S²TEM Centers SC

Solutions in Science, Technology, Engineering & Mathematics Education

S²TEM SC Innovation Configuration (IC) Map

Total Instructional Focus: Professional Learning

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White Paper: Professional Learning

Standard: Professional learning for STEM educators: is a system of continuous improvement that increases educator effectiveness in preparing students for success in college, careers, and citizenship; it is sustained by skillful leaders, data informed, research based and aligned with the school's mission, vision, and goals for STEM education.

Continuous Process

The school's mission, vision and goals for STEM education drive the continuous process of professional learning. It is keenly focused on the knowledge, skills, and dispositions that educators need in order to produce positive student outcomes. Personal and professional learning community goals are aligned with those of the school and district and monitored through an iterative cycle that includes these essential elements:

- identifying goals,
- planning,
- implementing,
- gathering evidence,
- self-assessing, and
- adapting.

The workforce and the community at large benefit from a well-educated citizenry. Therefore, the full school community, individually and collectively take action towards ongoing improvement with purpose and self-awareness through this recursive pattern.

Data Informed

Data collection and analysis is essential to this process. STEM professional learning is planned, implemented, and evaluated for effectiveness using a variety of sources and types of student, educator, and system data that answers these questions:

- What are the needs of the workforce locally and globally?
- In what ways do the demographics of staff and community impact teaching and learning?
- What learning strengths and deficits are our students demonstrating in current grades, subsequent grades and beyond K-12 schooling?
- What strengths and areas of growth are identified through classroom observations?
- Do our stakeholders perceive that our school is preparing students for college, careers, and citizenship?

The school is proactive in seeking the data to address these questions and use the analysis to shape the overall professional learning plan equipping educators with standards-based content and pedagogical content knowledge.

Deep Content Understanding

With the world growing in complexity at a rapid place, it is essential teachers have deep content understanding in the subjects they teach, and that they engage in continuous learning. The National Research Council report, *Successful K-12 Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*, states, "Teaching in ways that inspire all students and deepen their understanding of STEM content and practices is a demanding enterprise." The report goes on to suggest that middle and high school teachers earn degrees and achieve certifications in the subjects that they teach. Horizon Research cites studies that indicate a positive influence of math and science teachers' content knowledge on three key areas: how teachers engage students with the subject matter, how teachers select instructional materials, and how well students achieve in those subjects.

Theory in Action – STEM Professional Learning Experience

Pedagogical Content Knowledge

In addition to deep content knowledge, teachers need to be highly competent in teaching their discipline in order to make it comprehensible to others. Pedagogical content knowledge (PCK) is a phrase coined by educational psychologist, Lee Shulman. PCK is, he suggests, "a category of professional knowledge that distinguishes teachers from others who might know a subject well, but have no occasion to develop the knowledge entailed in teaching a subject." Areas of focus for STEM educators include:

- creating an innovative, collaborative classroom culture;
- aligning STEM assessments and instructional strategies with a standards-based STEM curriculum;
- implementing problem-based learning;
- integrating technology purposefully;
- incorporating 21st Century practices;
- promoting civic responsibility; and
- addressing the unique learning needs of those underrepresented in STEM fields.

STEM professional learning incorporates research on learning theories and STEM-focused pedagogy to build educators' capacity to positively impact intended student outcomes. Graduate classes, workshops, webinars, and other formats are available for teachers to further their STEM learning; however, the most powerful and sustained learning occurs when professionals learn together in learning communities.

STEM Professional Learning Communities

The WestEd report, *STEM Teachers in Professional Learning Communities: From Good Teachers to Great Teaching,* states, "To meet the needs of today's learners, the tradition of artisan teaching in solo-practice classrooms will have to give way to a school culture in which teachers continuously develop their content knowledge and pedagogical skills through collaborative practice that is embedded in the daily fabric of their work." The expectation in STEM schools is that teachers share their expertise. Efforts to develop and maintain a professional learning community in STEM-minded schools are continuing and systemic. School leaders set expectations, providing the time and space for teachers to plan instruction and learn from student work and data. Participants in STEM PLCs share values, goals and collective responsibility for the learning that impacts student achievement.

