CHAPTER 8

What Is Your Perspective of STEM Education?

As we have seen, the acronym *STEM* began at the National Science Foundation (NSF) as an efficient means to identify and communicate four disciplines. With time, *STEM* began being used in discussions of education policy. Again, the acronym's use generally referred to the quartet of disciplines but the use expanded and became more ambiguous as references included, for example, STEM education, a STEM program, integrative STEM, and STEM initiatives. In the policy arena, a STEM perspective referred to perceived outcomes related to knowledge economies, technical innovations, the basis for businesses and industries to thrive, the competencies for a 21st-century workforce, and national security. The ambiguity of STEM in national policy discussions is understandable and acceptable as a general term referring to four disciplines. Policy makers did not have to consider what STEM might mean for specific K–12 school programs. They only had to consider the general implications of policies for the disciplines. At the state level, there are, among other things, STEM councils, networks, hubs, centers, strategic plans, directors, coordinators, and coalitions. All are undoubtedly helpful, but one has to ask about the various perspectives and implicit definitions from which they are recommending changes in graduation requirements, preservice teacher education, teacher licensure, district curricula, professional development, and classroom practices, not to mention state standards, curricula, instruction, and assessments.

However, as use of the acronym moves from national policies to state and local education, there is a compelling need to clarify the meaning of *STEM* for school districts, and classrooms. In particular, one has to ask questions such as the following:

- What are the connections between STEM education and national priorities?
- What about recent developments in common core standards?
- How do STEM perspectives align with funding for Race to the Top?
- Will STEM be included in the reauthorization of the Elementary and Secondary Education Act (ESEA), also known as No Child Left Behind?
- Does STEM have any place in the Next Generation Science Standards?

As the use of the acronym *STEM* gets closer to school districts and especially classrooms, the requirements for clarity and meaning not only increase, but they become critically urgent as well. That said, I caution against the inclination to look for one definition that is acceptable to all.

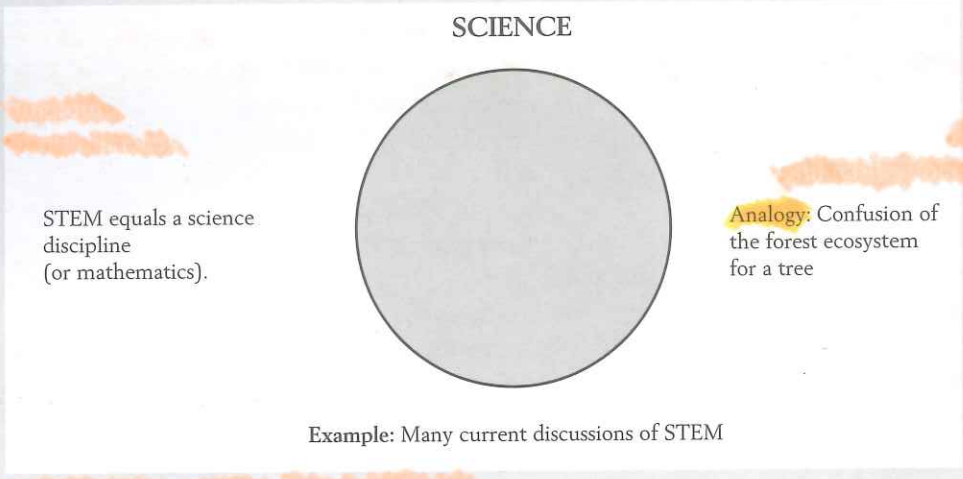
STEM PERSPECTIVES

This chapter presents different perspectives of STEM education. The goal is to clarify and not confuse the issue of STEM. These perspectives are based on many discussions, articles, reports, and projects where there is reference to STEM.

STEM Equals Science (or Mathematics).

In this first perspective, the use of the acronym *STEM* only means science, and occasionally a specific discipline such as physics or biology. This use of STEM is most confusing due to the multiple disciplinary orientations contrasted with the single discipline reference. In some cases, the referent may be a discipline other than science or mathematics—for example, "We have a STEM program, and it is Engineering Design" (see Figure 8.1).

