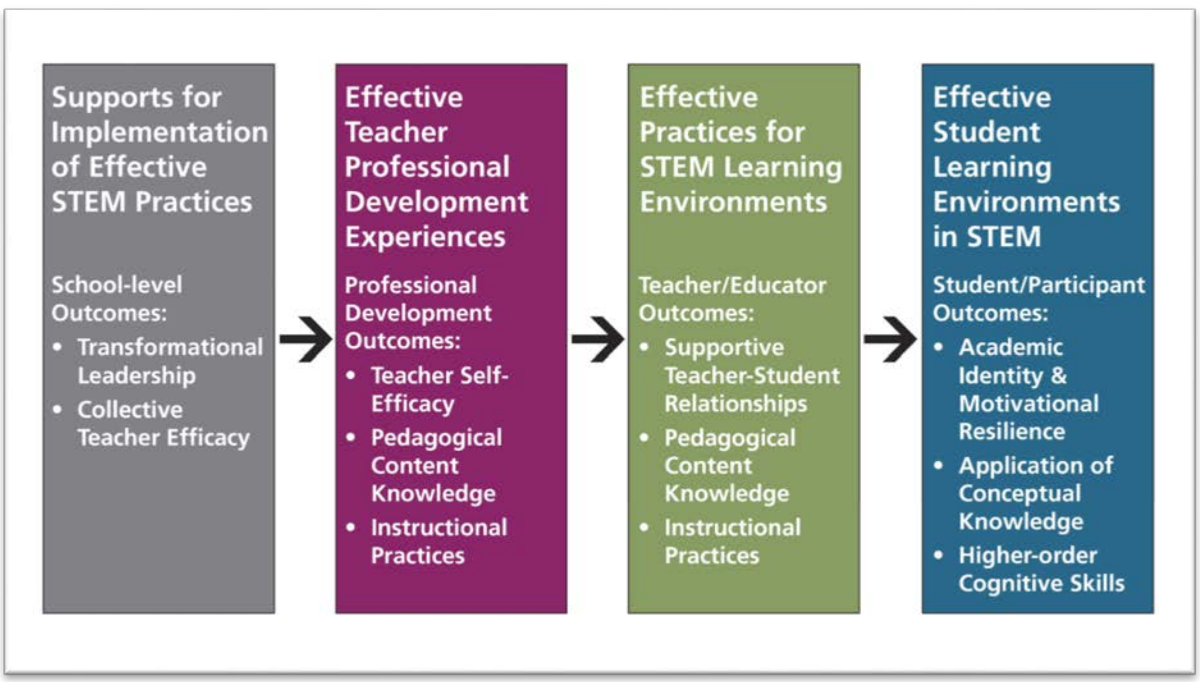
Developing and supporting effective STEM education for all youth requires partners to focus on a shared set of outcomes and utilize common measures to determine progress towards those outcomes. The Portland Metro STEM Partnership is committed to equipping and supporting partners with the measurement tools to effectively determine progress towards shared goals while building their capacity to effectively utilize information and data to improve STEM educational experiences for all youth. Our support includes:

- Equipping partners with meaningful common measurement tools include selection, training, and implementation support
- Utilizing developmental evaluation strategies to support program improvement
- Facilitating collaborative design-based research projects aimed at transforming teaching and learning
- Investigating the validity, reliability, and utility of PMPS- and locally-developed assessments within the diverse contexts of the partnership
- Advising on needs assessments, gap analysis, and program evaluation

