



Department of
Education

STEM Strategic Plan

An Integrated K-12 STEM Proposal for Tennessee

Division of College, Career & Technical Education | Revised January 2018



Executive Summary

The need for fully integrated K–12 STEM education in Tennessee has never been more critical. STEM (science, technology, engineering, and math) is the fifth-fastest-growing occupational cluster in the South and the seventh-largest employer with projected employment of 2.6 million workers by 2020. In order to prepare our students to take advantage of the vast opportunities in this field, we must equip students with the knowledge and skills to successfully embark upon a STEM pathway and ultimately a high-demand STEM-related career. Too many STEM jobs are being left unfilled, meaning our graduates are missing valuable opportunities to join one of the fastest growing industries in the nation. STEM education stands as a key strategy to address these gaps, provide additional opportunities to Tennessee students, and to strengthen Tennessee’s economic future.

If Tennessee is to lead the nation in STEM industry growth, it is essential that Tennessee adopt and promote robust STEM-based instruction utilizing Tennessee math and science standards as the primary focus. By aligning state math and science standards with STEM practices, we can increase student achievement in STEM learning, expand student access to effective STEM educators, and build broad-based community awareness for STEM professions. Together, Tennessee can equip students for the STEM careers of the future and lead the nation in STEM talent development.

In June 2014, the Tennessee Department of Education established a STEM Leadership Council to address the issue of STEM-related gaps. Specifically, the council has examined how to provide primary and secondary students in Tennessee access and exposure to rigorous STEM-related learning pathways through the state’s math and science standards. This work is all with the ultimate goal of postsecondary attainment and the development of a dynamic pipeline of future STEM professionals who are highly skilled across industries and in academic research.

These priorities along with the essential stakeholders who will lead the collaborative statewide approach are woven throughout this document (*Figure 1*). This STEM strategic plan will set Tennessee on a path to lead the nation in meaningful STEM-based instruction, anchored by the new rigorous state math and science standards, and ensuring a strengthened position in the national and global STEM-related industrial fields.

Figure 1



Strategic Recommendation Summary

Under the direction of the STEM Leadership Council and in partnership with the Tennessee Department of Education, the following recommendations have been developed to address the full integration of STEM education in K-12 learning. These recommendations reflect the promotion of a fully integrated approach, targeting four priority areas to drive the integrative work of state math and science standards with broader STEM-related focuses. These four priority areas are: curriculum and instruction, student achievement, educator professional development, and community and postsecondary partnerships.

Successfully addressing the four priority areas within the K-12 STEM strategic plan depends heavily on dedicated and integrated science instruction, as mandated by our new science standards to be implanted during the 2018-19 school year. The Tennessee Science Standards require the integration of technology and engineering within and beyond the science context. This, alongside the intentionally aligned mathematics standards will result in a STEM instructional plan for all students.

Curriculum and Instruction

Summary: Develop a seamless integration of curriculum incorporating new state math and science standards with STEM instructional practices and career exploration applications.

Strategy: Create integrated math and science modules for K-12 focusing on the new Tennessee state math and science standards connecting STEM practices and career applications.

Recommendations:

- Create K-12 modules that utilize the new Tennessee math and science standards and incorporate STEM instructional practices and career exploration for students.
- Provide instructional and community resources for the integration of K-12 classroom learning and external-based learning opportunities focusing on project-based, hands on learning and applications.

Achievement

Summary: Strong math and science curricula and instruction can ensure strong growth in student achievement in Tennessee.

Strategy: Ensure STEM components, which are already present in the state's math and science standards, are taught in a cohesive, innovative fashion such that student achievement scores increase and are representative of an integrative STEM learning approach.

Recommendations:

- Develop integrative guidance for districts that incorporates math and science student achievement along with other components essential to the development of strong school STEM cultures and focuses.
- Create a designation, in partnership with the Tennessee STEM Innovation Network, which recognizes schools for promising practices in integrative STEM instruction.

Professional Development

Summary: Create an environment that allows educators to continue to learn and pursue opportunities that will build their capacity to provide better STEM learning opportunities for students.

Strategy: Design professional development that provides support in implementing STEM integration for all teachers K-12, particularly in the fields of math and science utilizing the state standards.