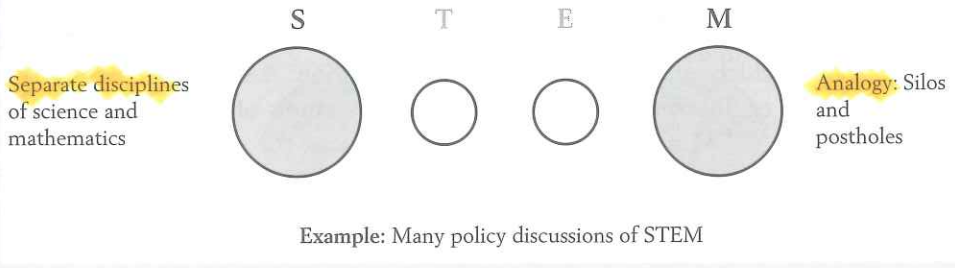
Figure 8.1. Single-Discipline Reference



STEM Means Both Science and Mathematics.

In some cases, STEM refers to both science and mathematics. This perspective should not be surprising due to the long history of these disciplines as curricular components in American education. In some discussions of STEM, individuals refer to the separate disciplines as silos. In this perspective, there are silos and postholes (excuse the mixed metaphor). The silos are clearly visible and the postholes are somewhat visible, but the essence of a hole is that there is nothing there; it is empty space, but you know that it is a hole (see Figure 8.2).

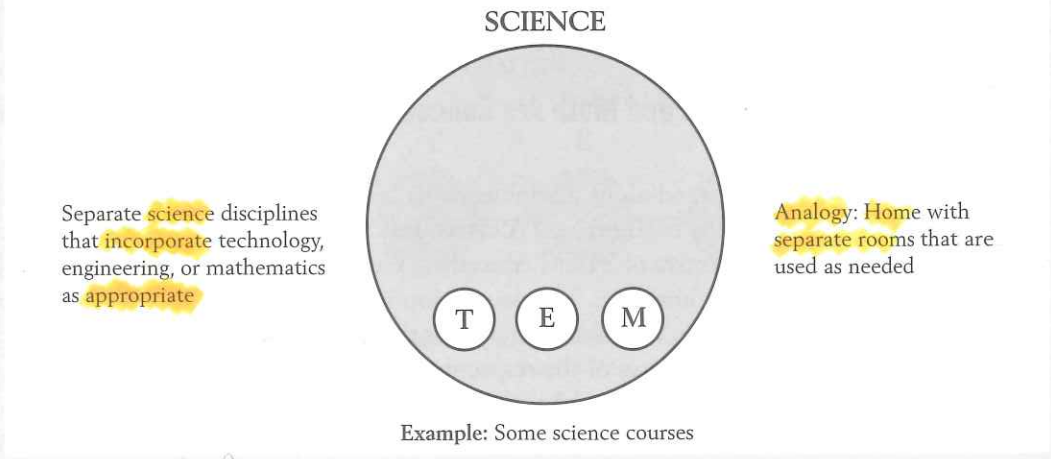
Figure 8.2. STEM as a Reference for Science and Math



STEM Means Science and Incorporates Technology, Engineering, or Math.

Some science teachers incorporate examples of technology and engineering in their lessons. Occasionally elementary teachers introduce engineering and design problems; egg drops are a common example. However, the engineering design is often confused with science practices. This perspective represents the first step toward an integration, but the teacher keeps science (or math) as the dominant discipline and, as appropriate or needed, introduces the other disciplines. As you can imagine, this perspective may have several different variations (e.g., science incorporating technology, science incorporating math, or science incorporating engineering; see Figure 8.3).

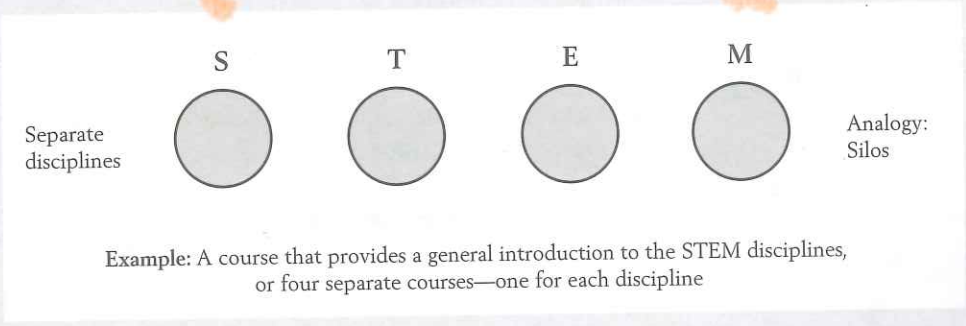
Figure 8.3. Separate Science Disciplines That Incorporate Other Disciplines



STEM Equals a Quartet of Separate Disciplines.

