T.I.M.E. FOR STEM

TRANSFORMING INTEGRATIVE MAKERSPACE EDUCATION

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Maker Education

Involves working with one's hands in interdisciplinary STEM environments that incorporate various tools, materials, and technologies (Valente, 2019)

Students learn about STEM subjects in a project-based fashion that promotes interaction and engagement in activities around new topics and technologies (Valente, 2019)

Students become more aware of the design of the world around them and begin to see themselves as people who can test their ideas, make changes, and improve their results.

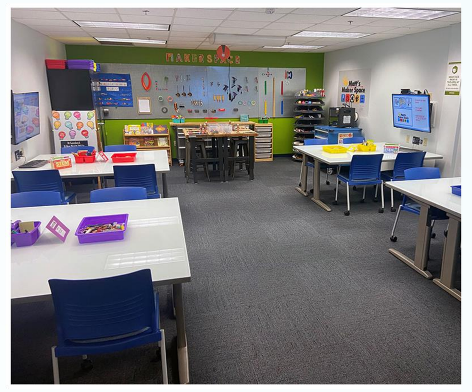
Maker-centered learning has shown an increased proficiency in STEM subjects and extended interest in STEM fields as a result of makerspace education (Clapp, 2016).

STEM professions are expected to grow 8.8% in the next 10 years, compared to 5% for other professions (U.S Bureau of Labor Statistics, 2018).

Maker Labs

Collaborative workspaces for making, learning, exploring, and sharing, utilizing high-tech to no-tech tools

Hands-on, project-based learning



Teacher Preparation

Forty percent (40%) of teachers recently reported that they were underprepared to effectively teach in a maker environment (Cross, 2018).

In-service and pre-service teachers often identify a need to boost their prior experience with STEM or recognize an anxiety associated with STEM instruction due their lack of understanding of STEM pedagogical content (Wu, 2019)

Elementary educators have an opportunity to create early educational experiences for students that can improve attitudes toward STEM subjects, develop higher level and critical thinking skills, and improve proficiency in mathematics and science.

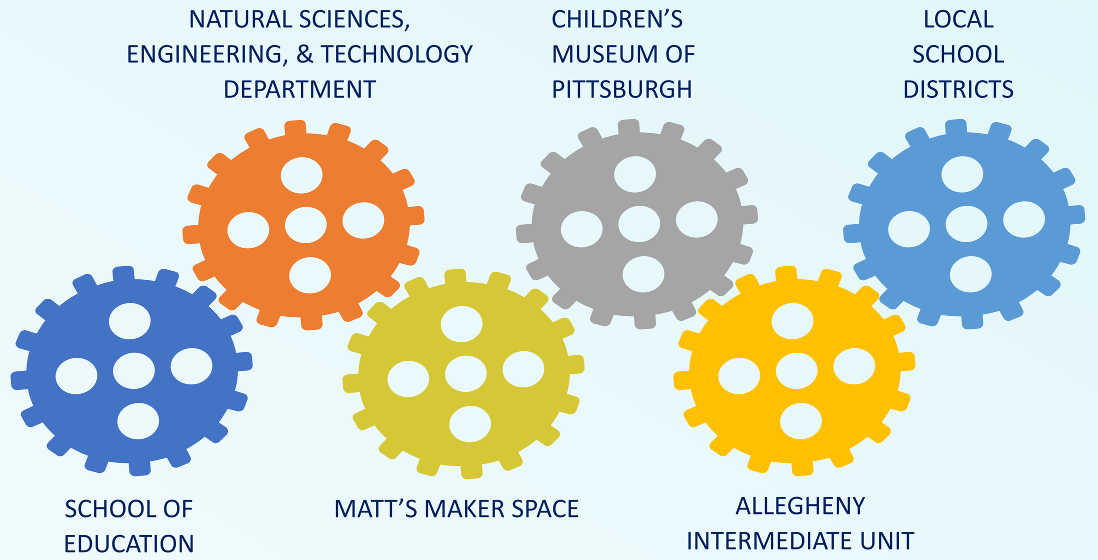
NSF Grant Project

The overarching goal of TIME for STEM is to improve the quality and effectiveness of STEM education for faculty and pre-service teachers through makerspace education

Research Question

What do pre-service teachers (education students) and faculty members identify as areas of pedagogical growth in STEM learning and teaching in a makerspace environment?

Institution and Community Partners



Three Year Project Focus Areas

Year 1 – Professional Development Training Sessions

Trainings focused on STREAM learning in maker education settings focusing on varied materials, resources, assessment, curriculum development/connection, and maker education structure

Community and Institutional Partners conducted the trainings for participants.