Recommendations:

- Provide and support consistent funding for high-quality STEM professional development in conjunction with the rollout and ongoing support of the state math and science standards.
- Adopt guidelines for quality STEM educator professional development.
- Create quality STEM micro-credentials to provide STEM educators a standard for high-quality STEM practices.
- Implement a system of periodic reviews of state STEM-related professional development practices and monitor effectiveness.

Community and Postsecondary Partnerships

Summary: Both community and postsecondary STEM partnerships play a critical role in creating meaningful connections between state math and science standards taught in the classroom and practical applications outside of school. These partnerships can create an environment in which students develop high-level STEM skills and knowledge inside and outside of the classroom and increase their readiness for future careers.

Strategy: Establish community and postsecondary STEM partnerships that provide meaningful connections for students.

Recommendations:

- Partner with postsecondary institutions to create seamless STEM pathways, ensuring all students are postsecondary and career ready.
- Advocate for policies and legislation that provide incentives for the creation and sustainability of partnerships, CTE opportunities, and hands-on learning opportunities. This will be accomplished through student work-based learning experiences, teacher externships, and student and teacher research opportunities.
- Develop the ability to access and exchange information across the state regarding STEM partnerships in order to track outcomes and support partnership creation and development.

State of STEM in Tennessee

Right now, there is a shortage of qualified STEM job applicants to fill the demand our state has. In order to ensure we have a ready workforce to fill the pipeline of STEM related career needs, we must ensure that Tennessee students are well prepared for the challenges of a STEM career. In order to advance economically, Tennessee is shifting attention to new technology in order to modernize conventional economic divisions such as agriculture and manufacturing.¹ Failure to meet this need will lead our state's STEM-related businesses to seek other means to meet demand, including moving their companies outside our state or importing talent from outside our borders.

STEM is the fifth fastest growing occupational cluster in the South and the seventh largest employer, with projections of 2.6 million workers by 2020. STEM jobs are central to the innovation and technological growth of this state. This in turn makes many policy and business leaders strong proponents of increasing the STEM-education pipeline. STEM jobs pay well at every level, presenting graduates with vast opportunities to launch a career and a life. It is a trend that remains consistent across time, making STEM jobs a strong factor in increasing the broader state tax base.²

As Tennessee strives to maintain and advance its economic stability and workforce, we must make it our goal to increase the number of students who come through and out of K-16 education prepared for these high-demand STEM-related careers. Unfortunately, students who choose to pursue these careers are often inadequately prepared to take on the challenges these positions demand. Secondary and postsecondary students are often lacking critical thinking, problem solving, and collaborative skills that are imperative for success. This too often affects their on the job performance. Students often struggle not only with academic knowledge when applying for a job, but they also face challenges involving real world applications like problem solving, conducting independent research, and proactively seeking solutions.

¹ Rosenblum, I., & Kazis, R. (n.d.). Middle-Skill STEM State Policy Framework. Retrieved April 1, 2016, from <http://www.jff.org/publications/middle-skill-stem-state-policy-framework>

² Rosenblum, I., & Kazis, R. (n.d.). Middle-Skill STEM State Policy Framework. Retrieved April 1, 2016, from <http://www.jff.org/publications/middle-skill-stem-state-policy-framework>

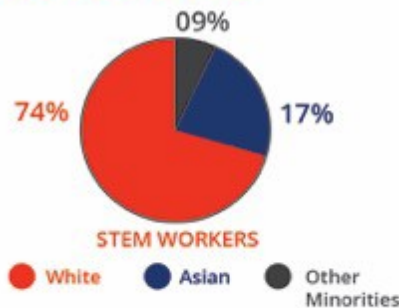
As a state, we also recognize that we must close the STEM gap for women and minorities. Women and minority groups represent approximately 70 percent of college students in the U.S., but receive only 45 percent of the undergraduate degrees awarded in STEM disciplines.³ STEM is not only the place where the vast majority of the highest paying jobs are found, it is also the place where the wage gap between men and women is the smallest. Currently, in STEM fields, women earn 92 cents for every dollar earned by men, compared to 77 cents for other non-STEM fields.