Let's go back to the metaphor of silos. The reference to STEM in this perspective includes science, technology, engineering, and math, all with places in school curriculum. In some schools, the *T* is included as information technology and the *E* is a course such as Project Lead the Way. This perspective may cover four separate courses or separate units within a course. There are a couple of issues associated with this perspective. If there are three or four separate courses in high school, which ones will be required for graduation? A second issue is the inclusion of technology and engineering. Incorporating separate sections of a course with a title such as Introduction to STEM might be one example. Think of the general science textbooks that had separate units on the science disciplines. So, have the students had ample opportunities to study the respective disciplines (see Figure 8.4)?

Figure 8.4. Separate Disciplines



Example: A course that provides a general introduction to the STEM disciplines, or four separate courses—one for each discipline

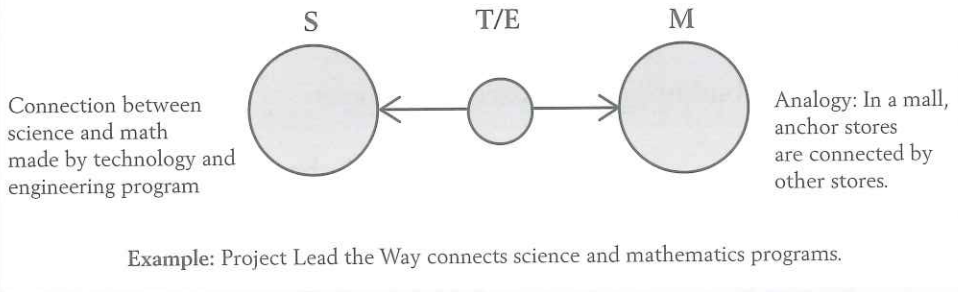
Although the representation shows the silos as equal, this is not usually the case, especially when requirements for graduation from high school are considered.

STEM Means Science and Math Are Connected by One Technology or Engineering Program.

Science and math are stand-alone disciplines with connections to another program that emphasizes technology and/or engineering. A career and technical education (CTE) program is an example of this perspective of STEM education. Here, individuals will indicate that CTE, for example, is the STEM initiative. The assumption is that science and math already are integral to the school curriculum. One should note that their connection is not necessarily a coordination of concepts and processes of the respective disciplines (see Figure 8.5).

The California project Linked Learning: Pathways to College and Career Success is a very nice example of using technology and engineering projects to connect core subjects of science and math to experiences in professional and technical education in fields such as biomedical

Figure 8.5. Science and Math Connected by Technology or Engineering Program



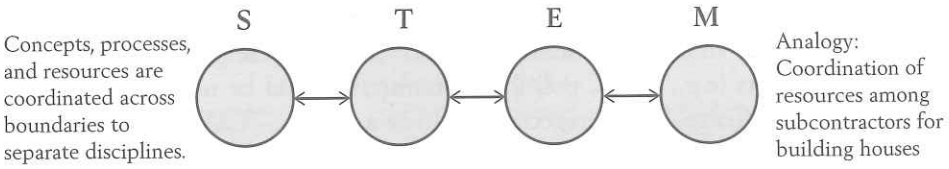
Example: Project Lead the Way connects science and mathematics programs.

and health sciences, energy resources, information technology, and agriculture. In this example, students also experience work-based learning (Hoachlander and Yanofsky 2011).

STEM Means Coordination Across Disciplines.

We can begin with a common example. Science teachers often ask mathematics teachers to introduce concepts in math that will be applied in science. Less frequently do math teachers ask science or technology teachers to apply math concepts. But in some cases, concepts and processes can be introduced and applied in the different STEM disciplines. Figure 8.6 represents an ideal. In reality, two of the four disciplines likely will coordinate concepts and processes.

Figure 8.6. Coordination Across Disciplines

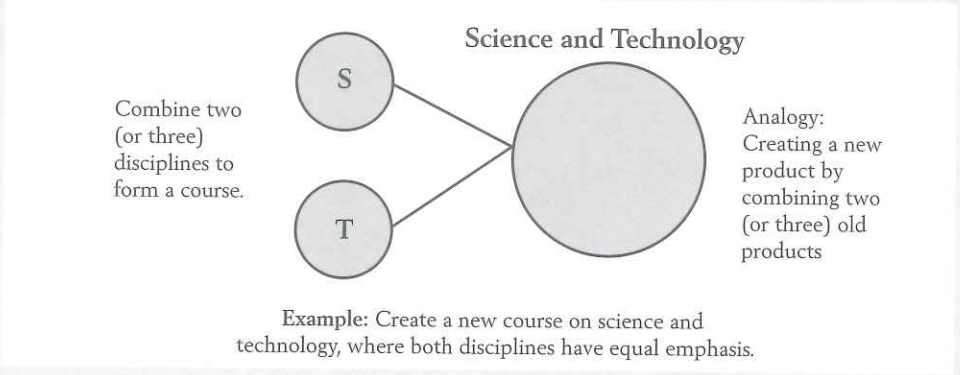


Example: Graphing is introduced in math class when it will be needed in an engineering course.

