Developing High Quality STEM Programs

Tiffany Neill, M.Ed.

Executive Director of Curriculum and Instruction

engageok ON THE ROAD

Email: Tiffany.Neill@sde.ok.gov

O: 405-522-3521

@tiffanyneill

Presentation Topic: Session Goals

- **Explore** characteristics of a high-quality STEM Programs
- **Consider** how current state standards for STEM support high-quality STEM learning
- **Discuss** steps schools/districts can take to ensure all students have access to STEM education.
- **Gain** resources to support schools/districts in planning STEM spaces and programs

Introduction: STEM

THINK Imagine the ideal STEM classroom or program. What are students doing and what are teachers doing? Feel free to draw or write your thoughts.

SHARE With a partner or your table.

Introduction: STEM

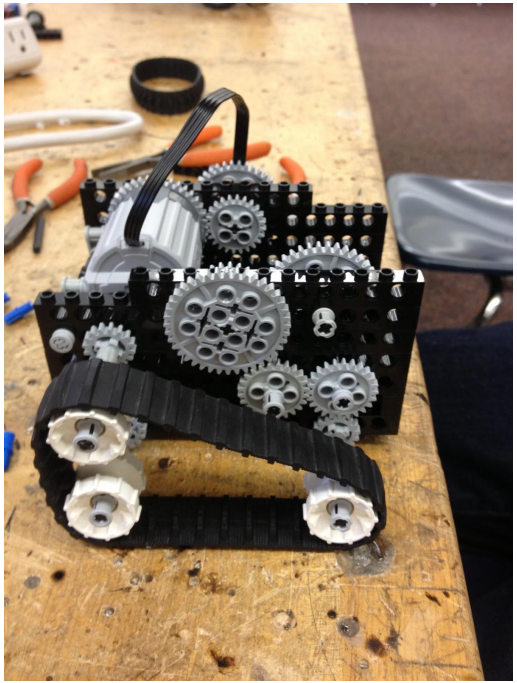
THINK Imagine the ideal STEM classroom/program. What are students doing and what are teachers doing? Feel free to draw or write your thoughts.

SHARE With a partner or your table.

STEM Programs: Vision and Coherence

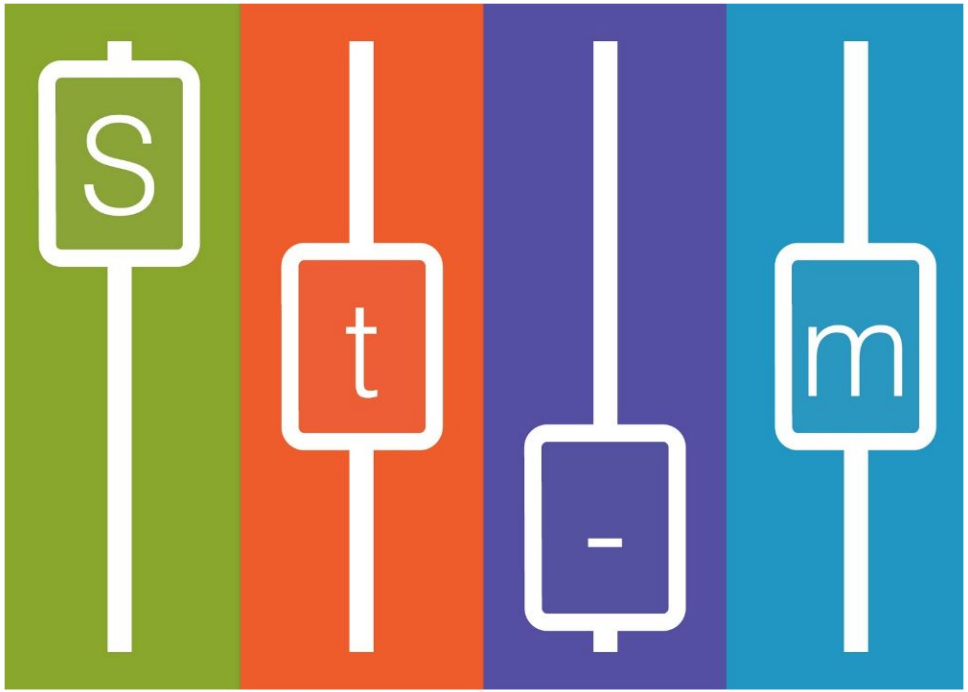
- **All STEM education programs** should **start with a vision** for how STEM knowledge and skills will contribute to a student's future.
- Whatever the vision, the design of a corresponding **program should reflect that vision**, including:
  - Educational strategies
  - Curricular Options
  - Classroom Environment

What is STEM?



Google “STEM activity” and you’ll see towers, bridges, and a lot of projects that use **copious amounts of tape, candy, and spaghetti**. Add “middle school” or “high school” to your search and you’ll find more **wires, gears, and robot cars**. In just a few moments, some **180 million search results** might leave you believing STEM is about **building and programming**.

STEM Framework



The answer to “**What is STEM?**” is not easily (or accurately) understood by Googling and **requires us to take a closer look** at the disciplines comprising STEM.

Science

S

S (UPPERCASE)
Science **content and practices** are **equally** represented and **on grade level**.
s (lowercase)
Science **content or practices** are **absent** or science content and practices are **not on grade level**.
__ (underscore)
Science **content and practices** are **absent**.