Even as STEM careers offer the smallest gender wage disparity, the following sobering statistics illuminate the urgency to invest more girls and minorities in the field:

STEM Facts on Women & Girls



74% of STEM workers are male. Only 26% are female.



Women comprise more than 20% of engineering school graduates, yet only 11% of practicing engineers are women.



Women were 28% of all workers in S&E occupations in 2010, up from 21% in 1993.

Women's presence among computer/mathematical scientists declined from 31% to 25% over the period, but only because men's rate of growth in this area was higher than women's. The number of women working in computer/mathematical sciences has increased more than in any other broad occupational area.



Of 100 female bachelor students, 12 graduate with a STEM major but only 3 continue to work in STEM fields 10 years after graduation.



The wage gap between women and men is much smaller in STEM occupations than other occupations. In STEM fields, women earn \$0.92 for \$1 earned by men, compared to \$0.77 for other fields.



Although women fill close to half of all jobs in the U.S. economy, they hold less than 25 percent of STEM jobs.

Women with STEM jobs earned 33 percent more than comparable women in non-STEM jobs, considerably higher than the STEM premium for men. As a result, the gender wage gap is smaller in STEM jobs than in non-STEM jobs.

³ Executive Office of the President: President's Council of Advisors on Science and Technology (2012). "Report To The President Engage To Excel: Producing One Million Additional College Graduates With Degrees In Science, Technology, Engineering, and Mathematic. http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-executive-report-final_2-13-12.pdf

Strategic Recommendations

The STEM Leadership Council was established in June 2014 to address the issue of STEM-related gaps. The council formed to address how to provide primary and secondary students in Tennessee access and exposure to rigorous STEM-related learning pathways leading to postsecondary achievement and the development of a diverse, robust, and dynamic pipeline of future STEM professionals who are highly skilled across industries and in academic research. (See Appendix A)

The following sections provide greater detail concerning the strategic plan recommendations. Each of the four priority areas (Figure 2) reflect the promotion of a fully integrated K-12 STEM approach reflective of the state’s math and science standards as the central focus to drive this integrative work.

Figure 2



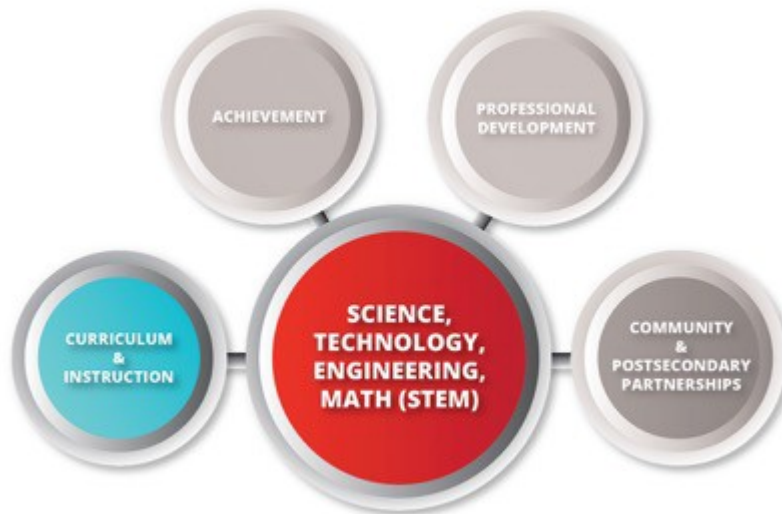
Successfully addressing the four priority areas within the K-12 STEM strategic plan depends heavily on dedicated and integrated science instruction, as mandated by our new science standards to be implanted during the 2018-19 school year. The Tennessee Science Standards require the integration of technology and engineering within and beyond the science context. This, alongside the intentionally aligned mathematics standards will result in a STEM instructional plan for all students.

Four Priority Areas for K-12 STEM



The four priority areas, which are reflective of the state’s new math and science standards, are addressed in depth below outlining the action steps needed to close the STEM academic and skills gaps in Tennessee.

