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## Breaking Silos: Cross- and Interdisciplinary STEM

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A background featuring a network diagram with black nodes and lines on a gradient of orange, green, and blue. The nodes are connected by thin black lines, forming a complex web-like structure. The gradient transitions from orange on the left to green in the middle and blue on the right.

# Breaking Silos

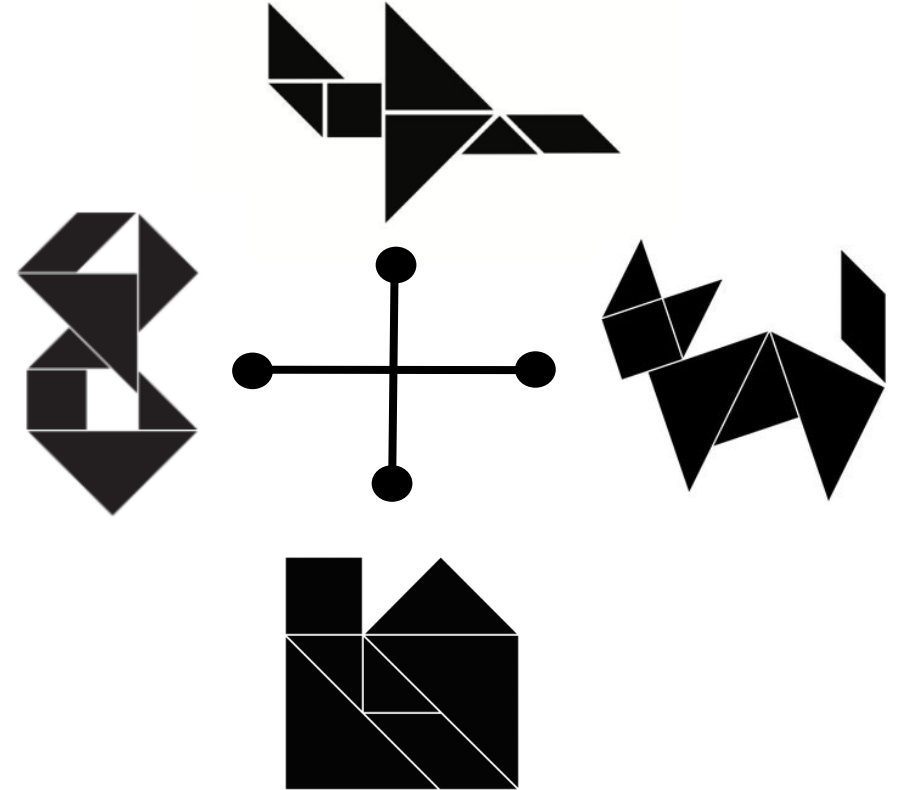
## Cross- and Interdisciplinary STEM

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Worldwide Campus

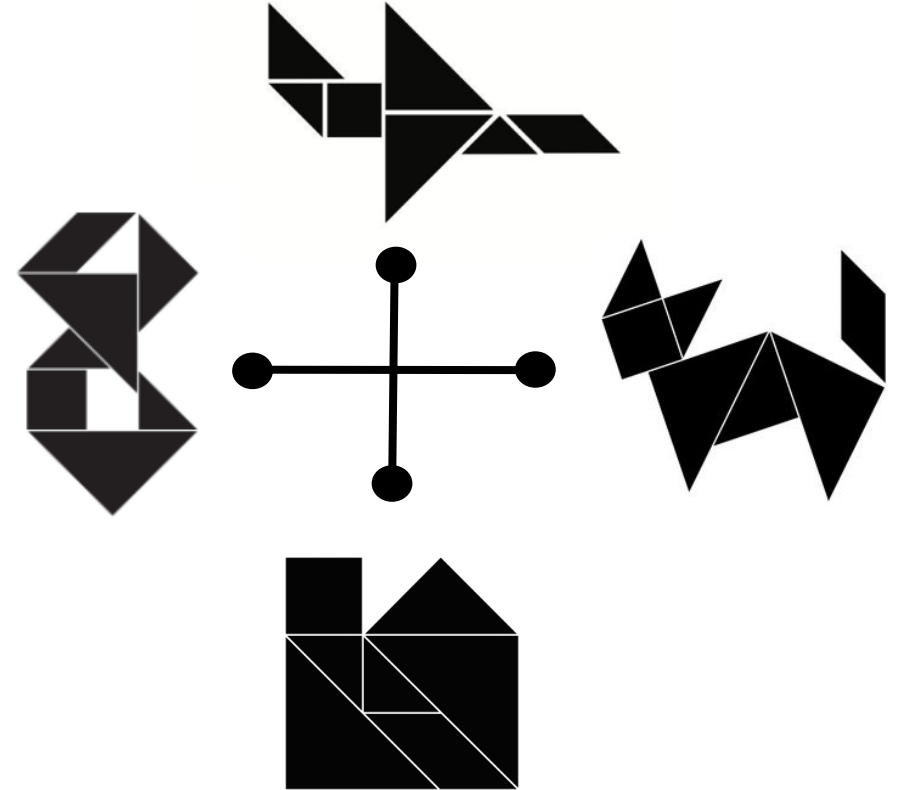
# Integrated STEM connects disciplines to enhance learning.