Science

S

S (UPPERCASE)
Science **content and practices** are **equally** represented and **on grade level**.
s (lowercase)
Science **content or practices** are **absent** or science content and practices are **not on grade level**.
__ (underscore)
Science **content and practices** are **absent**.

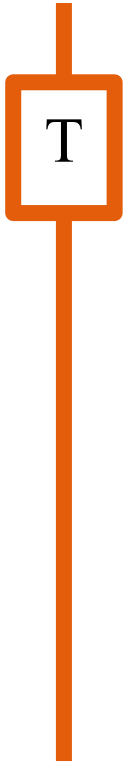
Science

S (UPPERCASE)
Science **content and practices** are **equally** represented and **on grade level**.
s (lowercase)
Science **content or practices** are **absent** or science content and practices are **not on grade level**.
__ (underscore)
Science **content and practices** are **absent**.

-

1

Technology



T (UPPERCASE)
Technology is both **created** and **operated purposefully**.
t (lowercase)
Technology is **operated purposefully** but **not created**.
__ (underscore)
Purposeful operation and **creation** of technology are **absent**.

Technology

t

T (UPPERCASE)
Technology is both **created** and **operated purposefully**.
t (lowercase)
Technology is **operated purposefully** but **not created**.
__ (underscore)
Purposeful operation and **creation** of technology are **absent**.

Technology

T (UPPERCASE)
Technology is both **created** and **operated purposefully**.
t (lowercase)
Technology is **operated purposefully** but **not created**.
__ (underscore)
Purposeful operation and **creation** of technology are **absent**.

Engineering

E

E (UPPERCASE)
Engineering **knowledge** and **design** are present, and **science and mathematics** concepts are **utilized**.
e (lowercase)
Engineering **knowledge or design** are **present** but **lacks utilization of science** and **mathematics concepts**.
__ (underscore)
Engineering **knowledge** and **design** are **absent**.

Engineering

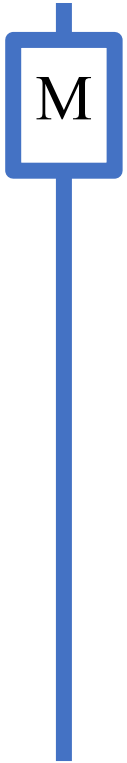
e

E (UPPERCASE)
Engineering **knowledge** and **design** are present, and **science and mathematics** concepts are **utilized**.
e (lowercase)
Engineering **knowledge or design** are **present** but **lacks utilization of science** and **mathematics concepts**.
__ (underscore)
Engineering **knowledge** and **design** are **absent**.

Engineering

E (UPPERCASE)
Engineering **knowledge** and **design** are present, and **science and mathematics** concepts are **utilized**.
e (lowercase)
Engineering **knowledge or design** are **present** but **lacks utilization of science** and **mathematics concepts**.
__ (underscore)
Engineering **knowledge** and **design** are **absent**.

Mathematics



M (UPPERCASE)
Mathematics **content and practices** are **equally** present and **on grade level**.
m (lowercase)
Mathematics **content or practices** are **absent** or mathematics content and practices are **not on grade level**.
__ (underscore)
Mathematics **content and practices** are **absent**.

Mathematics

m

M (UPPERCASE)
Mathematics **content and practices** are **equally** present and **on grade level**.
m (lowercase)
Mathematics **content or practices** are **absent** or mathematics content and practices are **not on grade level**.
__ (underscore)
Mathematics **content and practices** are **absent**.

Mathematics

M (UPPERCASE)
Mathematics **content and practices** are **equally** present and **on grade level**.
m (lowercase)
Mathematics **content or practices** are **absent** or mathematics content and practices are **not on grade level**.
__ (underscore)
Mathematics **content and practices** are **absent**.

STEM Framework: Reflection

THINK How might the STEM Framework be utilized to support educators and schools in casting a vision for a STEM class or program?

