carolina's comprehensive STEM Strategic Plan.

STEM Education – An Economic Imperative for North Carolina

North Carolina is undergoing a critical economic transformation. The state is moving rapidly from a low-skill, low-wage economy to a high-skill, knowledge-based, technology, and innovation economy, and these changes demand an adaptable workforce. As this transformation occurs, NC's traditional "middle jobs" — those that paid a family-sustaining wage and required minimal formal education or training— are disappearing. Furthermore, impending baby-boom retirements will exacerbate an emerging gap between workers' skills and job demands.

In our state's newly emerging industries, such as agribusiness, advanced manufacturing, technology and research, excellence in *S*cience, *T*echnology, *E*ngineering, and *M*athematics (STEM) is essential. As the President indicated in his 2011 State of the Union address, "We know what it takes to compete for the jobs and industries of our time…. **We need to out-innovate, out-educate, and out-build the rest of the world**."[2] This country's "success as a nation depends on strengthening America's role as the world's engine of discovery and innovation."[3] Technological innovation accounted for almost half of this country's economic growth over the past 50 years, and almost all 30 of the occupations expected to grow the fastest in the next decade will require at least some background in STEM.[4]

In North Carolina there are approximately 400,000 STEM-related jobs, and more than 70,000 net new STEM-related jobs will be created by 2020. This reflects a growth rate greater than for all other jobs in North Carolina. STEM-related jobs in North Carolina pay 64 percent more than the average job., These STEM-related jobs will serve as the economic engine driving this state's future. Yet, even during the periods of highest unemployment, companies reported difficulty finding qualified workers for STEM-related jobs.[5]

North Carolina has arguably the finest business climate in America. Sources such as Site Selection Magazine, Chief Executive Magazine and Forbes consistently tout North Carolina as a leading state in which to do business. The state was 2nd in the nation for job creation between September 2009 and September 2010, and 5th in the nation for personal income growth since June 2009. There has been a ten percent increase in corporate profits.[6] To maintain that supremacy, workers must have the skills leading companies demand, and those skills are clearly STEM focused.

Both public and private sectors recognize this need, and have stepped up to develop efforts to address it. Through Governor Beverly Perdue's JobsNOW initiative, the state aggressively is working to create jobs, train and retrain its workforce, and lay the foundation for a strong and sustainable economic future. **North Carolina's educational system is a critical partner as it represents probably the single most important factor in assuring the state has the best available supple of workers.**[7]

This critical need is non-partisan, a concern for Republicans and Democrats, public and private citizens, local and state and national leaders. The Lt. Governor's JOBS Commission is a bipartisan effort to align education requirements with today's business needs. In addition, North Carolina can boast of a myriad of STEM programs and initiatives across public and private sectors. These programs are not only designed to produce and inspire the next generation of scientists, technologists, engineers, and mathematicians, but also help prepare ALL students successfully compete in the 21st century economy. These include programs and activities

intended to directly engage students, as well as programs and activities designed to recruit, prepare, and retain effective educators in the STEM areas. North Carolina has strong pockets of promising practices and many strengths to be leveraged across the state.

This critical workforce need combines with a large number of programs and high rate of innovation requires a coordinated STEM Education Strategic Plan. This strategy aligns, innovates, and advances the STEM skills all students need to ensure their success in every community of North Carolina.

Aligning K12 with K20 and Economic Needs

North Carolina has not been idle in STEM education. Through *Career and College – Ready, Set, Go!* and programs such as *Career & College Promise*, North Carolina is leading the transformation of our state's system of public education to ensure all students graduate from high school equipped to succeed in a career, in a two- or four-year college, or in technical training, and prepared to compete successfully in a global, knowledge-based and innovation economy. The Standard Course of Study has been updated based on nationally-recognized Common Core standards, essential standards and international standards. Teachers and principals are being provided tools and access to professional development that will help them reach all students, and technology is being used to support student learning. Because excellence in STEM skills are essential for our workforce in a global, knowledge-based, and innovation economy, a crucial component of the transformation includes improving STEM Education for all students.

North Carolina recognizes our workforce needs are not that of a single organization, institution or sector. Many of the initiatives to reach these goals should directly connect and leverage existing or future efforts across institutions along the education-to-workforce continuum.

The Framework for the STEM Education Strategic Plan

Students and educators are the focal point of every effective education strategy, but North Carolina understands these critical resources are a vital part of a larger system and environment. Through extended conversation with K20 education system leaders, research of hundreds of local, state and national initiatives, and deliberate engagement of private sector, foundations, economic development and other non-education stakeholders, North Carolina has created the first statewide STEM Education Strategic Plan. The STEM Education Strategic Plan focuses on three immediate and reinforcing priorities, outlines measurable goals and twelve corresponding strategies. These twelve corresponding strategies have been vetted through multiple lenses to position North Carolina as a leader, both educationally and economically.

The North Carolina Department of Public Instruction and NCCCS have produced a list of Current and Needed STEM Initiatives associated with the three priorities, provided in Appendix I.