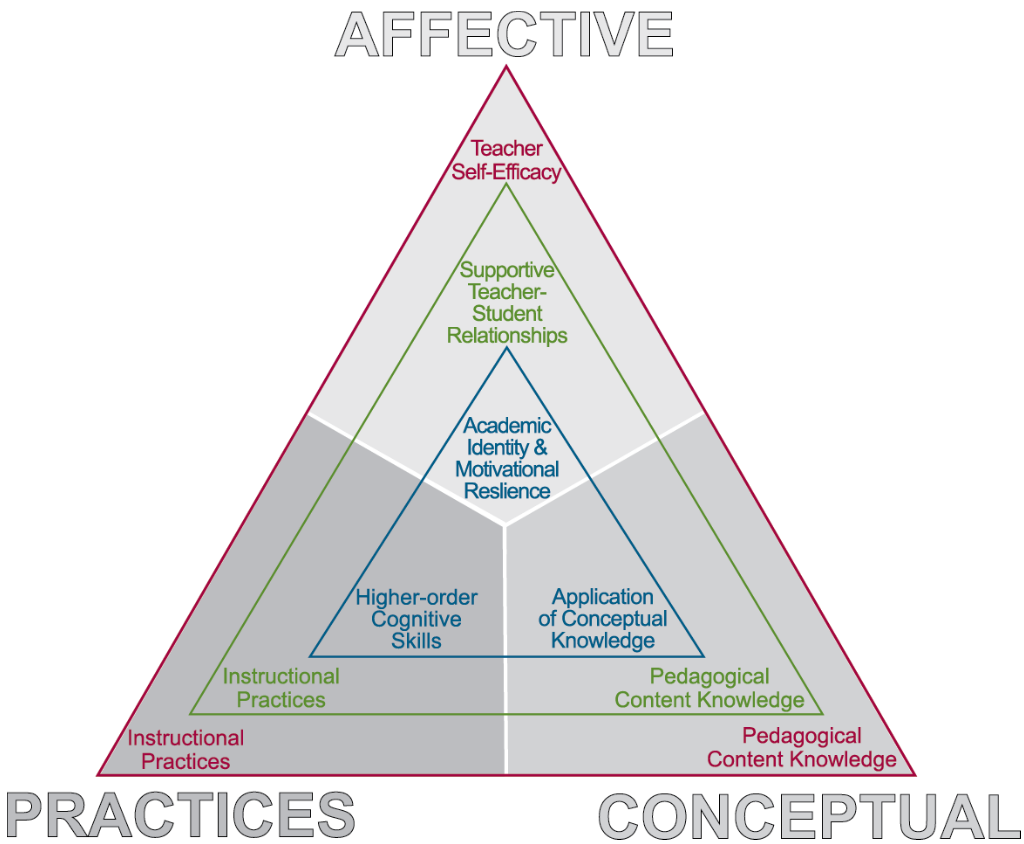
PMSP Common Measurement System

We believe that to improve outcomes for students, we need to create effective learning environments by utilizing research- and evidence-based practices. Educators, therefore, need quality professional development to effectively employ those practices as well as appropriate leadership and other supports.



Our common measurement system focuses on **Student Outcomes** (inner triangle), **Teacher Outcomes** (middle triangle), and **Professional Development Outcomes** (outer triangle). The vertices of the triangles represent three critical domains for effecting change or growth, whether it is student learning or educator practices:

- **Affective Domain** – Students' and educators' beliefs in their capabilities and the relationships they form
- **Conceptual/knowledge Domain** – Students' and educators' knowledge and their ability to apply that knowledge in new situations
- **Practices/skills Domain** – Students' and educators' skills and practices they employ as learners and teachers



For a complete description of the research behind the PMSP Common Measures Framework, please see Saxton, E., et al., (2014) A Common Measurement System for K-12 STEM Education: Adopting an educational evaluation methodology that elevates theoretical foundations and systems thinking. *Studies in Educational Evaluation*. Available here: http://dx.doi.org/10.1016/j.stueduc.2013.11.005

STUDENT OUTCOMES: Effective STEM Learning Environments

Academic Identity

Students' deeply held views of themselves and their potential to enjoy and succeed in STEM classes and careers.

> ***Components:*** Identity, belonging/relatedness, competence/efficacy, autonomy/ownership, and purpose.
>
> ***Rationale:*** This is the fundamental student transformation that needs to be accomplished if we are going to see the effort and determination students need to achieve in STEM.