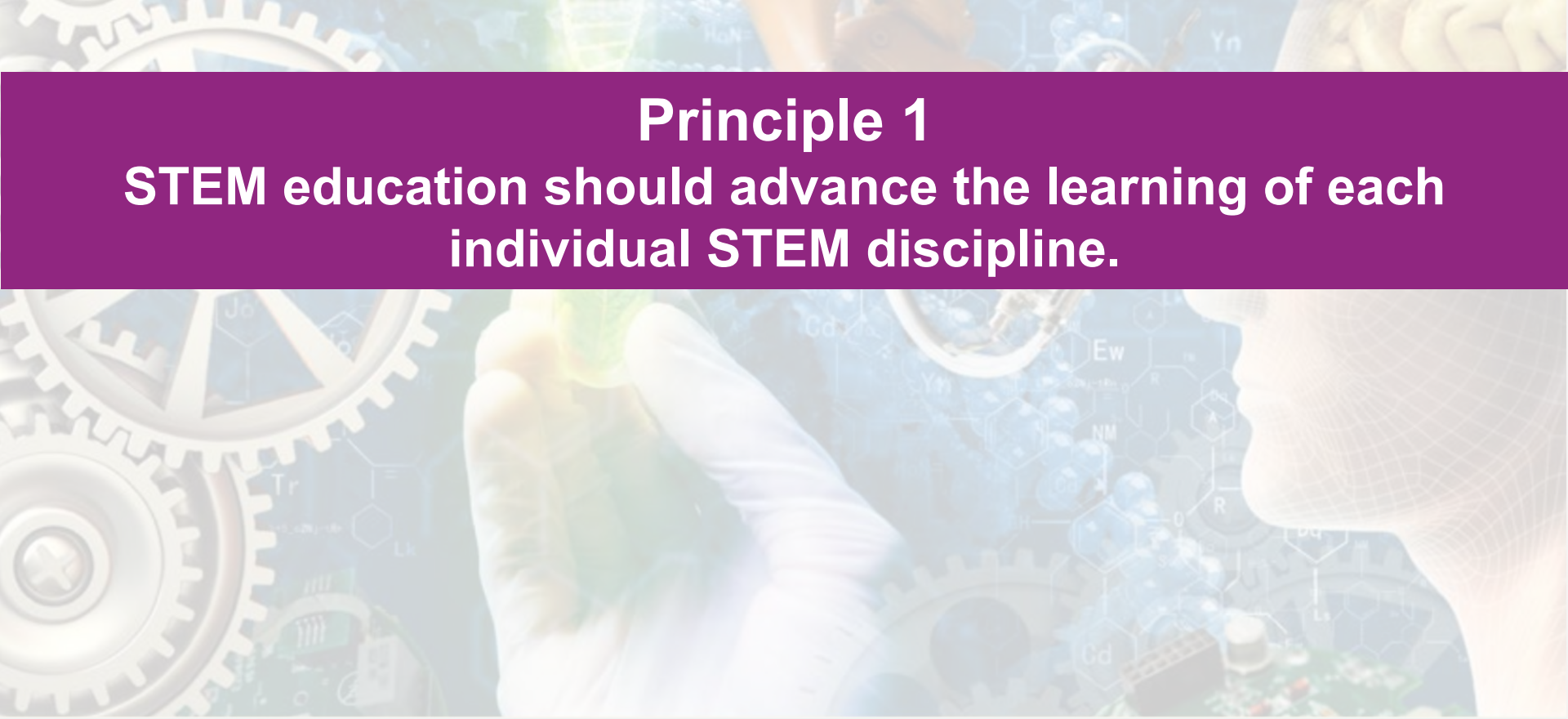
SHARE With a partner or your table.

STEM Framework: Reflection

THINK How might the STEM Framework be utilized to support educators and schools in casting a vision for a STEM class or program?

SHARE With a partner or your table.

STEM^4: The power of collaboration for change



Principle 1

STEM education should advance the learning of each individual STEM discipline.

Principle 1

STEM education should advance the learning of each individual STEM discipline.

Principle 2

STEM education should provide logical and authentic connections between and across individual STEM disciplines

STEM^4: The power of

Principle 1

STEM education should advance the learning of each individual STEM discipline.

Principle 2

STEM education should provide logical and authentic connections between and across individual STEM disciplines

Principle 3

STEM education should serve as a bridge to STEM careers.

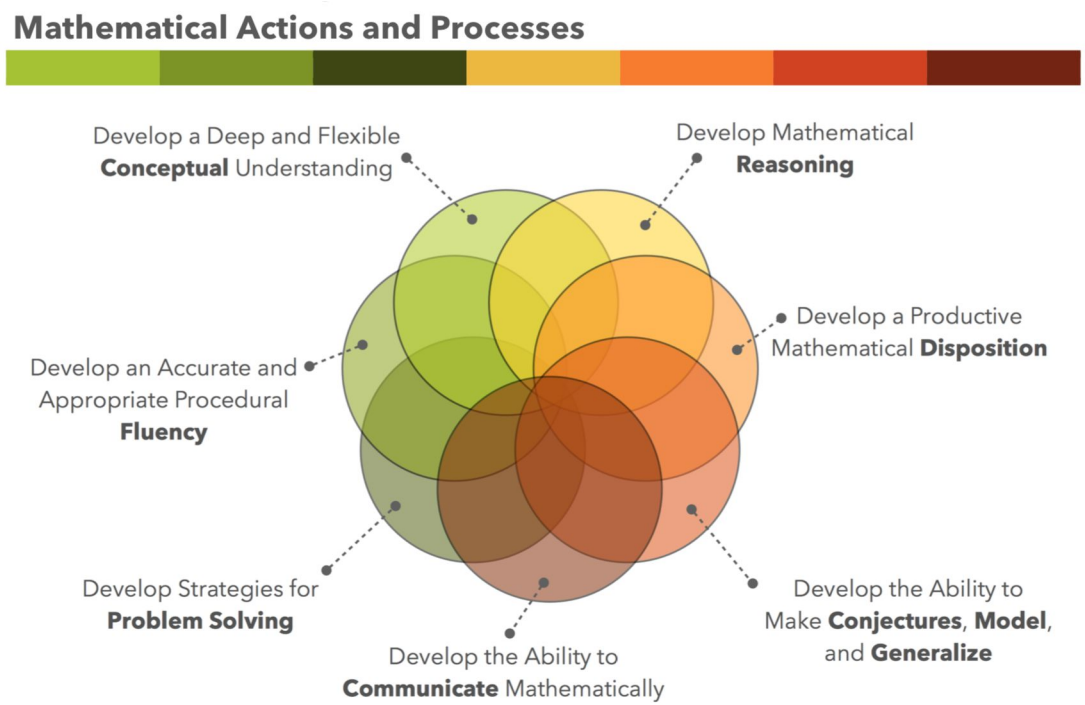
Key STEM Program Qualities

- Need for **conceptual understanding and disciplinary skills** now reflected in all state STEM standards.
  - Oklahoma Academic Standards for **Mathematics**
  - Oklahoma Academic Standards for **Science**
    - Integrate **Engineering Practices**
  - Oklahoma Academic Standards for **Computer Science**