Supports Long Term Change

STEM professional learning applies current research on adult learning and provides educators with support for long-term change in practice. This support is differentiated based on the needs of the professional learner as he or she moves from novice to expert in the implementation of STEM principles. As learning goals are set and monitored through a continuous cycle of improvement, the educator engages in self-assessment, and receives appropriate interventions, modeling and descriptive feedback from the professional learning community. According to Learning Forward's Standards for Professional Learning, "…researchers have found that it can take 50 or more hours of sustained professional learning to realize results for students." With positive learning results for students being the primary aim of professional learning, its value must be demonstrated through collective commitment and the provision of time and resources.

IC Maps Purpose

According to Shirley Hord (2006), "Innovation Configuration Maps, or IC Maps, provide a description of what a specific educational innovation "looks like" when well implemented. It provides a mental image of an innovation in operation and "vision" toward which the user is moving. Thus, the IC map provides a tool that shares information and helps individuals and organizations figure out where they are and what they need to do to move toward implementation." S²TEM Centers SC has created an IC map for Characteristics of High Functioning STEM schools and schools wanting to become more STEM-Minded.

The desired outcome is stated on the left. Decreasingly desirable levels along the continuum are to the right. *Sustaining* signifies the ideal and highest quality of implementation and reflects the processing of all actions through a data-informed, evidence-based continuous improvement process.

STEM schools aligned with the criteria identified in the IC maps will progress toward developing students with world class knowledge, world class skills, and life and career characteristics as defined by the Profile of the SC Graduate.

IC Maps Format

Overarching Standard for the respective IC Map.

Standard: Professional learning for STEM educators: is a system of continuous improvement that increases educator effectiveness in preparing students for success in college, careers, and citizenship; it is data informed, research based, aligned with the school's mission, vision, and goals for STEM education and sustained by skillful leaders.

Words defined in the glossary are highlighted in blue

Desired Outcome(s) are listed in each IC Map as statements of STEM school characteristics as related to the Overarching Standard (shown above).

PL1 = Professional Learning Map, 1st Desired Outcome

Title of IC Map (i.e. Professional Learning)

Total Instructional Focus – Professional Learning

Sustaining	Fully Implementing	Refining and Expanding	Progressing	Getting Started
Desired Outcome PL1: Professional learning is the collective responsibility of all STEM educators and is the result of active engagement in a STEM professional learning community (PLC). It is a system of continuous improvement aligned with the school's/district's mission, vision, and goals for STEM education.				
PL1.Leaders1: Support faculty and staff in setting and implementing professional learning goals				
Model and employ with fidelity ALL essential elements of a continuous improvement process school wide including: • identifying STEM goals • planning • implementing • gathering evidence • self-assessing • adapting Support and maintain commitment to personal and PLC learning of faculty and staff through observation, reflecting conversations, and feedback as aligned with the school/district goals for STEM education.	Model and employ the essential elements of a continuous improvement process school wide including: • identifying STEM goals • planning • implementing • gathering evidence • self-assessing • adapting Support commitment to personal and PLC learning of faculty and staff through observation, reflecting conversations, and feedback as aligned with the school/district goals for STEM education.	Provide ongoing support to faculty and staff as they work toward their individual and PLC STEM focused goals for professional growth through observation, reflecting	Support faculty and staff as they work toward their individual and PLC STEM focused goals for professional growth through observation and feedback.	Collaborate with faculty and staff as individual STEM focused goals for professional growth are set.

Indicator by Role for the Desired Outcome (i.e. PL1), then the Role described (i.e. Leaders), then a number to represent which indicator is being outlined (i.e. 1) NOTE: Roles include Leaders, Teachers, Students, and Strategic Alliances.

5 Implementation Levels on the continuum from Getting Started to Sustaining. Read the map from right to left.

Within the white cells are descriptors for each of the 5 levels on the continuum.

IC Map: Professional Learning

Standard: Professional learning for STEM educators: is a system of continuous improvement that increases educator effectiveness in preparing students for success in college, careers, and citizenship; it is data informed, research based, aligned with the school's mission, vision, and goals for STEM education and sustained by skillful leaders.