Framework-at-a-Glance for Statewide STEM Education Strategic Plan

Priority	Goals	Recommended Strategies
Increasing our student, teacher and institutional STEM Achievement	• Increase student interest in STEM fields and in continuing their education • Increase STEM Achievement of K-12 students • Increase the graduation rate of students in STEM programs • Decrease postsecondary remediation rates • Increase the number of teachers prepared and delivering integrated STEM education	1. *Adopt a set of attributes for STEM schools and programs, aligned with 21st Century Skills, to assist public and private organizations to align, coordinate and advance STEM skills for all students.* 2. *Identify a set of measurable indicators along the education-to-workforce continuum to guide the current and future implementation of the STEM Strategic Plan.* 3. *Implement a designation for STEM Schools and Programs, aligned with the STEM Attributes, to drive the goals and measures outlined within this STEM Strategic Plan.* 4. *Identify high-quality tools and supports – such as rubrics, self-assessments – to enable schools, programs and businesses to advance consistent understanding and application of the adopted STEM Attributes.* 5. *Advance professional development for pre-service and in-service educators aligned with the integrated pedagogy and project-based learning methods of STEM teaching and learning.*
Gaining and sustaining broader Community Understanding and Support for the needs of a knowledge-based economy	• Increase community understanding, awareness, and support for the economic challenges.	6. *Coordinate a public awareness campaign to 100 counties utilizing public/private partnerships, to inspire and engage North Carolina citizens in this economic challenge.*
	• Increase the connections, partnerships, and growth of high-quality programs, schools, and tools	7. *Identify and convene leading programs, partners and schools to advance and highlight best practices to every county* 8. *Provide a one-stop action-oriented web-based resource for students, teachers, parents, and businesses to access and get involved in STEM learning*
Connecting, Leveraging & Increasing STEM Resources across public and private sectors to improve our citizens and their economic future	• Increase returns on public and private investments in STEM education • Align & coordinate the investments of public & private sector partners to scale high-quality programs efficiently	9. *Invest public and private funds over the next 10 years to scale effective STEM programs, policies and practices throughout every economic development region of North Carolina* 10. *Identify and fund a public/private partner for the coordination, evaluation and monitoring of STEM Education programs and initiatives* 11. *Incentivize collaborations based on evidence-based policies, programs and practice that greatly increases the number of students gaining STEM skills and continuing in STEM fields of work.* 12. *Establish a formal STEM Council to facilitate and coordinate the implementation of North Carolina's comprehensive STEM Strategic Plan.*

Priority 1: Improving STEM Achievement

Increasing student interest and performance in STEM require a relevant, rigorous curriculum, delivered by educators that have mastered integrated content across subjects, pedagogy, and 21st century instructional tools and assessments. Students and educators will operate in schools that have both effective instructional leaders and the support of parents, business and industry, and the community.

Goals:

- ✓ Increase student interest in STEM fields and in continuing their education
- ✓ Increase STEM Achievement of K-12 students
- ✓ Increase the graduation rate of students in STEM programs
- ✓ Decrease the postsecondary remediation rates
- ✓ Increase the number of educators prepared and delivering integrated STEM education

Strategy: Adopt a set of attributes for STEM schools and programs, aligned with 21st Century Skills, to assist public and private organizations to align, coordinate, and advance STEM skills for all students.

North Carolina has strong pockets of promising practices and many strengths to be leveraged across the state. However, we lack a framework to scale what works and a clear declination of the characteristics of a quality STEM education.

Beyond focusing on **S**cience, **T**echnology, **E**ngineering, and **M**athematics, STEM Education provides the opportunity to teach students what to do when they do not know what to do, how to process and take action in new and uncomfortable situations, and how to understand, interact, and lead in the jobs, communities, and world in which they live. Effective STEM Education schools and programs are characterized by the following attributes:

Integrated Science, Technology, Engineering and Mathematics (STEM) curriculum, aligned with state, national, international and industry standards

- o Project-based learning with integrated content across STEM subjects
- o Connections to effective in- and out-of-school STEM programs
- o Integration of technology and virtual learning
- o Authentic assessment and exhibition of STEM skills
- o Professional development on integrated STEM curriculum, community/industry partnerships and connections with postsecondary education connections
- o Outreach, support and focus on underserved, especially females and minorities and economically disadvantaged

On-going community and industry engagement

- o A communicated STEM plan is adopted across education, communities and businesses
- o STEM work-based learning experiences, to increase interest and abilities in fields requiring STEM skills, for each student and educator
- o Business and community partnerships for mentorship, internship and other STEM opportunities that extend the classroom walls

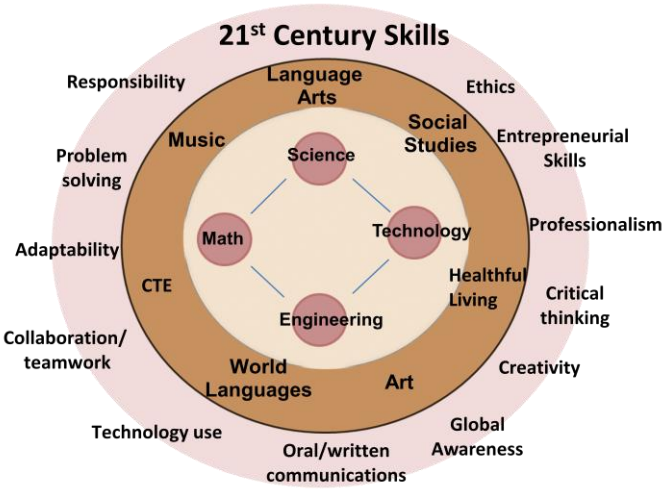
(Attributes continued on next page)

Connections with postsecondary education

- Alignment with students' career pathway with postsecondary STEM program(s)
- Acquisition of postsecondary credit and industry credential while in high school

These attributes are central to the 21st Century Skills expected to be the overall goal of all education in North Carolina, as outlined in Figure 1 below.

Figure 1



Strategy: Identify a set of student-achievement indicators along the education-to-workforce continuum to guide the current and future implementation of the STEM Strategy.

To achieve the goals and remain focused on the priorities, no single measure or metric can suffice. And, while individual programs should receive rigorous evaluation and measurement, the Statewide STEM Education Strategic Plan will need data-driven prioritization based on valuable indicators in multiple areas. Both traditional education measures of student achievement (graduation rate, mathematics completion, etc.) and teacher/leader effectiveness measures are part of the prioritization, but must be designated with the end in mind – that is, preparing and growing North Carolina's trained workforce. To measure progress and provide ongoing prioritization, North Carolina should define a statewide STEM scorecard, highlighting indicators in four primary areas:

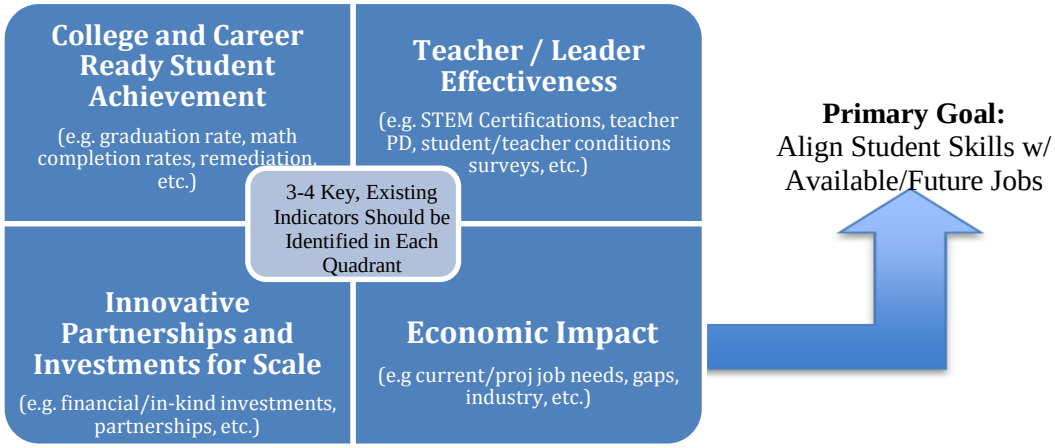


Figure 2.0 – Draft Scorecard areas to track specific progress indicators for STEM Strategy.

The pertinent education measures (student achievement and teacher/leader effectiveness) are currently included within the *Career & College: Ready Set Go!* initiative funded through Race to the Top, as well as the State Board of Education and NC Department of Public Instruction.

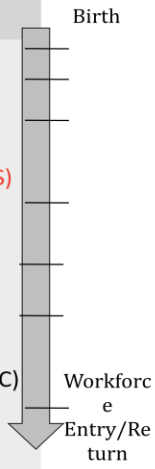
However, to effectively "close the gap between the number of existing and future jobs requiring STEM skills and the number of individuals with a valuable, postsecondary credential to fill those jobs" (Reference: SL 2010 41), consistent information on the number, types and availability of jobs in North Carolina's workforce is critical. The NC Department of Commerce and Workforce Development Commission have deep economic data from which key indicators could be identified.

Finally, financial, in-kind and resource alignment measures should be identified that provide insight into the investments by both public and private sector partners. State investments in these areas, as well as local, state and national investments in financial and in-kind support for STEM related activities – be they from public or private sources – will need to be measured to ensure collaboration, understand return on investment and inform prioritization decisions.

Indicators to Guide State STEM Strategic Plan

The following measures are recommended for compilation in reviewing students' achievement. These are listed as aligned with the education-to-workforce continuum:

Goal	Indicator*	Status
Increase STEM Interest of Students	Early Grades Student Survey	Pending
	ACT/SAT Survey	Pending
Increase K20 STEM Achievement	3rd Grade Math Proficiency	Existing (DPI)
	5th & 8th Grade Science Proficiency	Existing (DPI)
	8th Grade Algebra I Completion	Existing (DPI)
	Algebra II/Integrated Math III Completion	Pending (DPI)
	Career Readiness Certificate (ACT or WorkKeys)	Pending (DPI, NCCCS)
	Entry into either *Career & College Promise* STEM Pathway	January 1, 2012
	Completion of *Career & College Promise* STEM Pathway	January 1, 2012
	Entry into any of 8 STEM Career & Technical Ed. Clusters	Existing (DPI)
	Completion of STEM Career & Technical Ed. Concentrations	Existing (DPI)
	STEM Credentials Awarded	Existing (NCCCS)
	AP Course Completion in STEM areas (e.g Physics, Computer Sci., etc.)	Existing (DPI)
	Remediation rates in Math	Existing (NCCCS, UNC)
	University Transfer from CC with STEM, AAS	Existing (NCCCS)
	4-year STEM Degrees	Existing (UNC)
	Graduate STEM Degrees	Existing (UNC)
Increase Entry into STEM Jobs in NC	STEM Jobs (by cluster, by education requirement)	Existing (DOC/WIB/ESC)?
Increase STEM Certified Teachers	STEM Licensure/Certifications Begun	Needed
	STEM Licensure/Certifications Awarded	Needed



*** Measures are aggregated at School, District or State level. Student and Program level data would require Unique Student Identifier.**

The measures listed in black are currently collected, and may be compiled to prepare a baseline. Those listed in "red" are needed and should be prioritized. These measures are aligned and agreed to by K-20 systems. However, until a common unique identifier for students is utilized by all K20 systems, measurement will only be possible in the aggregate (School, District, Region or State level), not the program or student level.

The business sector has often repeated the mantra "what gets measured gets done". By initiating these measures along the education-to-workforce continuum, North Carolina will guide the Statewide STEM Strategic Plan at multiple levels. As soon as possible, the following additional steps need to be taken to increase local and state alignment with this strategy:

- Programs, policies and partnerships in current or new initiatives to advance the Statewide STEM Strategic Plan focus on at least one of the above indicators
- Common measures and indicators for public and private investments in STEM education need to be identified and compiled
- Where and when possible, North Carolina and its partners need to utilize the data compiled to guide and prioritize resources, policies and efforts towards agile decision-making to ensure the largest possible student progression in this STEM pipeline

- Additional, highly-pertinent measures and indicators may be identified to further enable guidance, policy and focus of the Statewide STEM Strategic Plan
- When available, a common unique student identifier (K-20) allows for program specific data.

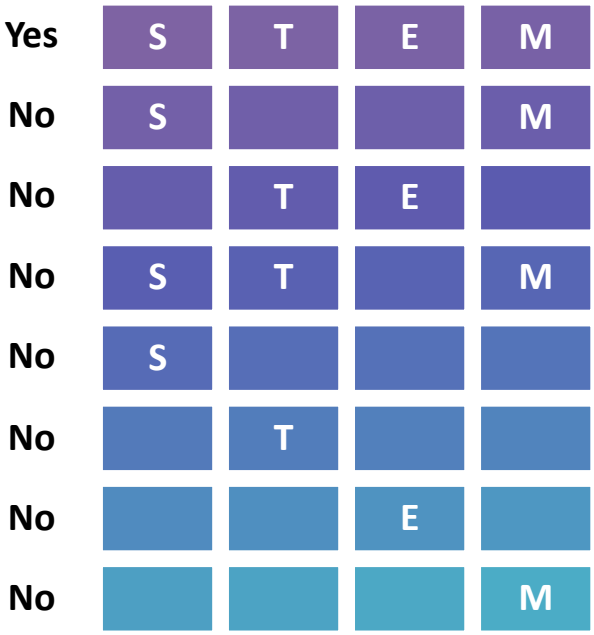
NC DPI and NCCCS have outlined more detailed indicators associated with the STEM Strategic Plan which may also be taken into consideration, included in Appendix II.