Priority One: Curriculum and Instruction



Key Recommendations Overview:

1. Create K–12 modules that utilize the new Tennessee math and science standards and incorporate STEM instructional practices and career exploration for students
2. Provide instructional and community resources for the integration of K-12 classroom learning and external-based learning opportunities, focusing on project-based, hands on learning and applications

1. Create K–12 modules that utilize the new Tennessee math and science standards and incorporate STEM instructional practices and career exploration for students

We recognize the importance of creating K-12 modules to ensure development of a seamless integration of curriculum incorporating the Tennessee state math and science standards with STEM practices and career exploration applications. To accomplish this we will:

Elementary (K–5)

1. Expose students to the content and engaging STEM applications in curriculum using the Tennessee state math and science standards and STEM practices
 - a. Consistently incorporate STEM vocabulary and practices aligned with the literacy expectations of the Tennessee math and science standards
 - b. Incorporate integrated lesson modules using the Tennessee state math and science standards highlighting different STEM practices and applications
 - c. Highlight STEM careers within the modules

2. Develop and coordinate professional development of district and school personnel responsible for implementing integrated STEM instruction
 - a. Math teachers, science teachers, instructional coaches, and guidance counselors

Middle School (6–8)

1. Expose students to the content and engaging STEM applications in curriculum using the Tennessee state math and science standards and STEM practices
 - a. Continue to develop and apply STEM vocabulary and practices as directed by the literacy expectations of the Tennessee math and science standards.
 - b. Incorporate integrated lesson modules using the Tennessee state math and science standards highlighting different STEM practices and applications
 - c. Incorporate STEM career applications within the integrated modules
 - i. Create integrated STEM lessons highlighting different careers using real-world applications emphasis on college and career ready
 - ii. Develop visual pathways to postsecondary for STEM careers
 - iii. Construct career interest surveys
 - iv. Compose a database of industries for STEM career fairs, industry speakers and tours
2. Develop and coordinate professional development of district and school personnel responsible for implementing the STEM career modules
 - a. Math teachers, science teachers, instructional coaches, STEM teachers, and guidance counselors

High School (9–12)

1. Expose students to the content and engaging STEM applications in curriculum using the Tennessee state math and science standards and STEM practices
 - a. Continue to develop and apply STEM vocabulary and practices as directed by the literacy expectations of the Tennessee math and science standards.
 - b. Incorporate integrated lesson modules using the Tennessee state math and science standards highlighting different STEM practices and applications
 - d. Incorporate STEM career applications within the integrated modules
 - i. Create integrated STEM lessons highlighting different careers using real-world applications emphasis on college and career ready
 - ii. Develop visual pathways to postsecondary for STEM careers
 - iii. Compose a database of industries for STEM career fairs, industry speakers and tours

2. Develop and coordinate professional development of district and school personnel responsible for implementing the STEM career modules
 - b. Math teachers, science teachers, instructional coaches, STEM teachers, and guidance counselors
3. Embed STEM strategies and applications into CTE coursework to ensure students are receiving hands-on real-world applications.

2. Provide instructional and community resources for the integration of K-12 classroom learning and external-based learning opportunities, focusing on project-based, hands on learning and applications

We understand the significance of providing resources that connect the importance of extending STEM practices and applications beyond the traditional school day. Some examples may include, but not limited to:

Elementary (K-5)

1. Provide external learning opportunities:
 - a. Promote SkillsUSA's "Jump into STEM" career exploration curriculum
 - b. Advocate for career exploration online resources

Middle School (6-8)

1. Provide external learning opportunities:
 - a. Advocate for career exploration online resources
 - b. Promote Technology Student Association for middle school

High School (9-12)

1. Provide external learning opportunities:
 - a. Promote Technology Student Association for high school
 - b. Advocate for SkillsUSA for high school
 - c. Advocate for career exploration online resources



Priority Two: Achievement



Key Recommendations Overview:

1. Develop integrative guidance for districts that incorporate math and science student achievement along with other components essential to the development of strong school STEM cultures and focuses
2. Create a designation, in partnership with the Tennessee STEM Innovation Network, which recognizes schools for promising practices in integrative STEM instruction

1. Develop integrative guidance for districts that incorporate math and science student achievement along with other components essential to the development of strong school STEM cultures and focuses