OAS-Mathematics: STEM Skills

OKLAHOMA ACADEMIC STANDARDS | MATHEMATICS

OKLAHOMA STATE DEPARTMENT OF EDUCATION
CHAMPION EXCELLENCE



Develop Strategies for Problem Solving

Analyze the parts of complex mathematical tasks and identify entry points to begin the search for a solution. Students will select from a variety of problem solving strategies and use corresponding multiple representations (verbal, physical, symbolic, pictorial, graphical, tabular) when appropriate. They will pursue solutions to various tasks from real-world situations and applications that are often interdisciplinary in nature. They will find methods to verify their answers in context and will always question the reasonableness of solutions.

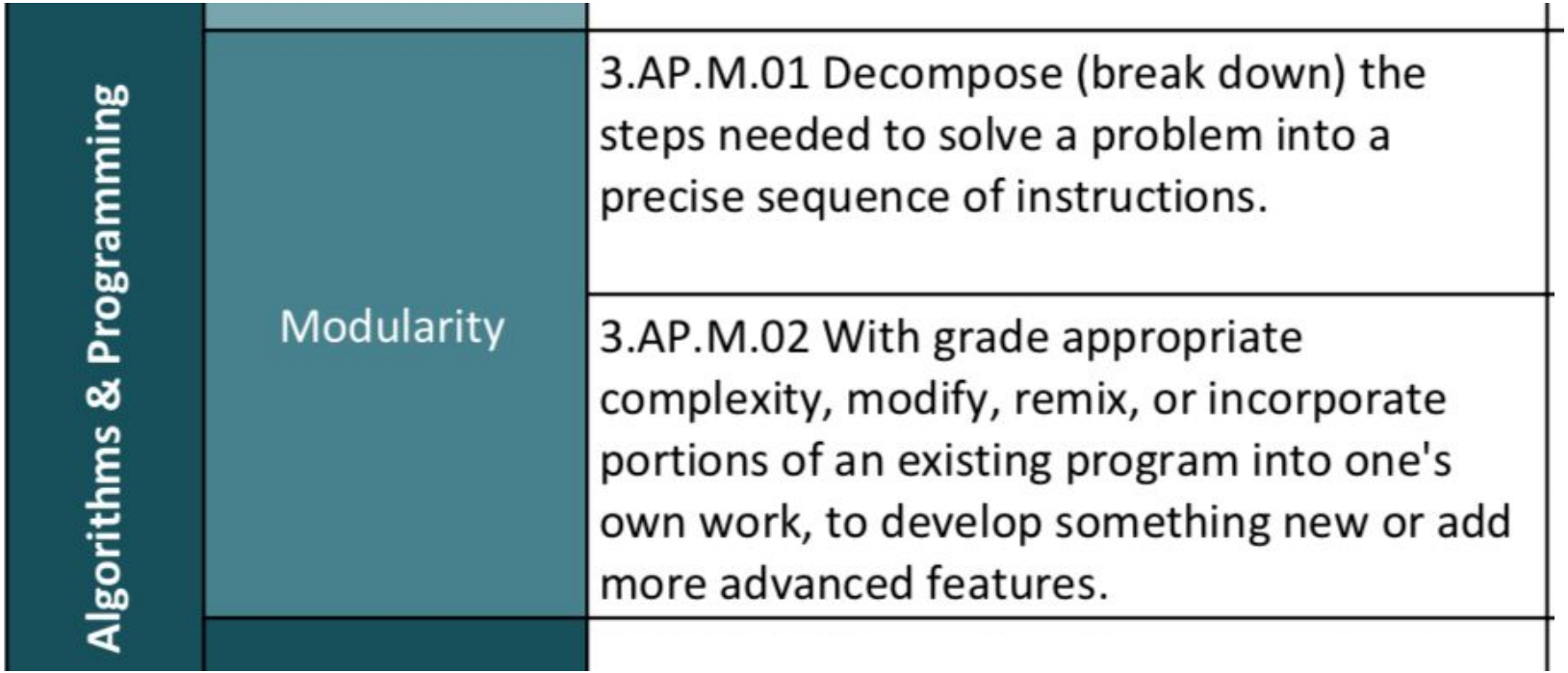
Develop Mathematical Reasoning

Explore and communicate a variety of reasoning strategies to think through problems. Students will apply their logic to critique the thinking and strategies of others to develop and evaluate mathematical arguments, including making arguments and counterarguments and making connections to other contexts.

Develop the Ability to Make Conjectures, Model, and Generalize

Make predictions and conjectures and draw conclusions throughout the problem solving process based on patterns and the repeated structures in mathematics. Students will create, identify, and extend patterns as a strategy for solving and making sense of problems.