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PL1.Leaders2: Set and monitor progress towards own personal, professional learning goals				
Maintain commitment to district wide STEM focused goals based on research on STEM education.	Collaborate with other school leaders to align individual STEM focused goals with district professional learning goals based on current research on STEM education.	Collaborate with other school leaders to align individual STEM focused goals with district professional learning goals. Engage in their own professional learning to stay abreast of current research on STEM education.	Align individual STEM focused goals with the district professional learning goals.	Collaborate with district administration to set individual STEM focused goals for professional growth.

Sustaining	Fully Implementing	Refining and Expanding	Progressing	Getting Started
Desired Outcome PL1: Professional learning is the collective responsibility of all STEM educators and is the result of active engagement in a STEM professional learning community (PLC). It is a system of continuous improvement aligned with the school's/district's mission, vision, and goals for STEM education.				
PL1.Teachers1: Engage actively in professional learning communities				
Engage actively in a professional learning community (PLC) by • collaborating on instructional plans; • contributing individually using the strengths of all to support the collective goals of the PLC; • deprivatizing classroom practice; • taking action to overcome barriers to collective responsibility; and • monitoring and adjusting the PLC's vision, values, and goals through a continuous improvement process.	Develop the STEM PLC's shared vision, values, and goals for STEM professional learning that impacts all learners. Contribute to efforts to identify and overcome barriers to collective responsibility for the learning of all students and professionals. Barriers may include, but are not limited to: • lack of collaborative time and effort, • uneven distribution of resources, • vague priorities, • ill-managed change process, • lack of staff engagement, • lack of trust, and • fear of retribution.	Form a STEM professional learning community (PLC) with a shared vision for student and educator learning focus of PLC may include but is not limited to: • curriculum integration, • building a collaborative classroom culture, • problem-based learning, • 21st century skills, • instructional technology, • assessment in the STEM classroom, • deeper content knowledge, and • pedagogical content knowledge. Consider how individual STEM professional learning goals impact the STEM PLC's learning goals and vice versa.	Seek common learning goals within collegial groups based on student learning outcomes, available data and the needs of the school and district.	Take responsibility for their individual STEM professional learning and meet in collegial groups to share individual learning. STEM professional learning focus may include but not limited to: • curriculum integration, • building a collaborative classroom culture, • problem-based learning, • 21st century skills, • instructional technology, • assessment in the STEM classroom, • deeper content knowledge, and • pedagogical content knowledge.
PL1.Teachers2: Align personal, professional learning goals with PLC learning goals				
Maintain commitment to personal and PLC learning and support colleagues' commitment to individual and PLC learning as aligned with the school/district goals for STEM education Employ with fidelity and automaticity ALL essential elements of a continuous improvement process	Set, monitor, implement, and evaluate personal and PLC learning goals as aligned with the school/district goals for STEM education by employing the essential elements of a continuous improvement process including: • identifying STEM goals, • planning, • implementing, • gathering evidence, • self-assessing, and • adapting	Align personal STEM focused goals for professional growth with those of the professional learning community (PLC).	Collaborate with the school administration to set, monitor, implement and evaluate personal STEM focused goals for professional growth.	Collaborate with the school administration to set personal STEM focused goals for professional growth (e.g., Increase content knowledge, implement new teaching strategies or instructional technology).

Sustaining	Fully Implementing	Refining and Expanding	Progressing	Getting Started
Desired Outcome PL1: Professional learning is the collective responsibility of all STEM educators and is the result of active engagement in a STEM professional learning community (PLC). It is a system of continuous improvement aligned with the school's/district's mission, vision, and goals for STEM education.				
PL1.Strategic Alliances: Provide expertise, human, and financial resources to enhance learning experiences for educators				
Monitor the effectiveness of the plan through a continuous improvement process.	Collaborate with educators to develop a plan to provide active and ongoing support for educator learning that aligns with the community's, the strategic alliances', and	Assess the learning needs of educators and provide professional learning experiences to meet specific educator learning needs.	Seek opportunities to provide educator learning experiences such as: • engaging teachers in real world problem solving, simulations, and engineering design challenges to model • hosting job shadowing, and mentoring for educators to prepare them to better facilitate STEM learning opportunities for their students; • allowing their facilities to be used to host teacher learning experiences; and • sharing with teachers the knowledge and skills students will need to succeed in their fields.	Honor requests from educators to speak or make presentations at professional learning venues (e.g., faculty meetings, educator conferences, etc.) informing educators on how they can better prepare students for future success.