- **S**cientific inquiry to understand
- **T**echnological literacy to measure
- **E**ngineering design to learn from failure
- **M**athematical thinking to analyze



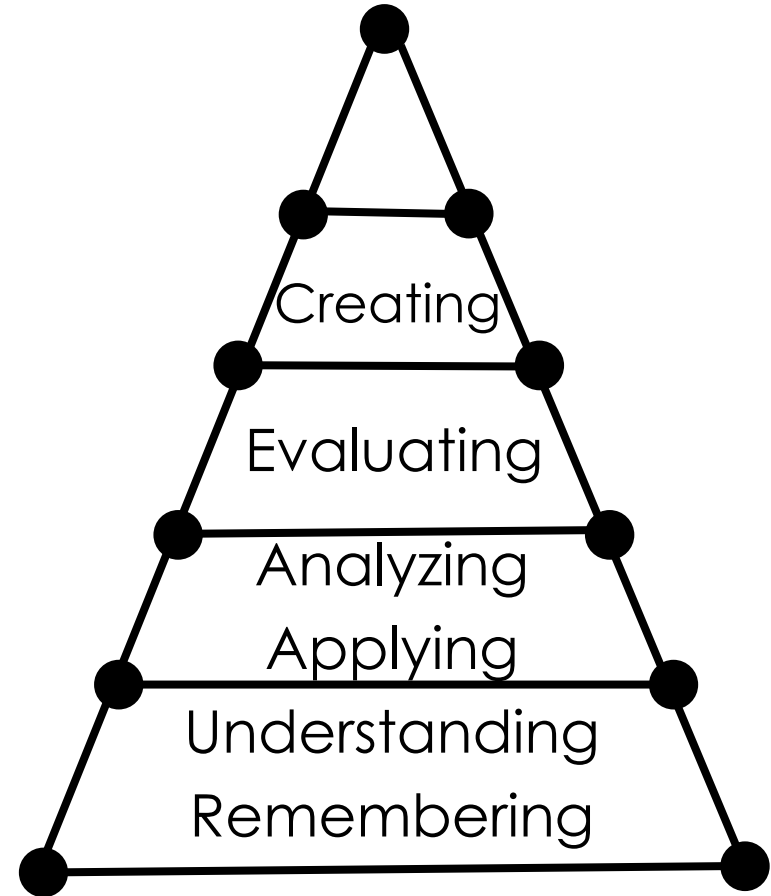
# Integrated STEM has characteristic pedagogical elements.

- an authentic, relevant context
- student-centered
- development of transferable skills
- use of real-world problems
- project-based
- teamwork and communication skills



