Defining STEM Education

STEM is "*...an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world problems as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy." (Tsupros, et al. 2009)*

Beyond the acronym representing the disciplines of Science, Technology, Engineering, and Math, STEM symbolizes the intersection of these areas–a dynamic whole that is in and of itself greater than the sum of its parts. The STEM learning experience seeks to foster critical thinking, problem-solving, creativity, and innovation. Effective instruction encourages students to explore, experiment, and iterate– mirroring the competencies, skills, and practices of professionals in STEM fields. By engaging in hands-on activities, collaborative projects, and inquiry-based learning, STEM students develop a deeper understanding of concepts and principles while cultivating essential 21st century skills for a fast-evolving workforce.

Scholars continue to grapple with precise definitions of STEM. For example, Li et al. (2020) concede that there is disparity across academia, industry, and government on the content of STEM. This diversity of opinion seems to pivot on a definition of "science" with some adhering to the strict inclusion of physical and biological sciences. However, this limitation excludes other domains that employ scientific methods, such as economics.

Li et al. cite an NSF publication that documents its “approved fields…under the umbrella of STEM” (NSF, 2014). This includes the traditional “core” disciplines, such as physics, chemistry, and materials research, but also includes disciplines in psychology and social sciences (Li et al., p. 2). As it rises in popularity, there is a call for improvement in the realm of integrated STEM education. Bybee (2010) notes, “the United States needs a broader, more coordinated strategy for precollege education in science, technology, engineering, and mathematics (STEM). That strategy should include all the STEM disciplines and address the need for greater diversity in the STEM professions, for a workforce with deep technical and personal skills, and for a STEM-literate citizenry prepared to address the grand challenges of the 21st century.” Thus, for STEM education to be effectively integrated, it must be taught in both a cohesive and applied manner. By integrating the principles and methodologies of science, technology, engineering, and mathematics, STEM education encourages students to explore the interconnectedness of these disciplines and to understand their real-world applications.

York et al. (2019) advocate training in systems thinking, since it is a “holistic approach for examining complex, real-world systems, in which the focus is not on the individual components of the system but on the dynamic interrelationships between the components and on the patterns and behaviors that emerge from those interrelationships”. They cite numerous benefits of systems thinking in STEM education, for example, promoting higher order thinking skills (such as critical thinking) and increasing students’ retention of material. Furthermore, instructors using systems approaches report that students more actively participate in their learning, learn content more deeply and conceptually, ask better questions, and make more connections between concepts both within and between STEM disciplines.

References

Brown, R. "Understanding STEM: Current Perceptions." *Technology & Engineering Teacher.*, vol. 70, no. 6, 2011, pp. 5–9, https://doi.org/info:doi/.

Bybee, R. W. (2010). EDITORIAL: What Is STEM Education? *Science*, *329*(5995), 996–996. http://www.jstor.org/stable/40802982

English, Lyn D. "STEM education K-12: Perspectives on integration." *International Journal of STEM Education*, vol. 3, no. 1, 1 Mar. 2016, https://doi.org/10.1186/s40594-016-0036-1.

Kelley, Todd R., and J. Geoff Knowles. "A conceptual framework for integrated STEM Education." *International Journal of STEM Education*, vol. 3, no. 1, 19 July 2016, https://doi.org/10.1186/s40594-016-0046-z.

Li, Y., Wang, K., Xiao, Y., & Froyd, J. E. (2020). Research and trends in STEM education: a systematic review of journal publications. *International Journal of STEM Education*, *7*(1). https://doi.org/10.1186/s40594-020-00207-6

Li, Y., Schoenfeld, A. H., diSessa, A. A., Graesser, A. C., Benson, L. C., English, L. D., & Duschl, R. A. (2019). Design and Design Thinking in STEM Education. *Journal for STEM Education Research*, *2*(2), 93–104. https://doi.org/10.1007/s41979-019-00020-z

National Science Foundation (2014). NSF Approved STEM Fields. https://btaa.org/docs/default-source/diversity/nsf-approved-fields-of-studycac2.pdf

Tsupros, N., R. Kohler, and Hallinen, J. (2009). STEM education: A project to identify the missing components, Intermediate Unit 1 and Carnegie Mellon, Pennsylvania

York, S., Lavi, R., Dori, Y. J., & Orgill, M. (2019). Applications of Systems Thinking in STEM Education. *Journal of Chemical Education*, *96*(12), 2742–2751. https://doi.org/10.1021/acs.jchemed.9b00261