Strategic Alliance
An individual or group of stakeholders who may be outside of the day to day work of schools, but who engage in ongoing active partnership with schools in developing and implementing a shared mission, vision and goals for STEM education. Strategic alliances may include but are not limited to businesses, institutions of higher education, community and civic organizations.

Sustaining	Fully Implementing	Refining and Expanding	Progressing	Getting Started
Desired Outcome PL2: STEM professional learning is differentiated, planned, implemented, and evaluated for effectiveness using a variety of sources and types of student, educator, and system data.				
PL2.Leaders1: Use data to inform individual and staff professional learning decisions.				
Engage school community in developing and employing a continuous improvement process to ensure the professional learning in STEM. Data sources may include: • demographics of students, community and staff; • classroom observations; • perception data of students, parents, and staff; • student learning data K-16 (e.g., HS graduation rate, college graduation rate…); • work force needs; and • community needs.	Collect and analyze, various data and use the findings to differentiate, plan, implement, and evaluate the professional learning in STEM. Data sources may include: • demographics of students, community and staff; • classroom observations; • perception data of students, parents, and staff; • student learning data K-16 (e.g., HS graduation rate, college graduation rate…); • work force needs; and • community needs.	Use multiple sources of data to differentiate, plan, implement, and evaluate the effectiveness of his or her own professional learning in STEM.	Use single source of data to plan, implement, and evaluate the effectiveness of staff professional learning in STEM.	Consider single source of data to plan staff professional learning in STEM.

Continuous Improvement Process
A data-informed, active and ongoing process in which self-directed learners at all levels of the school identify, plan, implement, monitor, and refine goals. This approach applies to the continuous learning and growth of students, faculty, staff, leaders, organization, and community.

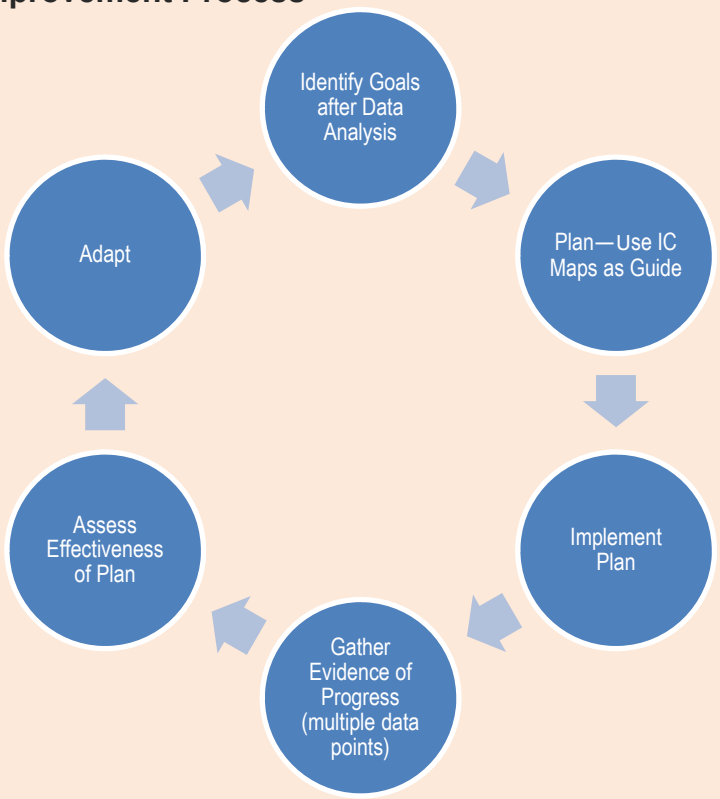
Examples can be found in the Glossary on pages 12 - 13.