Strategy: 3. Implement a designation for STEM Schools and Programs, aligned with the STEM Attributes, to drive the goals and measures outlined within this STEM Strategic Plan.

The term "STEM School" or "STEM Program" has become common across the country to designate a school or program with a particular focus on science, technology, engineering and/or math. However, no consistent method for applying the disciplines, rigor or integration of STEM subjects is in place. North Carolina should encourage and support the growth of STEM-focused institutions and programs by creating a STEM Designation for STEM Schools and STEM Programs.

Once adopted, a STEM Designation based on the STEM attributes will provide clear communication and consistent application of the term "STEM" to schools and programs. Much like the role of Leadership in Energy & Environmental Design (LEED) Certification in building standards, a STEM Designation can be a goal, an honor, and a framework for change.

Such a framework provides both a "roadmap" and a "destination" for schools and programs. For those STEM schools/programs able to show evidence of MOST of these attributes, the designation allows clarity and understanding of their approach with some fidelity to the statewide STEM strategy. For others, the designation makes clear where they might continue working with partners, stakeholders, and leaders to achieve the attributes that have not yet been attained in order to be designated a STEM School or program.



Is this STEM?

STEM is integrated and advances all subjects. While programs may be effective in one, two, or three of the areas, they will need to show attributes and gains in all four areas for designation.

Beyond the honor of obtaining a STEM designation, the adoption of STEM indicators and measures will assist the state, its' schools and programs to understand the goals that are critical with the STEM education-to-workforce continuum.

Strategy: Identify high-quality tools and supports – such as rubrics, self-assessments – to enable schools, programs and businesses to advance consistent understanding and application of the adopted STEM Attributes.

North Carolina will identify and, when needed, support the creation of rigorous, aligned tools and supports to facilitate schools and programs who wish to advance STEM skills for its students. These tools and supports should be evidence-based in nature, aligned with state, national and international standards, and increase the connectivity and consistency of STEM schools and programs. Organizations, both public and private, will build and share tools and supports aligned with the STEM attributes. The tools and supports that are aligned and show value for schools and programs should be considered for endorsement and proliferation by the STEM public/private partner and STEM Council (see Priority 3).

For example, the North Carolina Department of Public Instruction, Golden LEAF Foundation, the William & Ida Friday Institute for Education Innovation at NC State University and the North Carolina STEM Community Collaborative have collaborated on a rubric and self-assessment aligned with the STEM attributes (See Appendix III). The tools were originally designed for evaluation of programs under a private grant initiative. However, through the collaborative efforts, the tools will support schools – especially high schools – and programs within Race to the Top initiative, the Golden LEAF Foundation's STEM grant initiative, and NC State's MISO project documenting STEM projects. Tools and supports such as these should also be identified and distributed to any school or program willing to advance the Statewide STEM Education Strategic Plan. These tools not only support the on-the-ground efforts of schools and programs, but when implemented consistently, provide for increased alignment of public and private investments in STEM students, educators, schools and communities.

Strategy: Advance professional development for pre-service and in-service educators aligned with the integrated pedagogy and project-based learning methods of STEM teaching and learning.

Research shows that the single most important factor in student achievement is the impact of the teacher in the classroom. North Carolina recognizes that the educator in the classroom is part of a large system of education. As the 'point of the spear' for STEM education, the state must invest in professional development, tools and certification that allow for teachers and school leaders to master the integrated practices, pedagogy and curriculum to advance the STEM skills, attributes and learning for all students. Whether project-based, problem-based, Socratic, inquiry-based, virtual or other methods, teachers need access to these resources before entering the classroom to meet the demands of STEM education and improve instruction.

In particular, North Carolina should leverage its own substantial efforts with national partners and expertise in the areas of:

- Certification and/or Licensure for STEM Teachers (pre-service and in-service)
- Alternative Licensure methods for STEM Teachers

- STEM Teacher and Leader Development tied to the STEM Attributes and Tools
- Lateral-Entry for STEM Professionals into Education
- Part-time or Split-time STEM Professionals in the Classroom
- Alignment of STEM Teaching with Common Core, National and International Standards

Priority 2: Bolster Community Understanding & Support

Helping citizens understand the urgent need of STEM Education and building a sustained commitment to support STEM Education will require all citizens understand how to get involved and appreciate the consequences of failing to act – for themselves, their children, and their communities. It will require a shared vision of the future is regularly communicated and discussed by leaders in every sector, of every background, and in every community. It will require sharing information in an open, consistent, and straightforward manner. It will require engaging all stakeholders in meaningful ways and inspiring them to action that produces results in both the short- and long-term.

Goals:

- ✓ Increase community understanding, awareness, and support for the economic challenges.
- ✓ Increase the connections, partnerships, and growth of high-quality programs, schools, and tools

Strategy: Coordinate a public awareness campaign to 100 counties utilizing public/private partnerships, to inspire and engage North Carolina citizens in this economic challenge.

Traditionally, STEM education has been the domain of certain geographies (e.g. Research Triangle Park) or certain occupations (e.g.- doctors, engineers, researchers, etc.). The majority of adults in America consider themselves "not a 'math person'". While leaders in North Carolina recognize the economic value of strong STEM education for all students – especially in light of massive economic transformation across the state – there is considerable confusion on how, where and when students, educators and the general public can best get involved, get connected and take action to advance STEM skills.

North Carolina must engage the general public through traditional and social media efforts to raise awareness STEM education. Such a campaign needs to include messages that will:

- Convey the economic value of STEM skills to current and future students and adults.
- Increase awareness of high-quality STEM Schools and Programs in every economic development region of the state.
- Illustrate critical education changes and opportunities (e.g.- Common Core Mathematics, Virtual Learning, etc.) in ways that advance understanding and adoption of STEM skills.
- Raise awareness of the priorities, attributes, designations, and measurements of the Statewide STEM Strategies.
- Take advantage of public and private efforts, expertise, and outlets to encourage students, parents educators and business leaders to increase the number of students accessing and completing high-quality STEM programs.

