

Class notes

Owner **Kortney Arveseth**

Instructor **Dr. Kathryn Arnone**

Subject **STEM ▾**

Jan 19, 2026

Week #2: Integrated STEM and Defining STEM

READINGS (Main takeaway quotes from each section of the respective papers.)

Nadelson, L. S., & Seifert, A. L. (2017). Integrated STEM defined: Contexts, challenges, and the future. *Journal of Educational Research*, 110(3), 221-223.

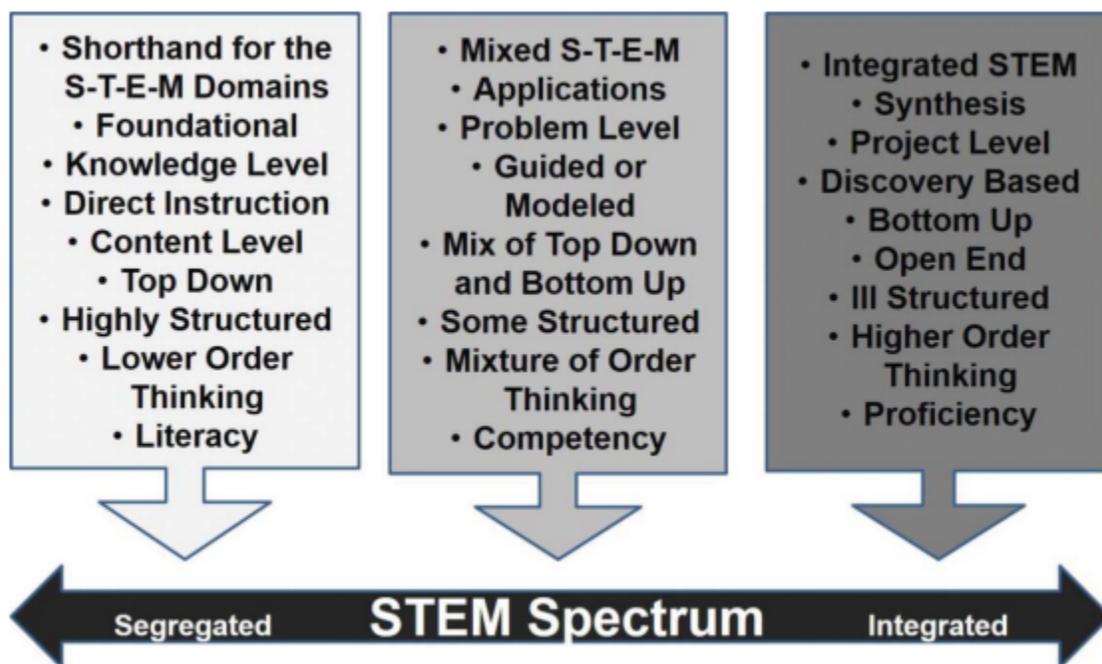
- “We argue that teaching and learning in the age of synthesis targets new domains of expertise: evaluating and applying seemingly disparate information,

accommodating the accelerated emergence of new knowledge and sophisticated technologies, preparing for transdisciplinary careers, and merging traditional disciplines to better meet the needs of citizens in the 21st century.”

- “Teaching students integrated STEM is critical in preparing them for the age of synthesis. Part of the preparation is engaging students in integrated STEM learning opportunities that require them to apply and synthesize from multiple STEM disciplines.”

DEFINING INTEGRATED STEM

- “Integrated STEM involves conditions that require the application of knowledge and practices from multiple STEM disciplines to learn about or solve transdisciplinary problems.”
- “We define integrated STEM as the seamless amalgamation of content and concepts from multiple STEM disciplines. The integration takes place in ways such that knowledge and process of the specific STEM disciplines are considered simultaneously without regard to the discipline, but rather in the context of a problem, project, or task.”
- “Integrated STEM is typically associated with project or problem based learning.”
 - “We are not advocating that all STEM teaching is integrated, rather we are promoting a greater mixture of the segregated foundational knowledge STEM with integrated project based STEM.”



JUSTIFICATION FOR SUPPORTING INTEGRATED STEM

- “Currently, the STEM that happens in research, industry, and society tends to reside at the integrated end of the spectrum. In contrast, most of the STEM that happens in K-12 schools is more aligned with the segregated end of the STEM spectrum.”
- “The justification for teaching integrated STEM is twofold: workforce talent development and increased instructional and learning efficiency.”