OAS-Computer Science: STEM Skills



OAS-Science: STEM Skills

Science and Engineering Practices

Asking questions and defining problems

Developing and using models

Planning and carrying out investigations

Analyzing and interpreting data

Using mathematics and computational thinking

Constructing explanations and designing solutions

Engaging in argument from evidence

Obtaining, evaluating, and communicating information

engageok ON THE ROAD

Key STEM Program Qualities

- Quality STEM education programs are generally designed to enable:
  - Hands-on, minds-on science and engineering
  - Relevant and applied mathematics
  - Effective integration and use of technologies
  - Dynamic application of STEM knowledge and skills relevant to contexts and problems

Key Educational Strategies in STEM

A number of curricular and instructional strategies are found in quality STEM Education (e.g. Banilower et al, 2010; NRC, 2012, 2009, 2005).

- Collaboration
- Critical thinking and problem solving
- Project-based learning

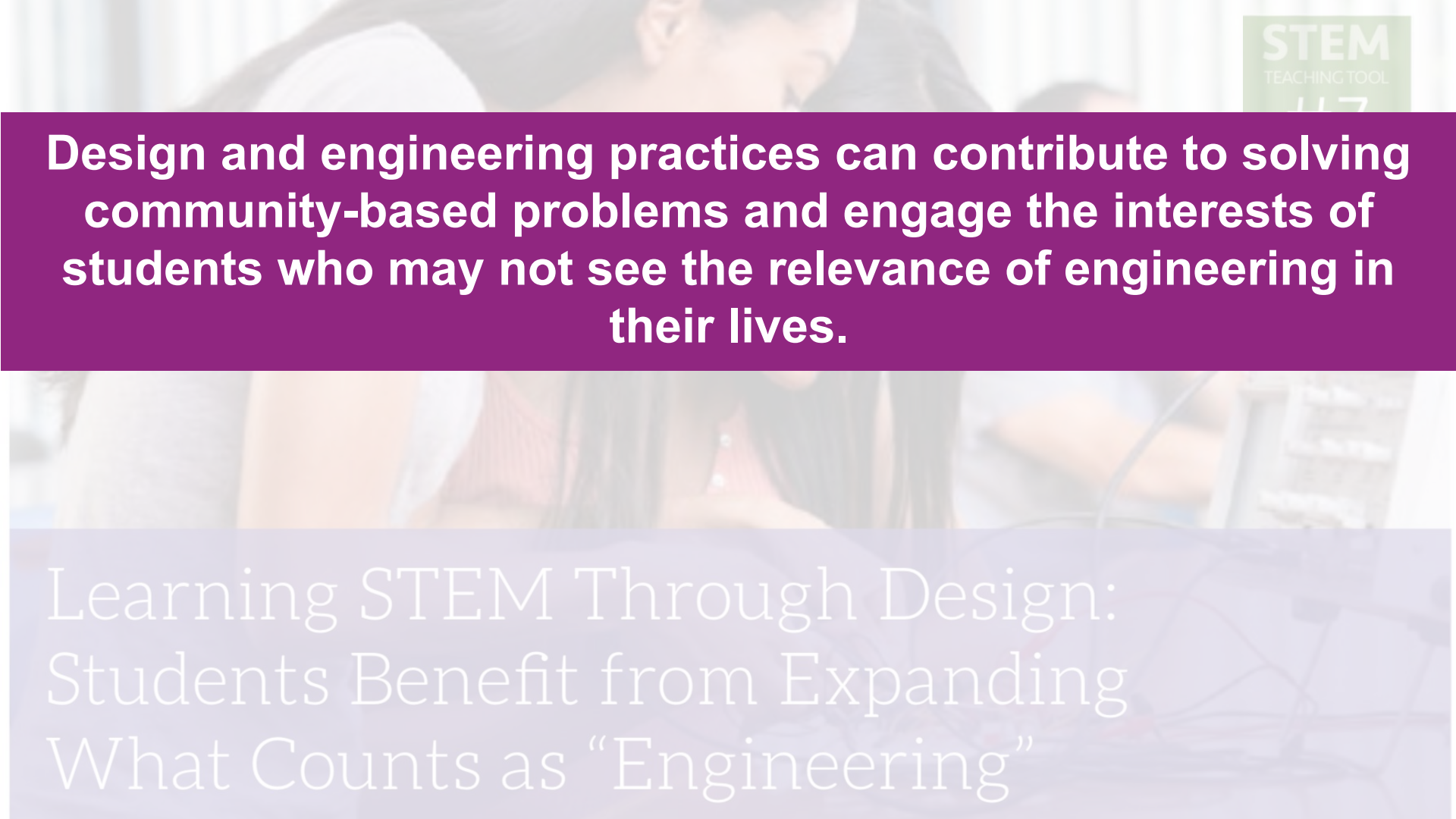
Key Educational Strategies in STEM

A number of curricular and instructional strategies are found in quality STEM Education (e.g. Banilower et al, 2010; NRC, 2012, 2009, 2005).