Strategy: Identify and convene leading programs, partners and schools to advance and highlight best practices to every county.

Over 500 schools, programs, non-profits, competitions, private partners, and informal learning organizations have been identified in North Carolina. These efforts vary in focus, quality, geography, funding, target audience, and in almost every other category and measure. These programs tend to focus most of their energy and resources on programmatic activities for which they were created – not highlighting themselves or seeking additional partners. However, this critical and varied group of partners, programs and schools offers an opportunity for the State to maximize shared resources, align efforts through partnerships, collaborate for further reach and value, and innovate new and better practices for the enrichment of STEM skills.

A public/private partner (see "Priority 3") needs to assist with the identification and convening of STEM Schools, programs and partners to advance and highlight best practices in every economic development region of the state. These best practices can serve as examples to regions without previous access, can spur additional innovations and partnerships, can assist effective programs in growing, and, ultimately, advance student achievement in every county.

Strategy: Provide a one-stop web-based resource for students, educators, parents, and businesses to access and get involved in the STEM initiative.

Access to information about STEM programs and schools is more critical and more available than ever before. However, no single resource for students, educators, businesses and the general public exist in North Carolina. As in other states, a single resource will allow these critical stakeholders access to each other and to STEM schools and programs with which they would like to be involved. For STEM Schools and Programs, such a single resource can assist in growing programs and partnerships.

A STEM Portal – a one-stop action-oriented web-based resource connecting students, educators, businesses and general public with STEM schools and programs – should take advantage of the valuable efforts undertaken by different organizations in the past. The University of North Carolina General Administration has documented university-level programs targeting K12 education as recently as 2009. The North Carolina Science Mathematics and Technology Education Center also documented and provided a searchable listing of programs targeting K12 math and science opportunities, while the North Carolina Business Committee on Education (NCBCE) has an Education Resource Guide for use by business, within which some overlap with STEM Education occurs.

The NC STEM Community Collaborative at the request of the Lt. Governor's Office, with the support of the Department of Public Instruction the Golden LEAF Foundation, have undertaken the design and project scope for a STEM Portal.

- The collaborative effort has documented over 500 organizations, public and private, with some form of STEM program. These include cross-referenced materials from previous efforts, as well as further statewide surveys.
- A Design Charette and focus groups with over 50 students, educators and administrators, business leaders, policy makers and foundation representatives was held at the Burroughs Wellcome Fund August 2011. The session, facilitated and documented by UNC-CH

School of Government Professor Shannon Tufts and her team, resulted in a report of the nice-to-have and need-to-have features of a STEM Portal for the different stakeholders.

- Surveys of other States' sites and interviews of State personnel regarding the service, features, costs and lessons learned through similar endeavors have been compiled by Stephanie Wright, graduate intern in mathematics and social sciences.
- Private sector support and partnerships have been successfully sought (over $25,000 from two different companies) to support the design and implementation of such a resource.

A STEM Portal is a tangible, useful tool to attract and activate those who wish to connect and advance STEM skills in their area. These previous efforts should be built upon, and it appears private sector funding and expertise combined with public sector endorsement and hosting would provide a comprehensive, action-oriented web-based resource for stakeholders to advance the Statewide STEM Strategic Plan. Appendix IV

Priority 3: Connect, Leverage and Increase STEM Resources

Leveraging public, private, and technology resources will allow North Carolina to achieve the greatest possible impact for its investments. This will require coordination, evaluation, and monitoring of STEM Education programs and initiatives. In addition, this will require formal and informal collaboration between schools, school systems, business and industry, and other private and public sector partners eliminating redundancies, inefficiencies, and inequities. Working together on challenges of scale will require difficult decisions, prioritization, and new models.

Goals:

- ✓ Increase returns on public and private investments in STEM education
- ✓ Align & coordinate the investments of public & private sector partners to scale high-quality programs efficiently

Strategy: Invest public and private funds over the next ten years to scale effective STEM programs, policies and practices throughout every economic development region of North Carolina.

Investments in STEM education have primarily come in the form of federal, state and local public education initiatives – such as *Career & College: Ready Set Go!,* Race to the Top, or Math Science Partnerships, STEM Schools, Career Clusters, etc. Public sector investments in education overall are significantly higher than any other source – private foundation grants, private industry philanthropy, and other financial and in-kind investments from non-governmental sources are less than 2% of education investments. Many of these efforts have resulted in valuable impact for target audiences. Investments in local and individual schools and programs should and will continue. However, sustaining innovative initiatives and scaling the best practices and impacts of these investments and their associated programs has been difficult, if not impossible.

Barriers to scaling high-quality and effective STEM efforts include:

- Lack of clear documentation of impact, effort, or growth parameters for programs
- Lack of sustainable resources – a "pilot" program may be successful, but not be feasible at scale, lack a plan for growth, or be able to access resources to "live" or grow beyond a pilot phase
- Lack of access to a channel to grow high-growth programs
- Lack of connection, understanding or value of out-of-state or nationally-validated programs already in existence
- Loss of interest, public will or continuous leadership support – due to political realities, issues or programs may be shunned or avoided
- Non-supportive or blocking policies – innovative programs may be hampered by existing, and sometimes unassociated policies. When policy waiver procedures exist, they can take time, even when expedited.

STEM education, however, presents a unique opportunity to align public and private investments, especially when focused on scaling what works. Private sector partners can see clearly valuable outcomes in the form of a trained workforce, even in non-traditional areas such as manufacturing and agriculture. The current policy environment also lends itself to policies that support scaling what works rather than building a new or different

effort. Finally, as public sector coffers return either flat or fewer resources, the state will require identification of partners and sharing of responsibility, expertise and models to reach a growing number of students and educators.

In 2010, a number of public and private partners such as The North Carolina Board of Science & Technology recommended an initiative that would include:

- A challenge grant from the State to encourage private sector investments in scaling.
- Identification of and focus on hands-on STEM learning experiences for K-12 grade, with a particular focus on the first 8 years of schooling.
- Success measured through identified student achievement, growth or expansion of programs, increase of access of high-quality programs to all regions, and alignment of programs with ongoing workforce and economic cluster needs of the state and its regions.