STEM Means Combining Two or Three Disciplines.

One form of integration begins by combining two disciplines, such as science and technology or engineering and math. A more complex model combines three of the four disciplines. Integrating science, technology, and math would be an example (see Figure 8.7).

Figure 8.7. Combining Two or Three Disciplines



Example: Create a new course on science and technology, where both disciplines have equal emphasis.

STEM Means Complementary Overlapping Across Disciplines.

STEM can be integrated by sequencing disciplines in units or courses, or in lessons so STEM becomes a central emphasis of the education experiences. Figure 8.8 indicates the potential of overlapping STEM disciplines that may occur, for example, in the process of investigating an answer to a scientific question or solving a design problem.

STEM Means a Transdisciplinary Course or Program.

There is a STEM perspective that involves the transdisciplinary approach to major issues such as global climate change, health problems, or use of resources for energy. A course called Sustainable Society might be an example in which the entire group of STEM disciplines, and perhaps others (e.g., ethics, politics, economics), would be used to understand a major contemporary challenge. This perspective could be a senior STEM seminar in which students likely would have taken two or three years of traditional science and math and perhaps a year of technology or engineering (see Figure 8.9).

Figure 8.8. Integrated Disciplines

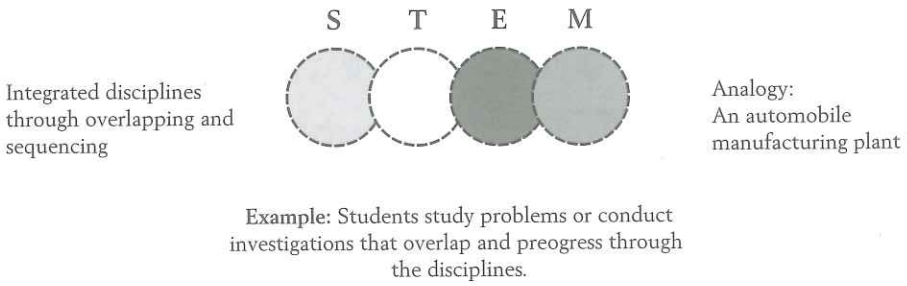
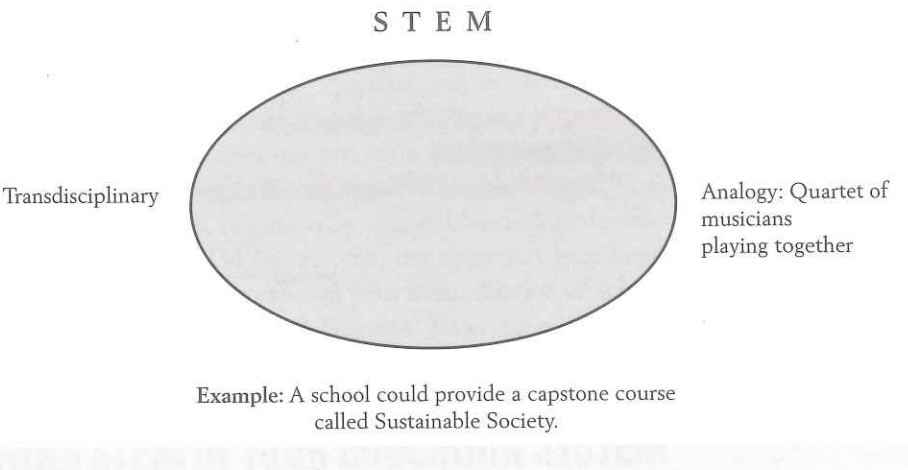


Figure 8.9. STEM as a Transdisciplinary Course or Program



CONCLUSION

As one can see, there are many perspectives to STEM education. This chapter presents nine perspectives, and no doubt there are others. My intention is not to present these and then indicate which one is the true STEM perspective. Rather, my intention is to help individuals, organizations, and agencies clarify different perspectives and give insights to those considering or engaged in education reform with a particular STEM perspective.

DISCUSSION QUESTIONS

1. How would you describe your perspective of STEM education?
2. Is there a STEM perspective not described in this chapter? If so, how would you describe it?
3. How would you explain the omission or marginal inclusion of technology and engineering in STEM education?