IMPORTANCE OF CONTEXT WHEN INTEGRATING STEM

- “Possible K-12 integrated STEM teaching and learning contexts include gardening, natural disasters, climate, agriculture, mining, transportation, or health.”
- “Optimal STEM learning requires alignment between the teaching and learning context and the students’ STEM knowledge and learning capacity.”
- “The context provides a means of scaffolding STEM learning by providing a process or project that allows for the exploration of multiple facets of knowledge. Further, the use of contexts for teaching integrated STEM enhances the meaningfulness and relevancy of STEM content which is likely to elevate students’ motivation and engagement in learning.”

CHALLENGES WITH TEACHING INTEGRATED STEM

- “The first substantial challenge to teaching integrated STEM is the effort required to implement a very different structure in an educational system that has a very established segregated STEM structure.”
- “The second major challenge that we recognize is teacher STEM knowledge and their professional mindset.”
- “Teachers who do not feel that they have the knowledge or are not willing to learn the concepts or content rapidly are not likely to be willing or capable for supporting an integrated STEM approach.”
- There is “a need for teachers to be comfortable with ambiguity and calculated risk taking.”

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, 3(1), 11.

BACKGROUND

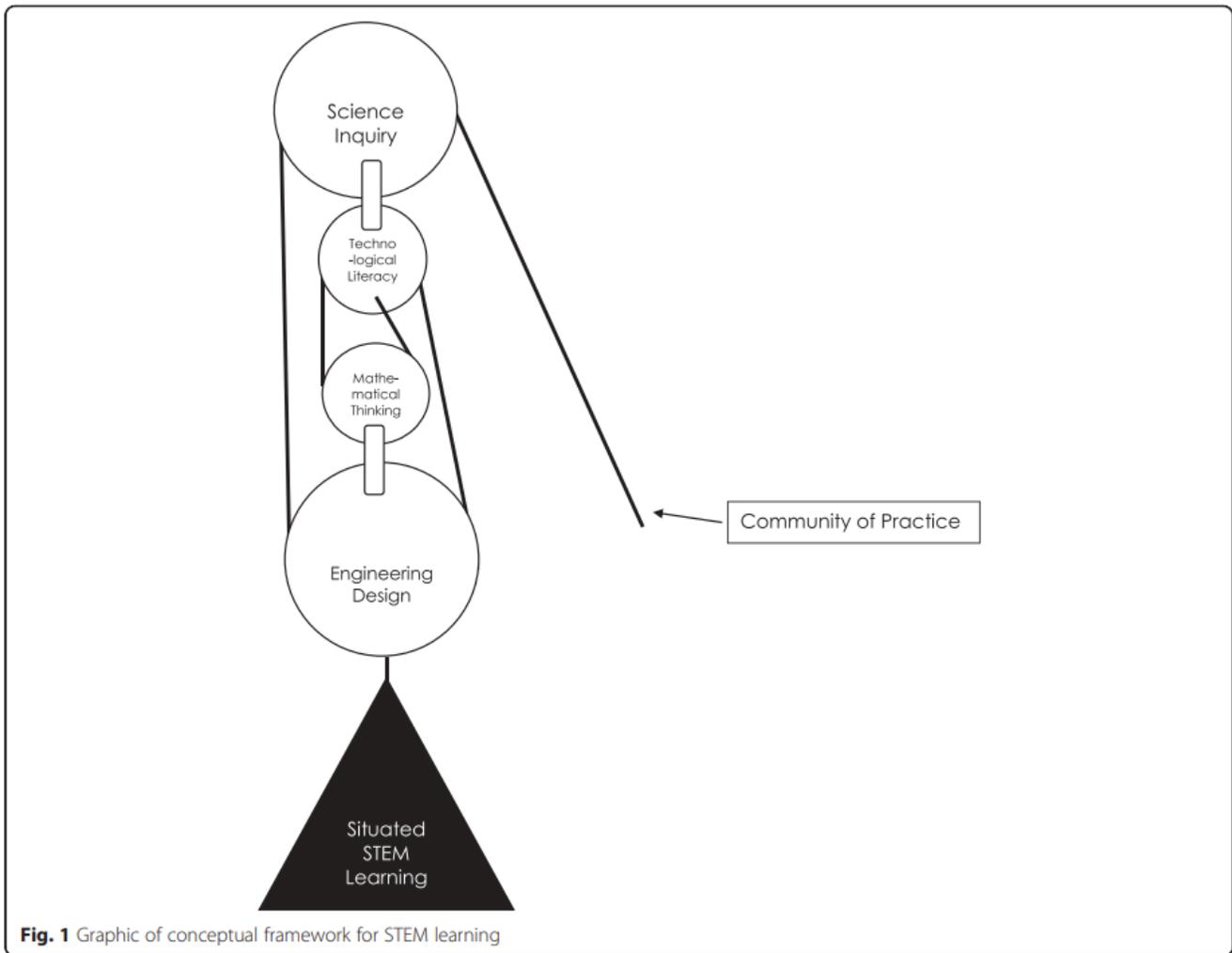
- “Engaging students in high quality STEM education requires programs to include rigorous curriculum, instruction, and assessment, integrate technology and engineering into the science and mathematics curriculum, and also promotes scientific inquiry and the engineering design process.”
- “STEM education can link scientific inquiry, by formulating questions answered through investigation to inform the student before they engage in the engineering design process to solve problems.”