The State of Massachusetts, consistently referenced by experts and researchers as a leader in STEM education, recently announced a similar program called "@Scale", to identify programs of high-quality and value to different economic development regions of the state. At the time of launch, public sector funds were in the process of identification, and private sector investments were under consideration once supported publicly.

Given the rapid expansion of North Carolina's knowledge-based economy, the multitude of high-quality programs, and the current environment, a set of public and private sector investments directly focused on scaling programs, policies and practices to every economic development region of North Carolina over the next decade must be identified and coordinated to dramatically increase the STEM skills of North Carolina's workforce.

Strategy: Identify and fund a public/private partner for the coordination, evaluation and monitoring of STEM Education programs and initiatives.

Leveraging public, private, and technology resources will allow North Carolina to achieve the greatest possible impact for its investments. This will require coordination, evaluation, and monitoring of STEM Education programs and initiatives. In addition, this will require formal and informal collaboration among schools, school systems, business and industry, and other private and public sector partners eliminating redundancies, inefficiencies, and inequities.

This will require a public/private partner with:

- Sufficient access to and in-house STEM expertise and business management
- A unique, established network of local, state and national STEM partners, networks and experts
- A willingness to prioritize the scaling and connectivity of high-quality and effective programs across the K20 education-to-workforce continuum above any single program
- The endorsement, support, guidance and input of public and private leaders from across the local, state, and national STEM education, education policy and innovation landscape
- The capacity to accept public or private resources and quickly disperse them, in consultation with NC DPI and other partners, to a network of partners, schools and programs.

The role of this public private partner will include working with NC DPI, and other public and private stakeholders in North Carolina and beyond, to:

- Define the attributes, protocols and resources to quickly and formally enact the recommendations of the Statewide STEM Education Strategic Plan;
- Support districts and schools engagement with each other and with state and national partners, either in person, online or by other means;
- Support effective decision-making, measurement and reporting on STEM tools, policies and practices;
- Research and recruit public and private experts, assets and resources for North Carolina's STEM needs;
- Accept, coordinate and rapidly disperse public and private investments for scaling high-quality STEM programs; and
- Advise on the alignment of policies, practices and partnerships with K20, private, and other sectors impacting STEM education, and vice versa.

Strategy: Incentivize collaborations based on evidence-based policies, programs and practices that greatly increase the number of students gaining STEM skills and continuing in STEM fields of work.

STEM Education occurs at the local level – in the classroom, home, museum, and business. Over 500 organizations engaged in STEM programs are documented. Many of these STEM programs quietly and effectively engage students, increase learning, and serve their target audience. Collaborations with other organizations occur – when mutually beneficial or led by visionary leaders – but, too often, funding, self-interest, energy, and/or programmatic incongruities serve as barriers to large to overcome.

North Carolina needs to incentivize collaborations of programs, schools and partners to advance the number of students gaining STEM skills and continuing fields of work. The following incentives have helped overcome barriers:

- Collaborative Grants – supporting evidence-based programs to extend to new geographies or new target audiences through multi-stakeholder collaboration
- Challenges or Competitions – setting up competitions or design challenges can fuel multi-stakeholder collaboration by providing a goal and some honor or resources for success. X Prize, Ashoka Challenge, or US Department of Education challenges are examples for possible emulation.
- Honors & Awards – celebration of partnerships, innovation and collaborations that extend student STEM skills and STEM fields of work. The Burroughs Wellcome Fund, NC Science, Mathematics Technology Center, and North Carolina Department of Public Instruction and many others award individuals and organizations in Science or Mathematics. Such incentives focused on collaborations also should be considered.
- Media or Travel Support – by providing resource support for travel to face-to-face conferences or study trips or supporting media attention for viable policies, programs and practice across organizations, the barriers for resource-stretched organizations can be overcome.

Strategy: Establish a formal STEM Council to facilitate and coordinate the implementation of North Carolina's comprehensive STEM Strategic Plan.

Science, Technology, Engineering, and Mathematics (STEM) education is vital in positioning NC to have a world-class workforce capable of competing in a global market.

It is recommended that North Carolina formally establish a STEM Council to facilitate and coordinate the implementation of North Carolina's comprehensive STEM Strategic Plan. It is imperative North Carolina develop and maintain continuity among the STEM efforts of the Department of Public Instruction, Department of Community Colleges, public and private universities and the private sector.

Endnotes

This document serves as a ***Draft Framework for this Statewide STEM Strategic Plan***, with the concurrence of the Governor's Education Cabinet, North Carolina's education systems' leadership, the Joint Legislative Joining Our Business & Schools (JOBS) Commission, the NC STEM Advisory Panel, and other public and private partners. The information, recommendations and findings of this report are informed by a broad set of research, reports, data, interviews, initiatives and efforts, including but not limited to:

- *Career & College: Ready Set Go!* North Carolina's K20 Education Plan, The Honorable Governor Beverly Perdue
- Statewide meetings and research of the NC Joining Our Business & Schools (JOBS) Commission, chaired by The Honorable Lt. Governor Walter Dalton
- The Governor's Education Cabinet, North Carolina General Assembly "SL 2010-41 Education Cabinet to Set STEM Priority & Goals", and research conducted by Education First Consulting
- The Career-Ready Commission Report, 2010, chaired by Superintendent June Atkinson
- UNC Tomorrow Report (2008), Inventory of University STEM Programs For K12(v2, 2009), and other research of the University of North Carolina System and its institutions
- NC Community College System Listening Tour, SuccessNC (2010), interviews and other data of NC Community College System and its institutions
- Advancing Innovation in NC (2009), Letter to Governor Beverly Perdue on STEM Needs (2010) and other research and data from the NC Department of Commerce and the NC Board of Science and Technology
- Interviews, research, findings and recommendations of the NC STEM Advisory Panel as well as 600+ local, state and national leaders from public and private organizations, conducted by the NC STEM Community Collaborative
- Publications from the Presidential Office of Science & Technology, US Department of Education, National Governor's Association, US Chamber of Commerce, Business-Higher Education Forum, Manufacturing Institute, Battelle, the Bill & Melinda Gates Foundation and others.