- Application to relevant, community, economic, and global contexts.
- Technology to enhance and engender teaching and learning of above
- Explicit attention to equity and inclusion

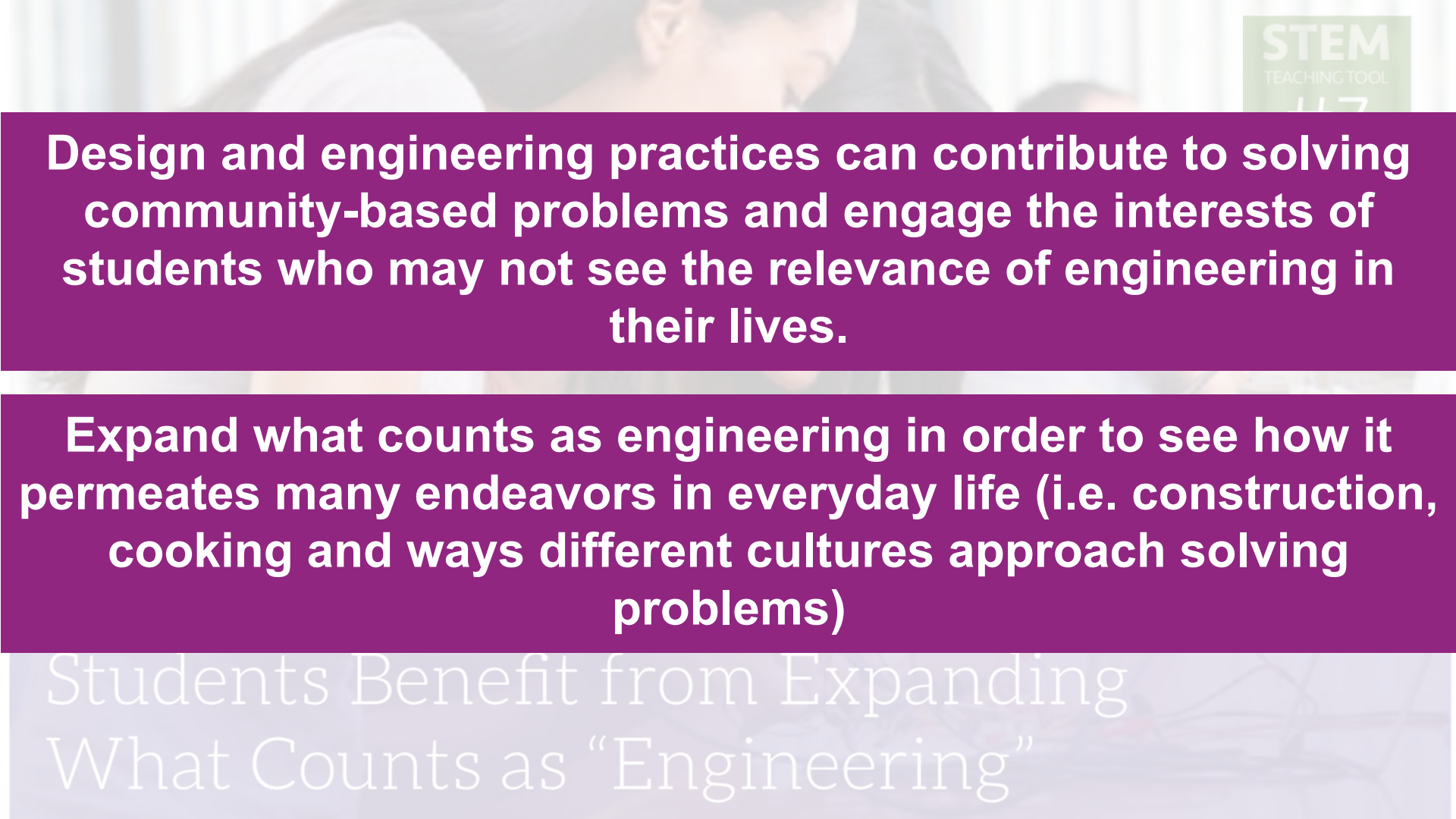
STEM
TEACHING TOOL
#7

Learning STEM Through Design: Students Benefit from Expanding What Counts as "Engineering"



Design and engineering practices can contribute to solving community-based problems and engage the interests of students who may not see the relevance of engineering in their lives.

Learning STEM Through Design: Students Benefit from Expanding What Counts as "Engineering"



Design and engineering practices can contribute to solving community-based problems and engage the interests of students who may not see the relevance of engineering in their lives.

Expand what counts as engineering in order to see how it permeates many endeavors in everyday life (i.e. construction, cooking and ways different cultures approach solving problems)

Students Benefit from Expanding What Counts as "Engineering"

STEM Education and Equity: Considerations

How can Making promote equity and excitement in STEM?

Failing Forward: Managing Student Frustration During Engineering Design Projects

engageok ON THE ROAD

Elementary STEM Learning Spaces: Spectrum

PreK-2 Science, Math

3rd-5th Science, Math

Elementary STEM Learning Spaces: Spectrum

PreK-2 STEM Specials (STEM Class, Makerspace)

3rd-5th Specials (STEM Class, Makerspace)

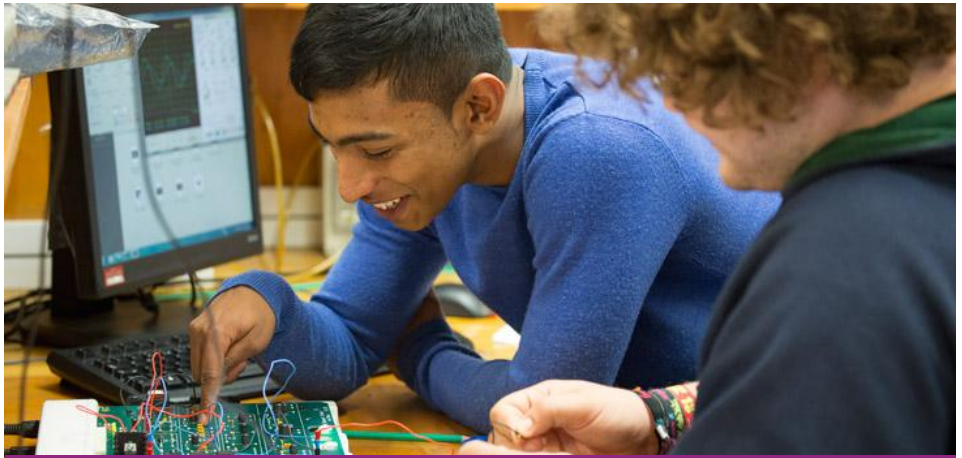
Secondary STEM Learning Spaces: Spectrum