Sustaining	Fully Implementing	Refining and Expanding	Progressing	Getting Started
Desired Outcome PL2: STEM professional learning is differentiated, planned, implemented, and evaluated for effectiveness using a variety of sources and types of student, educator, and system data.				
PL2.Teachers1: Use data to inform individual professional learning decisions.				
Partner with school community in developing and employing a continuous improvement process to ensure the collection, analysis and use of various data to collaboratively differentiate, plan, implement, and evaluate the effectiveness of personal STEM professional learning as well as that of the professional learning community (PLC). Data sources may include: • student achievement; • demographics of students, community and staff; • classroom observations; • perception data of students, parents, and staff; • student learning data K-16 (e.g., HS graduation rate, college graduation rate…); • work force needs; and • community needs.	Collaborate with school leadership and PLC to collect and analyze, various data and use the findings to differentiate, plan, implement, and evaluate the effectiveness of personal STEM professional learning as well as that of the PLC. Data sources may include: • student achievement; • demographics of students, community and staff; • classroom observations; • perception data of students, parents, and staff; • student learning data K-16 (e.g., HS graduation rate, college graduation rate…); • work force needs; and • community needs.	Use multiple sources of data to differentiate, plan, and implement, personal STEM professional learning as well as that of the PLC and **evaluate the effectiveness** of the professional learning in contributing to change in educator practice and increases in student achievement.	Use single source of data to plan, implement, and evaluate the effectiveness of personal, STEM professional learning.	Develop STEM professional learning goals using a single source of data.

Sustaining	Fully Implementing	Refining and Expanding	Progressing	Getting Started
Desired Outcome PL3: Professional learning incorporates research on learning theories, STEM-focused pedagogy, and STEM content to build educators' capacity to positively impact intended student outcomes.				
PL3.Leaders1: Ensure professional learning for self and staff is research based				
Ensure all professional learning is: • research based, • STEM focused, • differentiated (based on individual teacher learning needs), • data driven, • job embedded, and • aligned with intended student outcomes. Assess continuously faculty/staff progress in application of new approaches related to professional learning opportunities. Evaluate, using data, the impact of the new approaches on student outcomes and teacher practice.	Support and coordinate school wide actions related to research-based, STEM focused professional learning goal(s). Assess progress in the application of new approaches related to the professional learning goal(s). Determine the impact of the new approaches on student outcomes and teacher practice.	Collaborate with staff to set their specific, measureable, attainable, results-based, and time-bound (SMART) professional learning goals based on research and STEM focused pedagogy. Support action taken by staff towards their STEM focused professional learning goal(s). Take action towards personal STEM focused professional learning goal(s).	Collaborate with faculty/staff to begin crafting goals for student outcomes based on research on student learning theories, STEM focused pedagogy, and STEM content. Set personal SMART goals based on research and STEM focused pedagogy.	Promote and participate in research on student learning theories and STEM focused pedagogy that may include but not limited to: • creating an innovative, collaborative classroom culture; • implementing problem-based learning; • integrating technology purposefully; • incorporating 21st century practices; • promoting civic responsibility; and • addressing the unique learning needs of those under-represented in STEM fields.
PL3.Teachers1: Ensure professional learning for self and staff is research based				
Align research-based, STEM-focused professional learning goal(s) with intended student outcomes. Self-assess progress in the application of new learning related to his or her professional learning goal(s). Refine professional practice based on self-assessment and continuous learning.	Assess progress in his or her application of new learning related to the professional learni goal(s). Evaluate the impac the application of n learning on studen outcomes (e.g., increases in student achievement scores, performance of 21st Century skills, active student engagement ,etc.)	Collaborate with school leaders and professional learning community pedagogy. Apply action in the classroom related to the research- based, STEM focused professional learning goal(s) (i.e., the ability to translate research to practice).	Collaborate with content area and/or grade level colleagues to begin	Conduct research, individually and collectively, on student culture; • implementing problem-based learning; • integrating technology purposefully; • incorporating 21st century practices; • promoting civic responsibility; and • addressing the unique learning needs of those underrepresented in STEM fields.