Appendix I
Department of Public Instruction and Department of Community Colleges
Current and Needed STEM Initiatives

The following section highlights **Current Initiatives** and **Needed Initiatives** at the K-12 and Community College level, aligned with the goals within each of the three priorities.

Priority I: Increase STEM Achievement

Current Initiatives

K-12

1. STEM initiative is included in the Race to the Top federal grant to spur public school innovation to include:
   - Great teachers and leaders
   - Quality standards and assessments
   - Turnaround of lowest-achieving schools
   - Data systems to improve instruction
2. Common Core Standards are adopted in Mathematics and Language Arts; essential standards are adopted for all courses to be implemented 2012-2013
3. Ninety schools have Project Lead the Way (PLTW) programs to encourage students to enter the engineering profession
4. Seventy-two STEM Career Academies in Career and Technical Education (CTE) are operating in the State
5. The North Carolina New Schools Project (NC NSP) is developing 50 STEM schools (20 of which are RttT). The STEM curriculum reflects the state's economic workforce needs in North Carolina. The schools initially include the areas of energy and sustainability; health and life science; aerospace and advanced manufacturing; and biotechnology and agriscience.
6. Nine Transformation schools have STEM as a strategy for improvement
7. The North Carolina Virtual Public Schools (NCVPS) is developing eight STEM courses to provide quality teaching resources to remote and low achieving programs.
8. At DPI the 21st Century Community Learning Centers (21st CCLS), under Title IV B federally funded out-of-school projects, are infusing STEM activities into programs.
9. Career and College Promise is a state initiative to broaden and strengthen postsecondary completion.

Community Colleges

10. Completion by Design aims to build on proven, existing practices already underway at a number of forward-thinking community colleges by focusing on new approaches to key events during students' educational experience, from the first time they connect to the college through completion.
11. Enhance Math Capabilities by furthering the development of student math competencies for in-demand STEHM (Science, Technology, Engineering, Health and Math) careers by developing lab-based math instructional models and alternatives to the algebra/calculus track. Work with UNC

System to develop General Education certificate requirement prior to transfer with inclusion of gatekeeper math and English courses.

12. National Association of Manufacturing (NAM) Endorsed Skills Certification System involves aligning manufacturing-related associate degree programs at NC Community Colleges such as machining or mechanical engineering technology with accepted third party industry credentials like National Institute of Metal Working (NIMS) or the Manufacturing Skills Standards Council (MSSC) certifications. In obtaining industry-valued certifications, community college students will demonstrate to prospective employers that they possess the skills and knowledge to be valuable employees.
13. Expand Health Care Programs through weighted funding and greater use of distance education/simulation to enhance instruction and meet clinical requirements.
14. Facilitate College Readiness Standards by collaborating with State Board of Education/DPI to further utilization of community college placement testing prior to 12th grade and coordinate development of remediation strategies to include summer developmental bridge programs. Work with DPI and UNC System to develop alignment between common core high school standards, community college gatekeeper English and math courses, and UNC English and math requirements.
15. Strengthen Technical Education by reengineering technical education to allow for umbrella degrees in information, engineering, transportation, environmental, energy and building technologies with common general education core and stackable credentials/certificates and integrated emphasis on sustainability.
16. Focus Technology-enhanced Initiatives on developing media-based curriculum content, and expanding and coordinating capabilities for immersive learning, simulation, e-books and professional development to support strategic course development targets such as technical education's academic and technical cores; developmental and gatekeeper math redesign; concept-based nursing and health information technology curriculums; and certificate of transfer courses.

Needed Initiatives and Actions

K-12

1. Incorporate STEM strategies in Common Core and Essential Standards for staff development
2. Expand Math and Science for a fourth course in a sequence to include STEM curriculum strategies to encourage students to continue their education in STEM fields
3. Identify Level IV Math and Science substitute courses in the Programs of Study
4. Incorporate STEM strategies in science, technology, engineering and mathematics to develop interest in STEM related occupations
5. Define and support needs of career academies and identify success stories to share
6. Develop plan for recruiting underrepresented minorities and connect with community programs for after school
7. Develop virtual courses to offer STEM related courses in remote areas
8. Develop engineering standards for K-5, 6-8, 9-12 and infuse in curriculum
9. Encourage schools to take the college credit exam with PLTW courses
10. Encourage students to take four courses of the PLTW STEM curriculum
11. Assure schools in Turnaround status who are using a STEM strategy for their improvement plan have access to all resources and communications in STEM and receive the opportunity to participate

12. Provide staff development with teacher education instructors, teachers, counselors and school leaders on:
    a. STEM curriculum
    b. Community and industry engagement
    c. Connections with postsecondary
13. Create, recruit, hire, train, and retain NC STEM teachers initiative to produce the best and brightest professional educators
14. Collaborate with teacher education to support the lateral entry program to recruit teachers to teach in STEM areas

Community Colleges

15. Increase opportunities for entry level job training and degree attainment tied to industry certifications and licensure, and integration with Career Readiness Credentials and employability skills training.
16. Develop model for degree completion to support joint statewide targets with UNC System.

Priority II: Bolster Community Support

Current Initiatives

K-12

1. MCNC NC STEM Community Collaborative provides a single organizing unit for both public and private organizations to support scaling what works in STEM education.
2. Regional Education Services Alliances (RESA) provide coordination of regional activities in educational areas and the Economic Development Education Regions coordinate economic development in seven regions with State Board of Education members participating in each region.
3. The NC New Schools Project (NCNSP) collaborates with the private sector and higher education in the development of networks of STEM schools and districts, including on-going work and leadership through economically themed Industry Innovation Councils. NCNSP also convenes state and national conferences to build support and understanding for the need for comprehensive innovation in schools to ensure students graduate college and career ready.