Science Lab

Tech/Engineering Lab

Secondary STEM Learning Spaces: Spectrum

Specialized Lab Classes



Career Preparation Classes

Evolution of Makerspaces

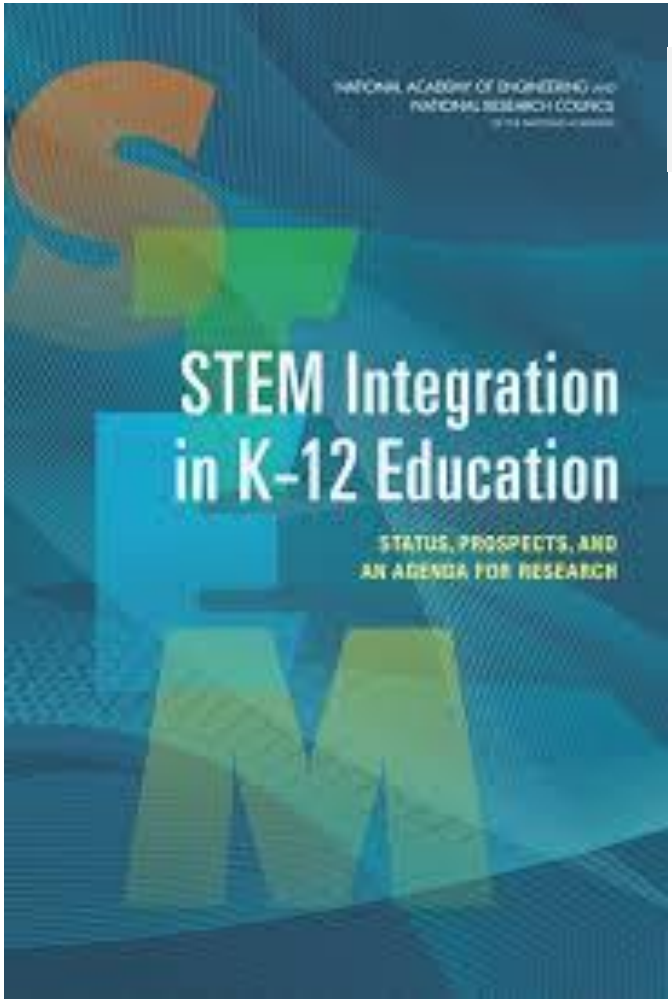
Wood Shops

Technology Education Classrooms

Evolution of Makerspaces

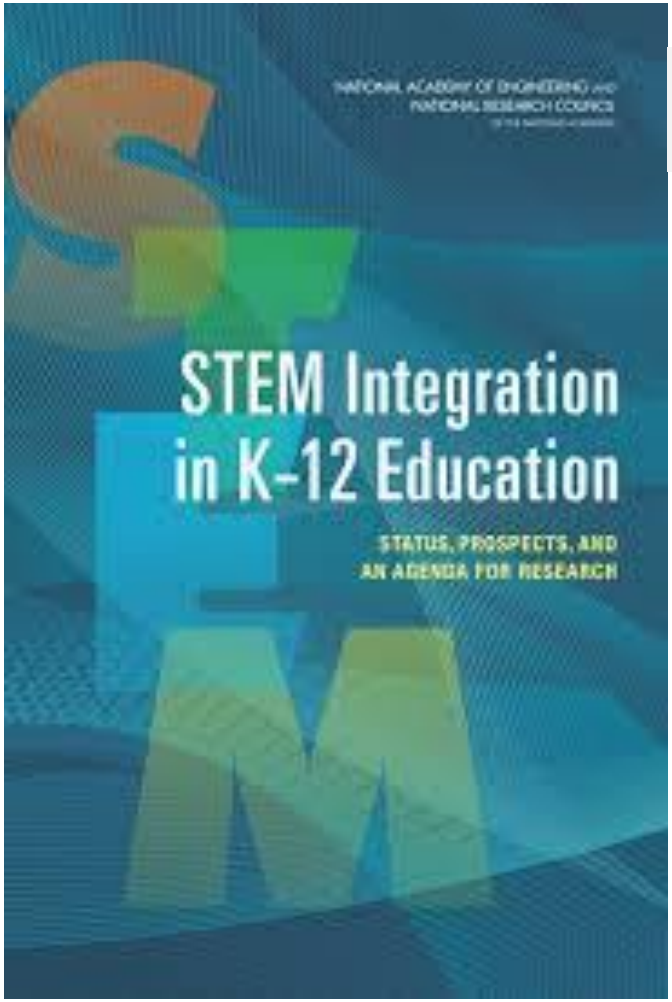
Dedicated Makerspace Classroom

School-Wide Accessible Makerspace



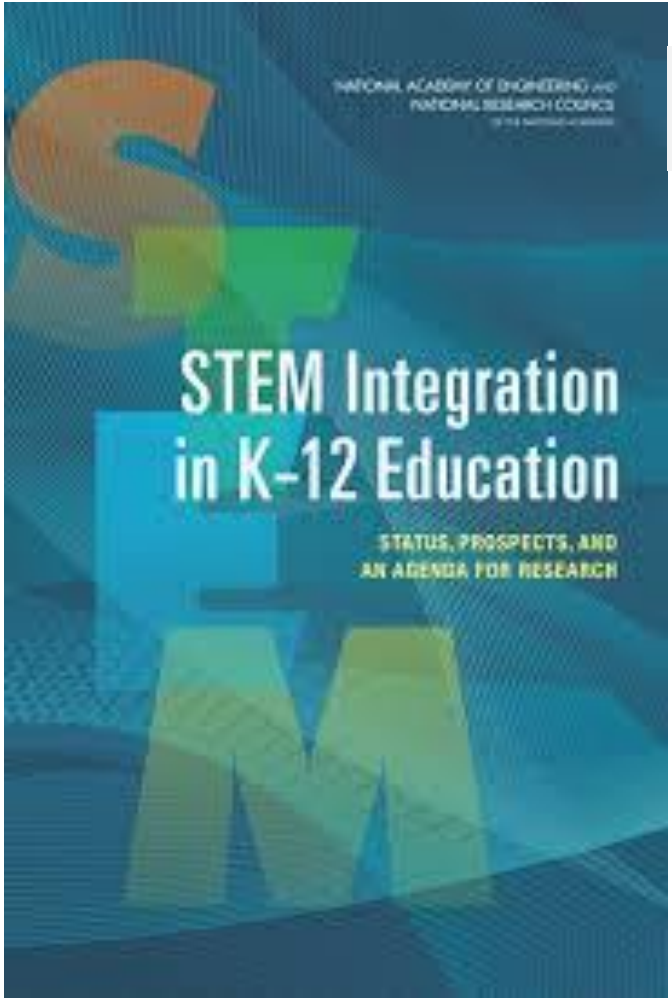
Recommendation 1

Integration across disciplines should be made **explicit** and **provide intentional support** for students to build knowledge and skills within and across disciplines.



Recommendation 2

Students knowledge in individual disciplines must be supported. **Connecting ideas across disciplines is challenging** when students have little or no understanding of the relevant ideas in an individual discipline.