Participants completed a pre-survey and post-training reflections

Year 2 – Course Revision and Pre-Service Teacher Training

School of Education faculty will revise PreK-4 methods courses (10 total) to include STREAM learning in maker education settings

PreK-4 Certification Program undergraduates will complete a pre-survey on STEM learning in maker space settings

PreK-4 Certification Program undergraduates will complete the revised methods courses which incorporate interdisciplinary STEM Teaching Domains from the National Institute of STEM Education

Year 3 – Field Experiences in Partnering Schools

PreK-4 Certification Program Undergraduates will develop interdisciplinary STEM lessons in maker spaces using the NISE Domains of Teaching Framework

School of Education faculty will observe and evaluate the PreK-4 Certification Program undergraduates teaching in the maker spaces using an observation rubric based on the NISE Domains of Teaching

PreK-4 Certification Program Undergraduates will complete a post-observation reflection

National Institute for STEM Education (NISE) Domains of Teaching

Measures the need for professional growth related to the impact of instruction and student achievement

*Utilized with approval from NISE for the T.I.M.E. for STEM study

Domain 1: Creating an Environment for Learning
- Creating a Positive Classroom Culture
- Establishing Cooperative Learning
- Integrating Technology
- Connecting Learning Outside the Classroom

Domain 2: Building Scientific Understanding
- Implementing Inquiry
- Addressing Student Misconceptions
- Facilitating Questioning and Discourse
- Utilizing Assessment
- Building Scientific Literacy

Domain 3: Engaging Students in Scientific and Engineering Practices
- Cultivating Scientific Investigation
- Developing Engineering Solutions
- Fostering Data Utilization
- Implementing Project Based Learning
- Building Scientific Explanations
- Promoting Scientific Argument

NATIONAL INSTITUTE *for* STEM EDUCATION

Post Training Sessions Preliminary Reflections

Results support the Research Question

Teachers embrace the idea of maker-education:
- This iterative process of human-centered design really does compliment the ideas that we have discussed in the maker space training
- There are many ways to authentically assess all students in maker education: collaboration, creativity, problem solving and communication.
- Understanding how to define maker education and what that looks like for different types of learners (learner identities).
- Wicked problem activity allowed us to empathize, define, ideate, prototype, and test. We communicated and presented our ideas to one another and shared feedback. I can't wait to try this type of activity with my students and see how we can take an interdisciplinary approach.

Teachers want to know how to apply maker-education in the classroom:
- Curious how these maker ideas and mindsets connect to curriculum and standards required in the elementary classroom.
- I would like to continue utilizing this method in the courses that I teach but my concern is time. How do I incorporate this into the curriculum?
- I would like to see what this looks like in the elementary classroom.
- How can we connect these concepts to the PA Standards of learning and create maker activities in the classroom that connect to the content?

Select Results from Pre-Survey

Domain 1: Creating an Environment for Learning

Participants indicated higher levels of learning activity in Bloom's Taxonomy using maker space education

Participants Comments Arranged Using Bloom's Taxonomy

Bloom's Category	Participant Comment
Level 1: Knowledge	No comments fit this category
Level 2: Comprehension	No comments fit this category
Level 3: Application	• The design and build aspects apply directly to developing capacity with tools and computers • Many makerspace skills are real-world: sewing, building, using power tools, and working with a team to solve a problem
Level 4: Analysis	• Students could identify a problem, such as water pollution, research the problem, and then create a solution. • Makerspace activities can explain various aspects of science, math, and engineering.
Level 5: Synthesis Level 6: Evaluation	• It promotes entrepreneurial skills in many fields. It helps students understand the process of innovation and problem solving. • Collaborating, solving problems, accepting challenges, revising ideas.

Domain 2: Building Scientific Understanding

Participants reported a "comfort level" with STEM knowledge corresponding to the knowledge level of their students

How comfortable are you in your STEM knowledge to…	Methods course instructors	Elementary school teachers
…ask questions at various levels of cognition, extend ideas, continue inquiry, and further student questions?	$\bar{x} = 2.4$ $s = .89$	$\bar{x} = 3.3$ $s = .57$
…use guiding questions to facilitate student learning in a makerspace environment?	$\bar{x} = 2.4$ $s = .89$	$\bar{x} = 4.0$ $s = 1.0$
…assess and critique student scientific design and creation in a makerspace environment?	$\bar{x} = 2.4$ $s = .89$	$\bar{x} = 3.6$ $s = .57$

Domain 3: Engaging Students in Scientific and Engineering Practices

Participants reported a "comfort level" with STEM knowledge corresponding to the knowledge level of their students

Seventy-eight percent (78%) of participants were unsure of how a makerspace could be utilized to interpret charts, tables, and graphical representations of data

Responses included:
- Not sure, I'm sure there are many ways
- No idea
- I'm not sure
- I look forward to learning about this.
- It allows students to manipulate the data making it more concrete
- Follow science experiments over time like plant growth