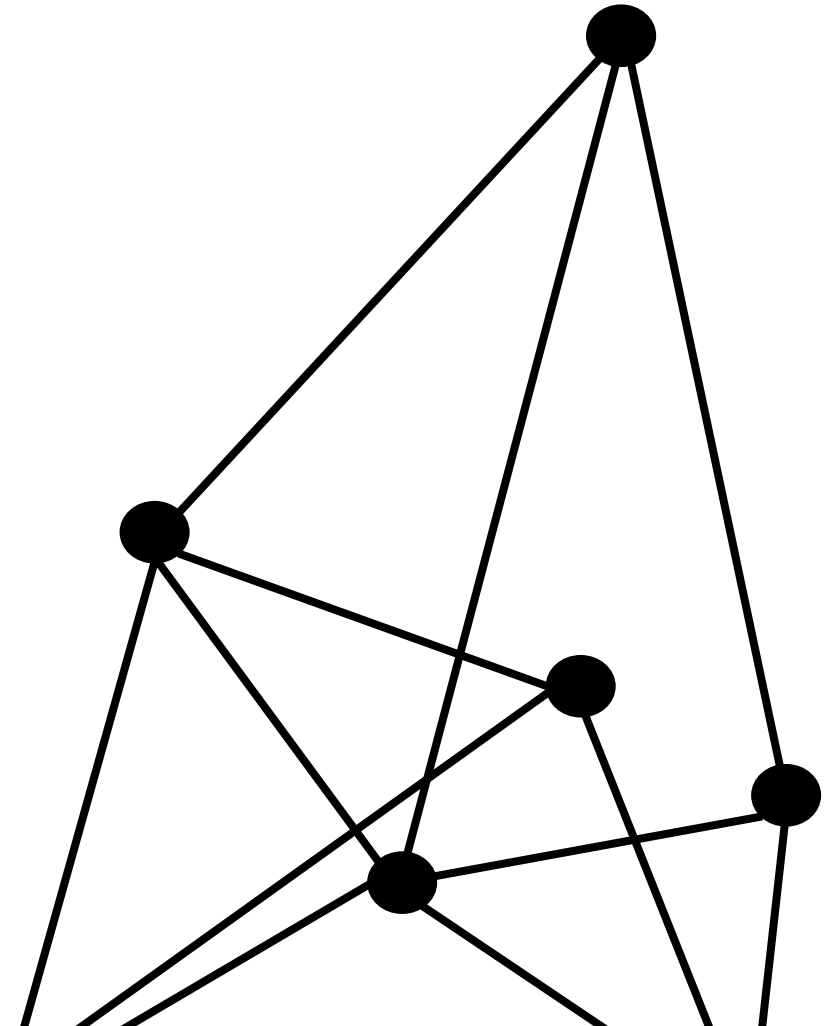
# Integrated STEM has multiple student benefits.

- Content mastery/performance
- Higher order thinking skills
- Problem-solving skills
- Creativity
- Retention