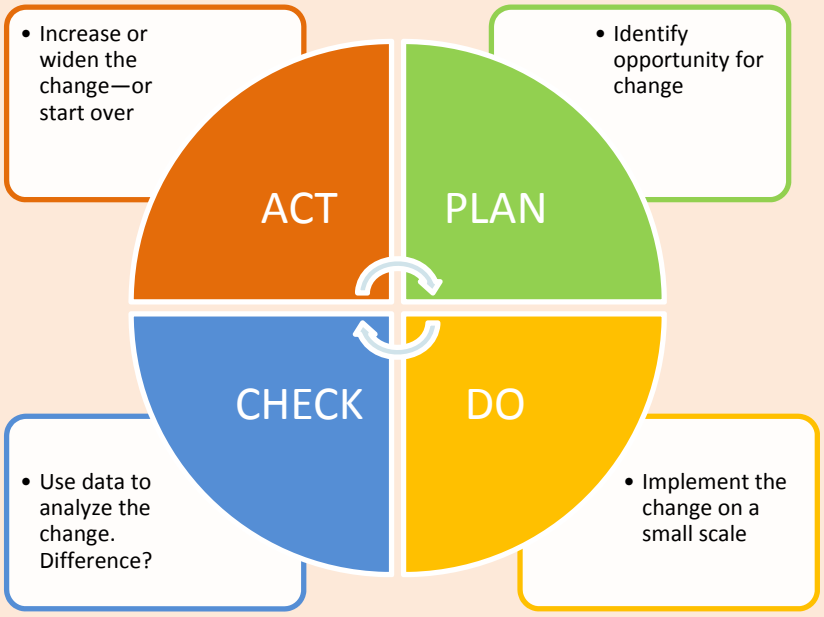
Professional Learning Community (PLC)
A group of educators who engage in job-embedded, collaborative learning; together, participants develop professional and student learning goals, and monitor progress towards meeting those goals through a continuous improvement process.

Glossary

Collaborative Norms	The capacities and skills that guide productive dialogue and discussion in collaborative groups. Each group member agrees to the norms and governs himself or herself accordingly. http://www.thinkingcollaborative.com/norms-collaboration-toolkit/
Collective Responsibility	The attitudes and beliefs that all stakeholders in the school community share the responsibility of ensuring high levels of learning for every child and that they use their communal strengths to prepare students for success within and beyond K-12 schooling.
Continuous Improvement Process	A data-informed, active and ongoing process in which self-directed learners at all levels of the school identify, plan, implement, monitor, and refine goals. This approach applies to the continuous learning and growth of students, faculty, staff, leaders, organization, and community. **Examples of Continuous Improvement Processes** (NOTE: These are a few examples; not an exhaustive list): **Example 1** **Continuous Improvement Process** 

Example 2

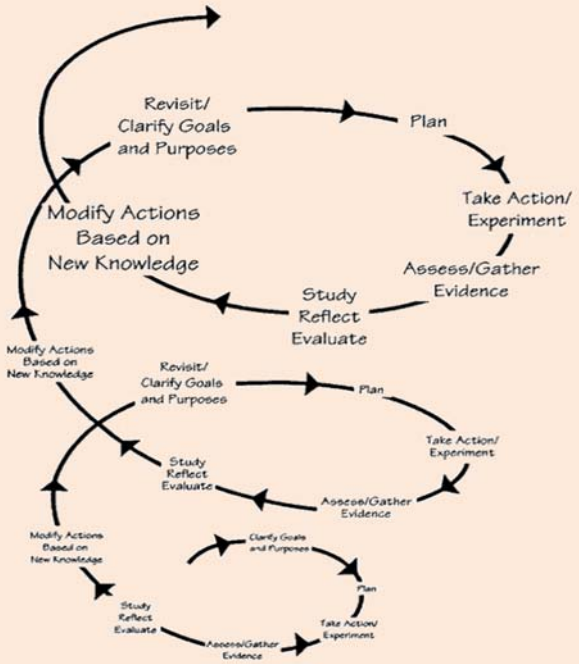
Continuous Improvement Process



(Deming, n.d.)