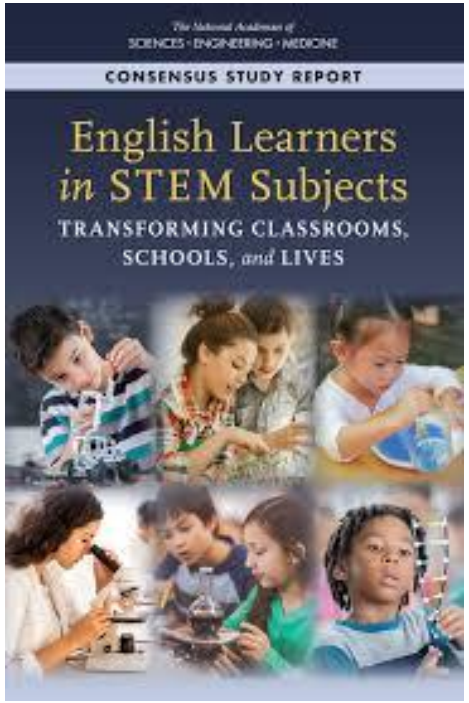
Recommendation 3

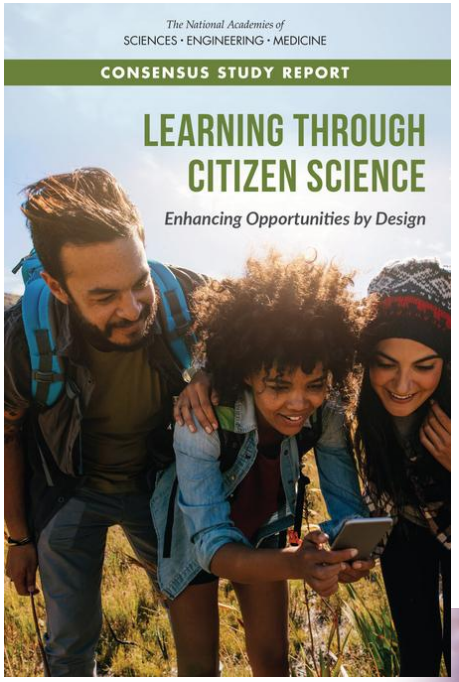
More integration is **not necessarily better.** It is imperative to have a measured and strategic approach to implementing integrated STEM.

STEM Framework: Reflection

THINK How might today's session be impacting the way you think about STEM, a STEM class or a STEM program differently?

Free Resources: National Academies Reports





Resources

Massachusetts: Best Practices for K-12 STEM Spaces

STEM Works

Champions of Excellence Rubric Mathematics

Champions of Excellence Rubric Science

Oklahoma Curriculum Frameworks

Oklahoma STEM Briefs

Stay Connected: Woova App

- Access handouts
- Up-to-date schedule
- Post photos
- Rank sessions

engageok ON THE ROAD

Email: Tiffany.Neill@sde.ok.gov

O: 405-522-3521

@tiffanyneill