Motivational Resilience

Characterized by students' enthusiastic hard work and persistence in the face of challenging STEM coursework.

> ***Components:*** Academic engagement and constructive coping/persistence.
>
> ***Rationale:*** Whole-hearted engagement and tenacity in demanding STEM classwork is essential to student learning and achievement.

(Furrer, & Skinner, 2003; Skinner, Kindermann, & Furrer, 2009)

Application of Conceptual Knowledge

Students' understanding of and thinking about ideas, theories and perspectives considered critical or essential within an academic or professional discipline or in STEM interdisciplinary fields recognized in authoritative scholarship. "....References to isolated factual claims, definitions, or algorithms are not indicators of significant disciplinary content unless the task requires students to apply powerful disciplinary ideas which organize and interpret information."

(Definition adapted from Lingard, Mills, & Hayes, 2006)

> ***Rationale:*** The focus on deep understanding and application of conceptual knowledge is key to student success in STEM because it more accurately reflects the way concepts are applied in the real world by scientists, engineers, and other STEM professionals. This outcome stands in stark contrast to rote memorization of isolated facts, definitions, formulas, or algorithms because application of conceptual knowledge results in longer lasting understanding of STEM content.

Higher-order Cognitive Skills

Students' higher order thinking or cognitive skills refer to their abilities to:

1. Problem solve: (a) Identify, frame, and solve complex problems, (b) apply knowledge and skills to novel problems and/or situations, and (c) assess the reasonableness of a process and/or solution;
2. Develop an argument based on evidence: (a) find, evaluate, analyze, and synthesize information and (b) evaluate complex ideas or chains of reasoning;
3. Communicate ideas, solutions, arguments, or conclusions in oral and/or written form
4. Utilize metacognitive skills: (a) Reflect on one's own thinking and reasoning and (b) choose and strategically use tools (technological and otherwise

(Adapted from Wood et al., 2007)

Rationale: Higher-order cognitive skills are important for student success in college, employment in STEM careers, and participation as informed citizens because they represent the use of STEM skills to recognize, evaluate, and solve complex problems, discover and advance new knowledge, and create solutions to complex real world problems.

EDUCATOR OUTCOMES: Effective Practices for STEM Learning Environments

Supportive Educator-Student Relationships

Educators 1) foster supportive and caring relationships with and among students, 2) provide challenging learning activities with high expectations, authentic academic work, and clear feedback, and 3) explain the relevance of activities and rules while soliciting input from students and respecting their opinions.

Rationale: Supportive relationships with educators are critical because they are the basis upon which students construct a positive academic identity and develop motivational resilience.

Pedagogical Content Knowledge (PCK)

1) Educators' knowledge of student thinking about specific STEM topics including prior knowledge, misconceptions, learning progressions, common difficulties, and developmentally appropriate levels of understanding.

2) Educators' understanding and use of the effective strategies for specific STEM topics including strategies to engage students in inquiry, represent STEM phenomena, and guide discourse about the STEM topic.
3) Educators' integration of technology to enhance instruction in meaningful and appropriate ways to promote key student College and Career Readiness outcomes

(Based on Schneider & Plasman, 2011; Manizade & Mason, 2011)

Effective Instructional Practices in STEM

Educators:

1) Facilitate active engagement of students in their learning.
    a. Educators assume the role of facilitator rather than authority figure
    b. Students assume the role of active learners
2) Emphasize deep content knowledge and higher-order cognitive skills by addressing learning goals in both areas.
3) Create and implement multiple and diverse opportunities for students to develop conceptual knowledge and cognitive skills.
4) Use frequent formative assessments (and summative assessments) to facilitate diagnostic teaching and learning. Educators and students are both stakeholders:
    - Educators set clear, developmentally-appropriate learning targets/performance criteria and select/develop formative assessment tasks that align with learning goals
    - Student's assume ownership over learning and engage in metacognitive activities
5) Educators and students contribute to a classroom culture of assessment for learning; that is, class wide focus on learning, student "honesty about understanding, mistakes, and feedback," and "an emphasis on dialogue and exploratory talk to support thinking" (Webb & Jones, 2009)
6) Implement learning activities that students find to be relevant, important, worthwhile, and connected to their cultural and personal lives outside of the classroom.