We acknowledge the relevance of ensuring the STEM components, which are already present in the state's math and science standards, are taught in a cohesive, innovative fashion such that student achievement scores increase and are representative of an integrative STEM learning approach. To accomplish this we will:

1. Create rubrics assessing STEM practices and allow students (K-12) to demonstrate proficiency as aligned with the Tennessee math and science standards

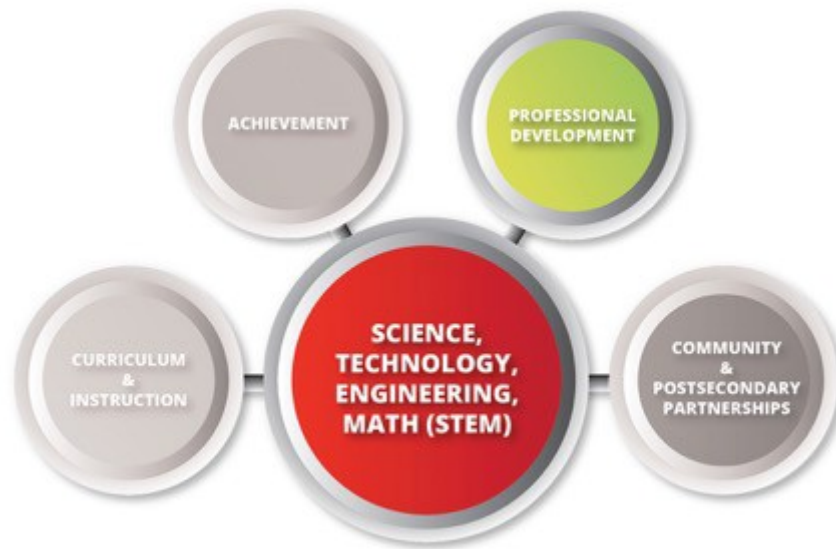


2. Create a designation, in partnership with the Tennessee STEM Innovation Network, which recognizes schools for promising practices in integrative STEM instruction

We respect the value of recognizing schools that value the importance of aligning STEM promising practices with Tennessee state math and science standards to increase student achievement. To accomplish this we will:

1. Create a STEM school designation sub-committee from the STEM Leadership Council consisting of effective STEM school leaders and representatives from across the state
2. Create an application process and an evaluation rubric based on the criteria set by the committee
3. Provide recommendations in partnership with the Tennessee STEM Innovation Network and the Tennessee Department of Education for which schools and/or programs are recommended for designation
4. Offer technical assistance to applicant schools and/or programs on STEM integration
5. Provide a platform for an annual recognition event

Priority Three: Professional Development



Key Recommendations Overview:

1. Provide and support consistent funding for high-quality STEM professional development in conjunction with the rollout and ongoing support of the state math and science standards
2. Adopt guidelines for quality STEM educator professional development
3. Create quality STEM micro-credentials to provide STEM educators a standard for high-quality STEM teacher practices
4. Implement a system of periodic reviews of state STEM-related professional development practices and monitor effectiveness

1. Provide and support consistent funding for high-quality STEM professional development in conjunction with the rollout and ongoing support of the state math and science standards

We affirm the significance of ensuring that professional development provided is seamless in the integration of math, science, and STEM practices. To accomplish this we will:

1. Advocate and support consistent funding for high-quality STEM professional development

2. Adopt guidelines for quality STEM professional development

We recognize the interest of creating policies to ensure high quality professional development. To accomplish this we will:

1. Create “gold standard” professional development that supports the integrated K–12 STEM initiative
 - a. Develop professional development centered on curriculum and instructional partnerships
 - b. Design professional development centered on partnerships with businesses, practices, or materials in partnership with the Tennessee STEM Innovation Network hubs

3. Create quality STEM micro-credentials to provide STEM educators a standard for high-quality STEM teacher practices

We acknowledge the need for STEM micro-credentials that will prepare educators to be proficient in effective STEM teaching. To accomplish this we will:

1. Create STEM micro-credentials that will ensure our teachers are effective, capable, willing and eager to imbed the use of STEM practices in their classroom
 - a. Collaborate with the Tennessee STEM Innovation Network to create a series of STEM Micro-credentials that will lead to a Tennessee STEM Master Educator credential.