DEFINING INTEGRATED STEM EDUCATION

- “We, however, define integrated STEM education as the approach to teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning.”
- “The authors acknowledge that teaching STEM from the proposed approach is not possible in all circumstances and could limit the content taught from this approach. Some necessary knowledge in mathematics and sciences that are theoretically focused may not provide authentic engineering design applications as well as common STEM practices limited by current technology.”

CONCEPTUAL FRAMEWORK FOR INTEGRATED STEM EDUCATION

- “Instead of teaching content and skills and hoping students will see the connections to real-life application, an integrated approach seeks to locate connections between STEM subjects and provide a relevant context for learning the content.”
- “The proposed framework as presented is intended for secondary education, specifically high school level educators and learners.”



- “The authors are not suggesting that all four domains of integrated STEM must occur during every STEM learning experience but STEM educators should have a strong understanding of the relationship that can be established across domains and by engaging a community of practice.”

PULLEY #1: ENGINEERING DESIGN

- “The very nature of engineering design provides students with a systematic approach to solving problems that often occur naturally in all of the STEM fields.”

PULLEY #2: SCIENTIFIC INQUIRY

- “Scientific inquiry prepares students to think and act like real scientists, ask questions, hypothesize, and conduct investigations using standard science practices. However, an inquiry based approach involves a high level of knowledge and engagement on the part of the teachers and students. Teachers often feel unprepared because they are lacking authentic scientific research and inquiry experiences themselves (Nadelson et al. 2012). They harbor misconceptions about

hands-on instruction, viewing a series of tasks and lab activities as being equivalent to scientific inquiry. However, practical and procedurally based hands-on activities are not equivalent to true science inquiry but must include “minds-on” experiences embedded within constructivist approaches to science learning.” (National Research Council 1996, p. 13)

PULLEY #3: TECH LITERACY

- “Mitcham (1994) combines these two views together when he identified four different ways of conceptualizing technology. He identifies technology as (a) objects, (b) knowledge, (c) activities, and (d) volition.”
- “STEM educators should provide students opportunities to think through technology as a vehicle for change with both positive and negative impacts on culture, society, politics, economy, and the environment.”

PULLEY #4: MATHEMATICAL THINKING

- “Studies have shown that students are more motivated and perform better on math content assessment when teachers use an integrated STEM education approach. A recent study found that **students performed better on post math content assessments** and increased STEM attitudinal scores **when engaging in learning activities** that included **engineering design** and **prototyping solutions using 3D printing** technology.” (Tillman et al. 2014). **INTERESTING!!! 3D PRINTING SPECIFICALLY!**
- “Williams (2007) noted that contextual teaching can give meaning to mathematics.”

THE ROPE: A COMMUNITY OF PRACTICE

(LIKE THE AUTHENTIC AUDIENCE OF PBL.)

- “When engaging students into a community of practice, we suggest that the learning outcomes be grounded in common shared practices. Community of practice can provide opportunity to engage local community experts as STEM partners such as practicing scientists, engineers, and technologists who can help focus the learning around real-life STEM contexts regardless of the pedagogical approach.”
- “Using a community of practice approach to integrated STEM can be challenging for teachers as they need to continually network with experts.”