(Saxton, E., et al., 2014)

PROFESSIONAL DEVELOMENT OUTCOMES:
Effective Educator PD Experiences

The PMSP holds its professional development (PD) to a high standard, as such the three PD outcomes will be measured by aggregating educator data from each program and focusing *not* on what is modeled in the PD, but on what is implemented in the classroom after educators complete the PD.

Educator Self-Efficacy

The belief that educators hold about their own capabilities to bring about desired outcomes of student engagement, motivation, and learning in STEM, as well as their own capabilities to implement culturally relevant instruction.

Rationale: Educator self-efficacy is important because it has been shown to be related to student learning and motivation outcomes, as well as, educator persistence in the face of challenges, instructional practices, and willingness to try new instructional methods.

(Based on Tschannen-Maran & Hoy, 2001; Klassen et al., 2011)

Pedagogical Content Knowledge (PCK)

1) Educators' knowledge of student thinking about specific STEM topics including prior knowledge, misconceptions, learning progressions, common difficulties, and developmentally appropriate levels of understanding.
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Effective Instructional Practices in STEM

Educators:

1) Facilitate active engagement of students in their learning.
   a. Teachers assume the role of facilitator rather than authority figure
   b. Students assume the role of active learners
2) Emphasize deep content knowledge and higher-order cognitive skills by addressing learning goals in both areas.

3) Create and implement multiple and diverse opportunities for students to develop conceptual knowledge and cognitive skills.
4) Use frequent formative assessments (and summative assessments) to facilitate diagnostic teaching and learning. Educators and students are both stakeholders:
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6) Implement learning activities that students find to be relevant, important, worthwhile, and connected to their cultural and personal lives outside of the classroom.

(Saxton, E., et al., 2014)

Supports for Implementation of Effective STEM Practices.

Collective Teacher Efficacy

The beliefs teachers hold about the shared capacity of their school's staff to positively impact their students' learning in STEM.

> ***Rationale:*** Collective teacher efficacy is important because it has been shown to be related to a school's academic climate, teacher commitment, and how school staff copes with challenges. It was also shown by multiple studies to have a significant, positive relationship to school-level student achievement.

(Based on Goddard, Hoy & Woolfolk Hoy, 2000; Klassen et al., 2011; Tschannen-Moran & Barr, 2004)

Transformational Leadership

"This type of leadership offers a vision of what could be and gives a sense of purpose and meaning to those who would share that vision. It builds commitment, enthusiasm, and excitement. It creates hope in the future and a belief that the world is knowable, understandable, and manageable. The collective action that transforming leadership generates empowers those who participate in the process. There is hope, there is optimism, there is energy. In essence, transforming leadership is a leadership that facilitates the redefinition of a people's mission and vision, a renewal of their commitment, and the restructuring of their systems for goal accomplishment."

(Roberts, 1985, p. 1024)

Components:

- Identifying and sustaining a vision: involve staff in defining and understanding school vision, mission, and goals
- Provides intellectual stimulation: questioning assumptions and encouraging creativity in approaching problems.
- Building collaborative structures: facilitating teacher collaboration for professional growth.
- Provides individualized support and consideration: recognize the unique needs of staff and support the professional learning of individuals.
- Inspirational Motivation: Encourages high performance expectations, enthusiasm, and optimism.
- Engaging communities: encourage family involvement and access assets of the community.

(Based on Sun & Leithwood, 2012; Bass & Avolio, 1994; Leithwood, Aitken, & Jantzi, 2001)