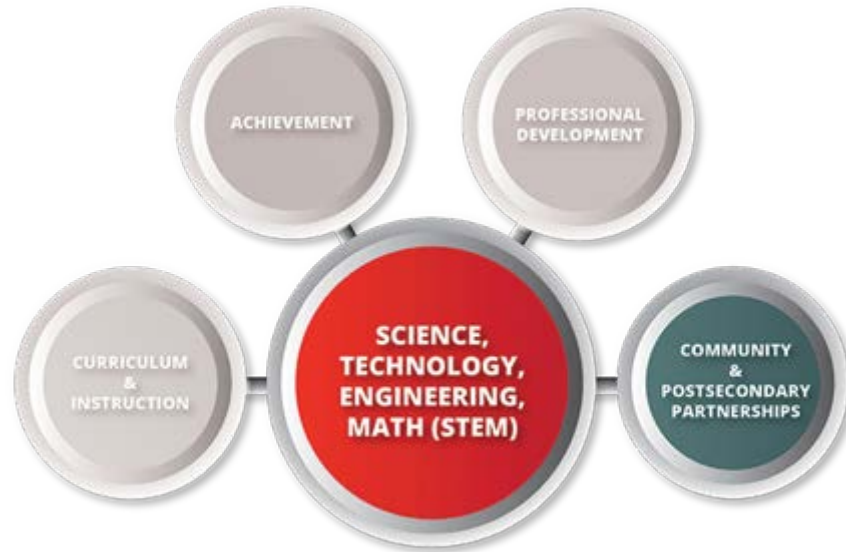
4. Implement a system of periodic reviews of state STEM-related professional development practices and monitor effectiveness

We affirm the need of a system for review of STEM professional development. To accomplish this we will:

1. Design rubrics that support the effectiveness of STEM related professional learning practices



Priority Four: Community & Postsecondary Partnerships



Key Recommendations Overview:

1. Partner with postsecondary institutions to create seamless STEM pathways ensuring all students are postsecondary and career ready
2. Advocate for policies and legislation that provide incentives for the creation and sustainability of partnerships, CTE opportunities, and hands-on learning opportunities. This will be accomplished through student work-based learning experiences, teacher externships, and student and teacher research opportunities
3. Develop the ability to access and exchange information across the state regarding STEM partnerships in order to track outcomes and support partnership creation and development

1. Partner with postsecondary institutions to create seamless STEM pathways ensuring all students are postsecondary and career ready

We recognize the importance of partnerships with postsecondary institutions to establish the understanding of STEM pathways. To accomplish this we will:

1. Improve existing partnerships and develop new partnerships with postsecondary institutions to collaborate on creating appropriate STEM pathways for students preparing them to be postsecondary and career ready

2. Advocate for policies and legislation that provide incentives for the creation and sustainability of partnerships, CTE opportunities, and hands-on learning opportunities. This will be accomplished through student work-based learning experiences, teacher externships, and student and teacher research opportunities

We understand the need to promote more external STEM opportunities for students that will allow for more collaboration between internal and external stakeholders. To accomplish this we will:

1. Create career exploration programs through partnering with local businesses (job shadowing, work based learning, internships, and externships)
2. Design career exploration fairs
3. Plan family STEM nights
4. Collaborate with local museums, libraries, parks, and community-based organizations providing experiences outside the classroom

3. Develop the ability to access and exchange information across the state regarding STEM partnerships in order to track outcomes and support partnership creation and development

We acknowledge the importance of establishing partnerships to collaborate consistently with to support STEM initiatives across the state. To accomplish this we will:

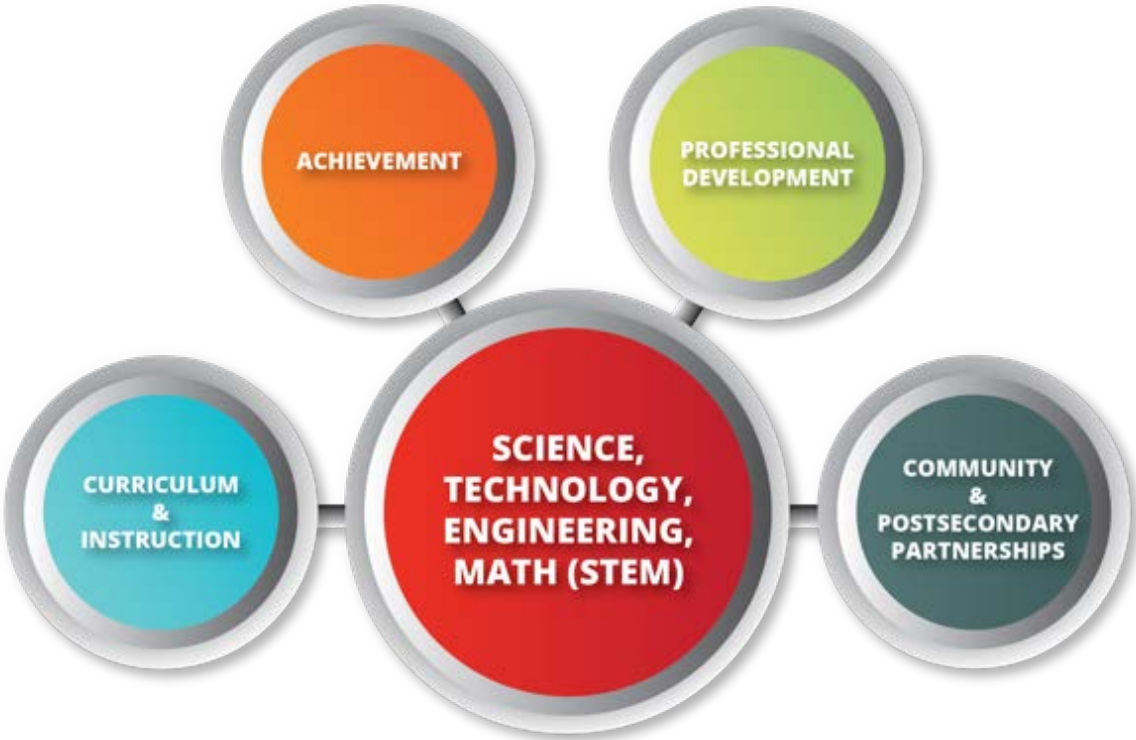
1. Create outlets to engage students, parents, teachers, and community organizations and businesses to address regional needs in STEM education through information and resource sharing
2. Advance initiatives with the partnership between local businesses and the STEM hubs to provide grant opportunities and scholarships
3. Establish professional development “warehouses” in utilizing access to the STEM hubs
4. Develop the connection between schools and the needs of local business



Conclusion

Through the adoption of this plan, the state will be poised to take the steps necessary to lead the nation in STEM-based instruction to ensure a strengthened position on the national and global STEM front.

This collaborative, statewide approach will help shape and strengthen Tennessee’s future both academically and economically. Implementing fully integrated K-12 STEM education, aligned to the department’s own strategic plan, ensures that we are creating opportunities for every child in Tennessee.



