Summary of STEM articles

The goal of this document is to familiarize the reader with pertinent research for implementing STEM in the classroom. Each article is broken down, with the pertinent findings of each article summarized. The full citation is at the end of each summary, should the reader wish to locate the full article.

Potential uses:

-Identifying key components for implementing a STEM program in the classroom.

-Providing evidence of a research-based foundation for curricular choices to show a CSS or school admin.

-For an administration or CSS wishing to seek the development of a robust STEM program to support math and science achievement and interest for their school site.

Research Articles

Title of Article/Chapter	**Alignment of Hands-on STEM Engagement Activities with Positive STEM Dispositions in Secondary School Students**
Source Title (journal, book, etc.)	Journal of Science and Educational Technology
Author(s)	Rhonda Christensen, Gerald Knezek, Tandra Tyler-Wood
Year	2015
Setting for Study (grades, subjects, etc.)	Middle and high school students in three treatment groups: 1. Middle school students participating in school-to-home, hands-on energy monitoring activities. 2. Middle and high school students participating in school based activities such as an after-school robotics programs 3. 11^{th} grade high school students enrolled in an academy of mathematics and science.
Participant Focus (teachers/students/etc.)	Student stem dispositions were assessed using the same STEM disposition instrument.
Research Question(s)	-What type of programing is optimal for nurturing or attracting students to STEM content and STEM careers? -How much effect does hands-on STEM engagement activities have on inclination of students toward STEM content and careers in middle school students? -How does the STEM dispositions of students involved in STEM programming compare to their age-level peers, high school STEM academy students, and STEM professionals?
Study Design	The study consisted of a literature review, followed by examination of correlational quantitative data from a STEM Semantics Survey. Data were compared across the three treatments.
Main Findings	*Primary influences in STEM interest in treatment 3 (academy students) were: -Natural inclination and self-motivation -Parent or family member -High-quality or motivating teachers

	*Middle school students participating in hands-on STEM engagement activities produce greater gains in content knowledge and more positive dispositions than those found in comparison groups" (p.903). -Middle school students participating in at-home STEM opportunities were less likely to have positive dispositions to science, math, engineering and to STEM careers than students involved in similar hands-on programs at the school site. -While there was a gender disparity pre-program for all three of the programs examined, with males showing a statistically significant, higher level of interest in all STEM fields, the gender disparity was rectified by the program. There was no statistical difference in the student interest in STEM fields by gender at the end of the program.
Implications for Practice	-High quality, motivating teachers providing quality, hands-on STEM activities in the classroom or through afterschool programs are essential for developing interest in STEM disciplines and careers. -Early introduction to quality hands-on STEM activities and instruction is crucial for keeping students interest in STEM fields in high school. -Hands on STEM instruction is crucial for nurturing female students in STEM subjects. -In order to foster student interest in STEM subjects, students should be offered hands-on, active learning experiences with real-world connections.
Citation (APA format)	Christensen, R., Knezek, G., and Tyler-Wood, T. (2015). Alignment of hands-on STEM engagement activities with positive STEM dispositions in secondary school students. *Journal of Science Education and Technology, 24*, p. 898-909. DOI https://doi.org/10.1007/s10956-015-9572-6

Title of Article/Chapter	**What's your goal? The importance of shaping the goals of engineering tasks to focus learners on the underlying science**
Source Title (journal, book, etc.)	Instruction Science
Author(s)	Laura J. Malkiewich and Catherine Chase
Year	2019
Setting for Study (grades, subjects, etc.)	Two separate studies involving high school students given an engineering challenge. Study 1: 86 students divided into 4 conditions Study 2: 78 students divided into 2 conditions: learning goal and outcome goal

Participant Focus (teachers/students/etc.)	This study focused on how students learn science from engineering tasks. Study 1: 86 11th grade students from an urban public school in the Northeast US. 43% White, 16% Black, 29% Hispanic, 9% Asian. 58% low SES (by free or reduced lunch). School ranked in 24th percentile of High Schools based on school standardized testing. Study 2: 78 Students grades 10-12 from a suburban high school 11% white, 2% black, 84% Hispanic, 3% Asian. 72% low SES based on free or reduced lunch. All students were in the accelerated science track.
Research Question(s)	-How do contrasting cases impact student performance on both engineering tasks and also on the learning and transfer of science? -How do goals and contrasting cases impact student learning and use of instructional resources> -How do learning processes (noticing, valuing resources and task performance) relate to learning and transfer?
Study Design	Study 1: All student built a lego cantilever. Half the participants received a content-focused goal (come up with a rule to determine the cantilever's center of mass). Half received an outcome goal (build the most effective cantilever. Half of each of those groups received contrasting cases while half did not, for a total of four conditions. Measures – performance on the engineering task, a learning subtest, a transfer task, a transfer task subtest, and a "deep structure" assessment for contrasting cases. Study 2: Based on the results of study 1, study 2 focused on the impact of outcome versus content goals. All students were given contrasting cases. Students were given a note sheet to note design ideas.
Main Findings	-Having students complete engineering design activities is not enough to have the students connect to or learn science. -Students often fail to learn and transfer science knowledge from engineering tasks because they are frequently too focused on the engineering task and not making the connection to science. -A content focused learning goal leads students to engage with the task in a way that maximizes science content transfer
Implications for Practice	-Engineering tasks that focus on content goals, rather than engineering goals, are likely to maximize student transfer of science content knowledge. -Contrasting cases allow for students to examine the deeper structure of a scenario.
Citation (APA format)	Malkiewich, L.J. and Chase, C.C. (2019). What's your goal? The importance of shaping the goals of engineering tasks to focus

	learners on the underlying science. *Instructional Science, 47*, p. 551-558. DOI: https://doi.org/10.1007/s11251-019-09493-2