STEM EDUCATION:
The SECEP Vision

Individually and together, science, technology, engineering and mathematics provide insights into philosophical and practical areas of human concern (NYSED, 1994). Although each field has its own character and methodology, there are numerous ways in which the disciplines overlap. In the United States, STEM education is a construct of the interconnection of the four component disciplines (Hacker, 2014).

According to Christenson (2011), the term "STEM" was first suggested by Judith Ramaley in 2001 when she was the director of the U.S. National Science Foundation's Education and Human Resources division. Ramaley said:

> *In STEM, science and math serve as bookends for technology and engineering. Science and math are critical to a basic understanding of the universe, while engineering and technology are means for people to interact with the universe.*

Taken separately, the four STEM subjects are defined in a National Research Council report in this way (Katehi, Pearson, & Feder, 2009):

> **Science –**the study of the natural world.
> **Technology**— the study of the human-made world, its artifacts and processes.
> **Engineering**—creating the human-made world, the artifacts and processes that never existed before.
> **Mathematics**—the study of patterns and relationships among quantities, numbers, and shapes.

STEM Fields

STEM fields can include a wide range of disciplines including mathematics; physical sciences; biological/life sciences; computer and information sciences; and engineering and engineering technologies (Chen and Soldner, 2013). STEM also includes such fields as advanced manufacturing, energy, graphic design, architecture, and building and construction (Carnevale, Smith and Melton, 2011). Health care is included in some frameworks.

STEM education, as conceptualized by the SECEP project:

- *Links this definition of STEM to higher education* and *majors in STEM fields*. Middle and high school STEM educational experiences are explicitly designed to prepare students to enter higher education STEM majors and career pathways by preparing students to acquire both STEM content knowledge and skills. Students are provided supports to succeed in challenging STEM college courses while still in high school.

- Focu*ses on emerging careers*: STEM education reinforces the knowledge and skills needed in the workplace and life such as problem solving, accuracy, attention to detail, inventiveness, and clear communications - all vital to success in emerging careers. Students' employment and postsecondary opportunities are increased when they are well prepared with these skills (Carnevale et al, 2011).

- *Emphasizes exciting, real world design experiences*: STEM students create solutions to real world problems using engineering and technology approaches. They engage in design projects that de-emphasize finding unique or correct solutions, but rather seek best or optimum solutions taking into account such factors as cost, materials, aesthetics, and marketability (Burghardt, 2013).

- *Creates integrated educational experiences:* Both engineering and technology education provide opportunities for students to work with and communicate about content from other disciplines. In

creating the human-made world, students in engineering and technology use knowledge from science, mathematics, social sciences, and humanities as well as manual and interpersonal skills.

- *Prioritizes STEM opportunities for traditionally underserved students*: Students from diverse racial and ethnic groups as well as from low-income families are underrepresented in STEM education and careers (Griffith, 2010). SECEP makes special efforts to insure that students from all backgrounds have the opportunity to explore options in STEM.

- *Aims for high level student outcomes.* A recent study of a middle school technology curriculum that used an engineering design approach found a significant increase in students' mathematical content knowledge as well as improvement in their attitude toward mathematics after participation in the curriculum. Students also earned significantly higher post-test scores than control group students (Burghardt, Hecht, Russo, Lauckhardt & Hacker, 2011).

As is the nature of engineering design itself, SECEP's path toward implementing purposeful STEM programs is an iterative process. It begins with a clear and shared vision of outcomes and core principles. It requires collaboration among expert curriculum developers, pedagogical experts, instructional coaches, and visionary school/college teachers and administrative personnel. Thus, the real promise of STEM education lies in the hands of committed educators who create joyful, relevant, and enduring learning experiences for their students.

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