Example 3

Feedback Spiral



(Costa & Kallick, Assessment in the learning organization, 1994)

Gatekeeping Processes Processes (multiple measures) that are the entry requirements for STEM courses of study.

Intra-disciplinary	Processes, methods, and language within a single discipline.
Interdisciplinary	Processes, methods and language from more than one discipline.
Professional Learning Community (PLC)	A group of educators who engage in job-embedded, collaborative learning; together, participants develop professional and student learning goals, and monitor progress towards meeting those goals through a continuous improvement process.
School Community	The collective group of stakeholders reflecting the environment in which the STEM school operates including the cultural norms, political influences, economic resources, and education levels.
Self-Directedness	Being guided by oneself to set challenging goals, develop a plan of action, persevere in the face of challenges, and accurately assess progress and performance based on evidence.
SMART Goals	**Framework for goal setting. SMART goals should be:** **S** = Specific **M** = Measurable **A** = Attainable **R** = Results-based **T** = Time-bound
Stakeholder	An individual or group with an interest in the success of a school in fulfilling its mission, includes but not limited to parents, students, faculty and staff, businesses, institutions of higher education and community organizations.
STEM Leadership Team (SLT)	A team representing the diversity of the community, consisting of school/district leaders and representatives from all stakeholder groups. The SLT will lead in the development and implementation of the STEM mission, vision, and goals ensuring that all stakeholder ideas and concerns are represented. SLT members should be influential within the groups they represent and able to articulate with clarity communication from their constituent groups to the SLT and vice-versa.
STEM Learning Ecosystem	A network of in-and-out of school STEM learning opportunities that work together to deepen students' STEM understandings; the system may be comprised of STEM learning experiences made available by schools, afterschool providers, universities, museums, science centers, community organizations, and families. "This phrase," according to the National Academy Press publication, Identifying and Supporting Productive STEM Programs in Out-of-School Settings, "refers to the dynamic interaction among individual learners, diverse settings where learning occurs, and the community and culture in which they are embedded. STEM learning ecosystem includes all of a community's STEM-rich assets, which include: • *designed settings,* such as schools, clubs, museums, and youth programs; • *naturalistic settings*, such as city parks, waterways, and forests and deserts; • *people and networks of people,* such as practicing STEM professionals, educators, enthusiasts, hobbyists, and business leaders who can serve as inspiration and role models; and • *everyday encounters* with STEM, such as on the internet, on television, on the playground, or during conversations with family members and other young people." http://www.nap.edu/catalog/21740/identifying-and-supporting-productive-stem-programs-in-out-of-school-settings

STEM Literacy	The knowledge, skills, attitudes, and capacities to: • integrate **transdisciplinary** concepts purposefully and strategically in the design and implementation of innovative solutions (explanations, products, processes) to complex, real-world, personal, local, and global challenges • think critically and flexibly • refine designs through an iterative process (e.g. engineering design process/continuous improvement process)
Strategic Alliance(s)	An individual or group of stakeholders who may be outside of the day to day work of schools, but who engage in ongoing active partnership with schools in developing and implementing a shared mission, vision and goals for STEM education. Strategic alliances may include but are not limited to businesses, institutions of higher education, community and civic organizations.
Transdisciplinary	Student driven approach to teaching and learning in which students, guided by their own questions, design solutions to solve complex, real world problems by calling upon the knowledge, skills, and processes of multiple disciplines as they need them.
World Class Knowledge	**(Source: Profile of the South Carolina Graduate)** • Rigorous standards in language arts and math for career and college readiness • Multiple languages, science, technology, engineering, mathematics (STEM), arts and social sciences
World class skills	**(Source: Profile of the South Carolina Graduate)** • Creativity and innovation • Critical thinking and problem solving • Collaboration and teamwork • Communication, information, media and technology • Knowing how to learn

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