Needed Initiatives and Actions

K-12

1. Build a Statewide STEM website for all North Carolina
   - Identify and connect schools
   - Identify resources and programs
   - Create a communication portal for schools
2. Build marketing plans on STEM career opportunities, course needs in school, and postsecondary options to recruit students, educators, parents and the community
3. Market the National Association of Engineers 14 Grand Challenges for Engineering to K-12 educators to:
   - Promote an awareness of STEM related issues

- Identify issues facing the US in the 21st Century
- Integrate them throughout education

4. Educate educators, parents and students about our need for STEM educated professionals capable of solving 21st Century concerns
5. Market STEM programs including summer programs for teachers , counselors and students
6. Market North Carolina School of Science and Math's programs for enrichment and professional development for teachers and counselors
7. Increase collaboration among schools, community colleges, colleges and universities, businesses, museums and other interested groups

Community Colleges

8. Enhance and expand the reach of the community college system STEM outreach through the use of BioNetwork's Mobile Training and Outreach program

Priority III: Leverage, Connect and Increase STEM Resources

Current Initiatives

K-12

1. The NC New Schools Project is developing STEM schools that serve as models for professional development and for the State curriculum in four theme areas as well as STEM literacy.
2. NC STEM Community Collaborative is building a web based network of STEM schools, resources, professional development and the ability to communicate among schools
3. The North Carolina School of Science and Mathematics provides specialized curriculum for 650 full-time students; Advanced Placement courses and enrichment programs to nearly 4000 students statewide, and professional development for more than 5000 North Carolina educators
4. Golden LEAF Foundation is supporting 10 STEM grants to grades 4-9
5. Engineering is Elementary® (EiE) sponsored by the Museum of Science in Boston, MA, is a project fostering engineering and technological literacy among children. The curriculum promotes K-12, science, technology, engineering and mathematics (STEM) learning and connects with literacy and social studies. There are three (plus 11 have received training) school systems in North Carolina using this curriculum. Professional development is sponsored by a staff member in the North Carolina State University College of Engineering
6. 4-H is developing STEM curriculum for out-of-school programs
7. NC Science, Math and Technology Education Center, through an USED Investing in Innovation (I3) Grant, is validating the implementation and impact of science inquiry-based instruction and materials in 46 schools (grades 1-8; 1100 teachers) in 7 districts over five years.
8. Burroughs Wellcome Fund supporting 5 low-performing elementary schools and one low wealth district for a six-year Singapore Math initiative, funding up to 8 new afterschool programs each year across the state that offer STEM activities, and identifying and funding for five years master STEM teachers to work with their districts and the state.
9. The Kenan Fellows Program for Curriculum and Leadership Development pairs at least 50 outstanding, practicing North Carolina teachers annually with STEM leaders in industry, education and academia for

a summer of research and intensive professional advancement, driven by North Carolina's specific economic development needs to increase STEM literacy and produce effective lessons for K12 educators.

10. NC Center for Afterschool Programs is partnering with the NC Museum of Natural Sciences to host annual statewide Youth STEM Summits and more broadly connect museums across the state with afterschool programs in the arenas of education, outreach, and professional development.

Needed Initiatives and Actions

K-12

1. Catalog programs and resources available to STEM K-12
2. Define STEM attributes for North Carolina public schools
3. Identify resources to support STEM inside and outside of the agency
4. Identify programs inside and outside the agency to infuse STEM education
5. Provide structure for private and public funds and in-kind resources to efficiently support scaling programs that are working to reach more students, educators, and communities

Community Colleges

6. Enhance weighted funding for technical education programs at community colleges.

Appendix II
Department of Public Instruction and Department of Community Colleges
Progress Measures

The following sections highlight additional Progress Measures at the K-12 & Community College level, aligned with the three priorities.

Potential Progress Measures/Indicators

Increase STEM Achievement

K-12

1. The percentage of STEM students graduating from high school in four years is increased
2. Fewer STEM students require remediation in postsecondary
3. There is an increase in postsecondary enrollment in STEM areas
4. The number of schools obtaining a STEM designation is increased
5. Student achievement in mathematics and science is improved.
6. There is greater inclusion of mathematics and science in the elementary schools
7. The number of students taking a fourth course in a sequence of math and science is increased
8. The number of students in a STEM career pathways is increased
9. The number of students continuing their education in STEM is increased
10. More underrepresented females, minorities, and economically disadvantaged students are in level four courses
11. The underrepresented females, minorities, and economically disadvantaged students in postsecondary education in STEM areas are is increased
12. The number of students completing virtual STEM courses is increased
13. Engineering standards are developed for K-5, 6-8, 9-12 and infused in curriculum
14. The number of students who complete college exams for PLTW courses is increased
15. The number of students in four PLTW courses is increased
16. STEM initiatives helped decrease the number of schools in Turnaround status
17. All teachers have access to job-embedded professional development to build educator capacity in both content and pedagogy for STEM learning experiences
18. The number of teachers and administrators participating in quality STEM education professional development is increased
19. The number of teachers qualified to teach in STEM areas is increased

Community Colleges

20. Percentage of first-time fall credential-seeking community college students who successfully complete ("C" or better) at least twelve hours within their first academic year
21. Percentage of previous developmental math students successfully completing a credit math course with a "C" or better upon the first attempt (within one year of developmental completion).

22. Percentage of first-time fall community college credential-seeking student graduation, transfer, or still enrolled with 36 hours after six years
23. Percentage of community college associate degree completers and those who have completed 30 or more credit hours with a GPA of 2.00 or better at a four-year college or university after two consecutive semesters within the academic year.

Bolster Community Understanding

1. Website portal is developed to connect schools identifying resources and create an communication portal for schools
2. Marketing plan is developed for :
    - Career opportunities
    - Postsecondary options
    - 14 Grand Challenges
    - Community Understanding
3. Data systems are established to measure student success and inform school personnel and legislature about how to improve the delivery of STEM education
4. Collaboration among interested groups is evident

Leveraging & Connecting Resources

1. Directory of programs and resources and professional development is defined for school use
2. Curriculum in STEM areas has infused project-based activities for all teachers
3. Aerospace; Health Sciences; Pre-engineering; and Agriscience and Biotechnology curriculum are developed for schools
4. There is an increase in the number of resources available to the schools for STEM education
5. There is an increase in the number of STEM out-of school programs available

Appendix III
STEM Schools Rubric (Draft)

Appendix IV

Appendix IV – Web-based Resource Design Documents

(pdf)

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