Appendix A: STEM Leadership Council Members

June 2014- June 2016

- **Tonya Mullinax** – Fourth Grade, E.L. Ross Elementary School, Cleveland City Schools
- **Margie Hawkins** – Science, Winfree Bryant Middle School, Lebanon Special School District
- **Lawrence Nussio** – Math and RTI, Rogersville Middle School, Hawkins County Schools
- **Shelli Brasher** – CTE STEM, Collierville High School, Collierville Schools
- **Adam Lightman** – Math, McGavock High School, Metro Nashville Public Schools
- **Dr. Joann Shriner** – Math & Virtual Learning, Putnam County School System
- **Dr. Glenn Acree** – Professor, Mathematics, Belmont University; Nashville Technology Council
- **Dr. Jim Barrott** – Vice President, Technology & Director, Tennessee College of Applied Technology, Chattanooga State Community College
- **Dr. Amy de Jongh Curry** – Associate Professor, Biomedical Engineering, University of Memphis
- **Dr. Chih-Che Tai** – Assistant Director/Professor of Science Education, Center of Excellence in Mathematics and Science Education, East Tennessee State University
- **Dr. Tracey Beckendorf-Edou** – Supervisor of Staff Development and Special Projects, Oak Ridge Schools
- **Melissa Abel** – Secondary Instructional Supervisor, Germantown Municipal School District
- **Rocky Riley** – Career and Technical Education Supervisor, Knox County Schools
- **Dr. B.J. Worthington** – Director of Schools, Clarksville-Montgomery County School System
- **Kathy Black** – Senior Vice President, Human Resources and Communications, Tennessee Valley Authority
- **Susan Duvenhage** – President & Chief Executive Officer, Adventure Science Center
- **Keith Hamilton** – Manager, North America Manufacturing, Bridgestone Americas
- **Bathsheba Sams** – Vice President, Human Resource Operations and Global Human Resources, International Paper
- **Ann Thompson** – Director, Workforce Development, Tennessee Department of Economic and Community Development
- **Wes Hall** – Director, Tennessee STEM Innovation Network (TSIN)
- **Dr. Danielle Mezera** – Assistant Commissioner, Division of College, Career and Technical Education
- **Heather Justice** – Executive Director of Career and Technical Education
- **Dr. Tammy Shelton** – Executive Director, Content & Assessment Design
- **Deborah Knoll** – STEM Career Cluster Consultant, Office of Career and Technical Education

Appendix B: STEM Leadership Council Members

June 2016–June 2018

- **Kattie Nash** – STEM Teacher, Prescott South Elementary, Putnam County School System
- **Sarah Jessie** – Instructional Science Specialist, Rutherford County Schools
- **Amy Smith** – Science Teacher, Millington Middle School, Millington Municipal Schools
- **Evelyn Bishop** – STEM Coordinator, Clarksville-Montgomery County School System
- **Randy Puckett** – CTE STEM Teacher, William Blount High School, Blount County Schools
- **Melissa Abel** – Secondary Instructional Supervisor, Germantown Municipal School District
- **Jessica Minton** – High School Science/STEM teacher, Germantown Municipal School District
- **Andrea Allen** – Science Supervisor K-12, Knox County Schools
- **Laurie Drummond** – School Counselor (K-5), W.A. Wright Elementary School, Wilson County Schools
- **Meri Kock** – School Counselor (9-12), Summit High School, Williamson County Schools
- **Clark Knight** – CTE Director, Shelby Municipalities
- **Holly Cross** – CTE Director, Oak Ridge City School System
- **Dr. Ashley Aldridge** – Elementary Principal, Jack Anderson Elementary, Sumner County Schools
- **Gordon Williams** – Mechatronics Program Director, Roane State Community College
- **Dr. Arrita Summers** – Director, TCAT Dickson
- **Dr. Stephanie Weeden-Wright** – Professor of Practice Electrical & Computer Engineering, Lipscomb University
- **Joelle Phillips** – President, AT&T Tennessee
- **Henry Schulson** – Executive Director, Creative Discovery Museum
- **Jan McKeel** – Executive Director, South Central Tennessee Workforce Alliance
- **Wes Hall** – Director, Tennessee STEM Innovation Network (TSIN)
- **Dr. Stephanie Ivey** – Project Director, West Tennessee STEM Hub; Associate Professor Department of Civil Engineering, University of Memphis; Director of the Intermodal Freight Transportation Institute and Southeast Transportation Workforce Center, University of Memphis
- **Deborah Knoll** – Council Lead and STEM Career Cluster Consultant, Office of CTE

- **Tennessee Department of Education STEM Leadership Council Advisors:**
 - **Candi Norwood** – Director of Student Success, Office of CTE
 - **Brian Caine** – Coordinator of Science, Office of Content & Assessment Design
 - **Melissa Haun** – Math Coordinator, Office of Content & Assessment Design
 - **Leigh Bagwell** – Coordinator for School Counseling, Office of Student Readiness & Early Postsecondary
 - **Robbie Mitchell** – Executive Director of Academic Strategy & Operations, Office of Academic Strategy & Operations
 - **Patrice Watson** – Executive Director of College & Career Pathways, Office of College & Career Pathways