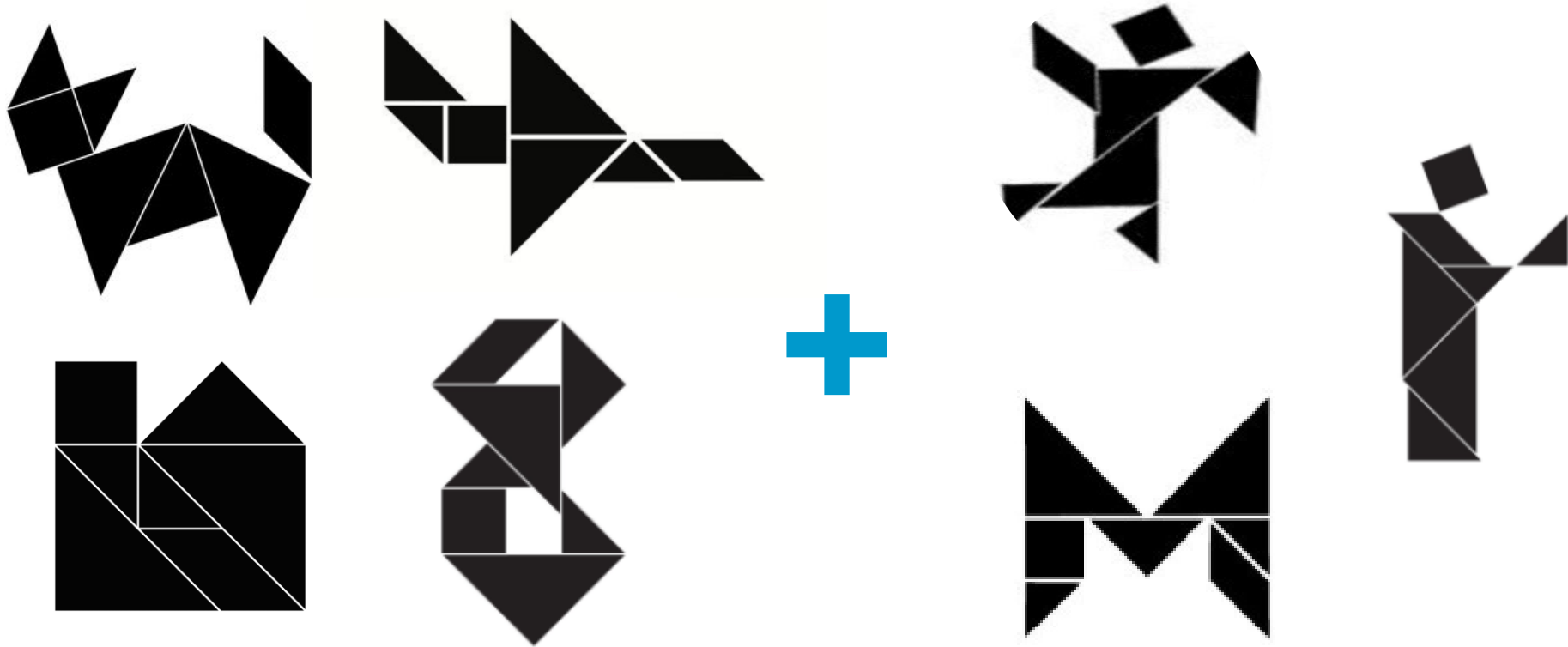


# Integration has several variations.

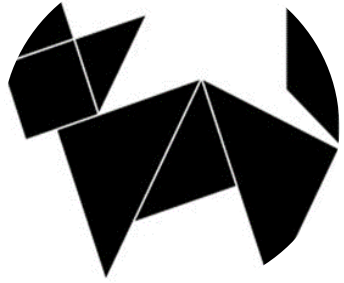
- **Cross-disciplinary**  
views one discipline from perspective of another
- **Multidisciplinary**  
explores a problem from multiple disciplinary viewpoints with people from different disciplines working together
- **Interdisciplinary**  
integrates the knowledge and skills of multiple disciplines in a unified approach, focusing on the interrelationships.



Integration of humanities into STEM is not very common.



STEM → STEAM



## Science

Ask question  
Develop explanation  
Systematically investigate  
Analyze data using quantitative thinking  
Construct argument from evidence



## Technology & Engineering

Identify problem  
Analyze existing solutions  
Investigate to identify design criteria and constraints  
Analyze data using quantitative thinking to locate optimal design  
Construct argument from evidence



## Mathematics

Create abstractions  
Look for solution entry points  
Investigate with logic and reason  
Analyze data using quantitative thinking  
Construct argument from evidence



## Humanities

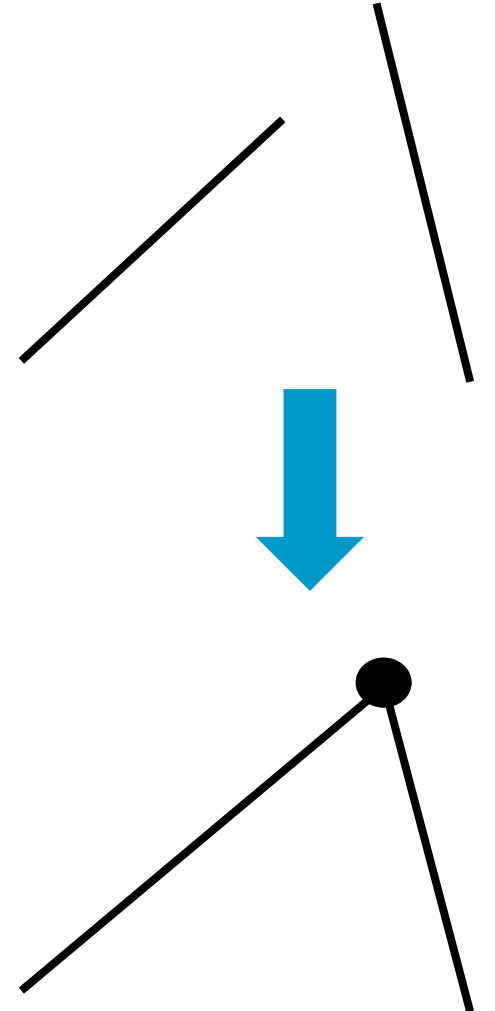
Identify elements  
Question assumptions and identify existing information  
Organize information  
Analyze data by looking for patterns  
Construct argument from evidence



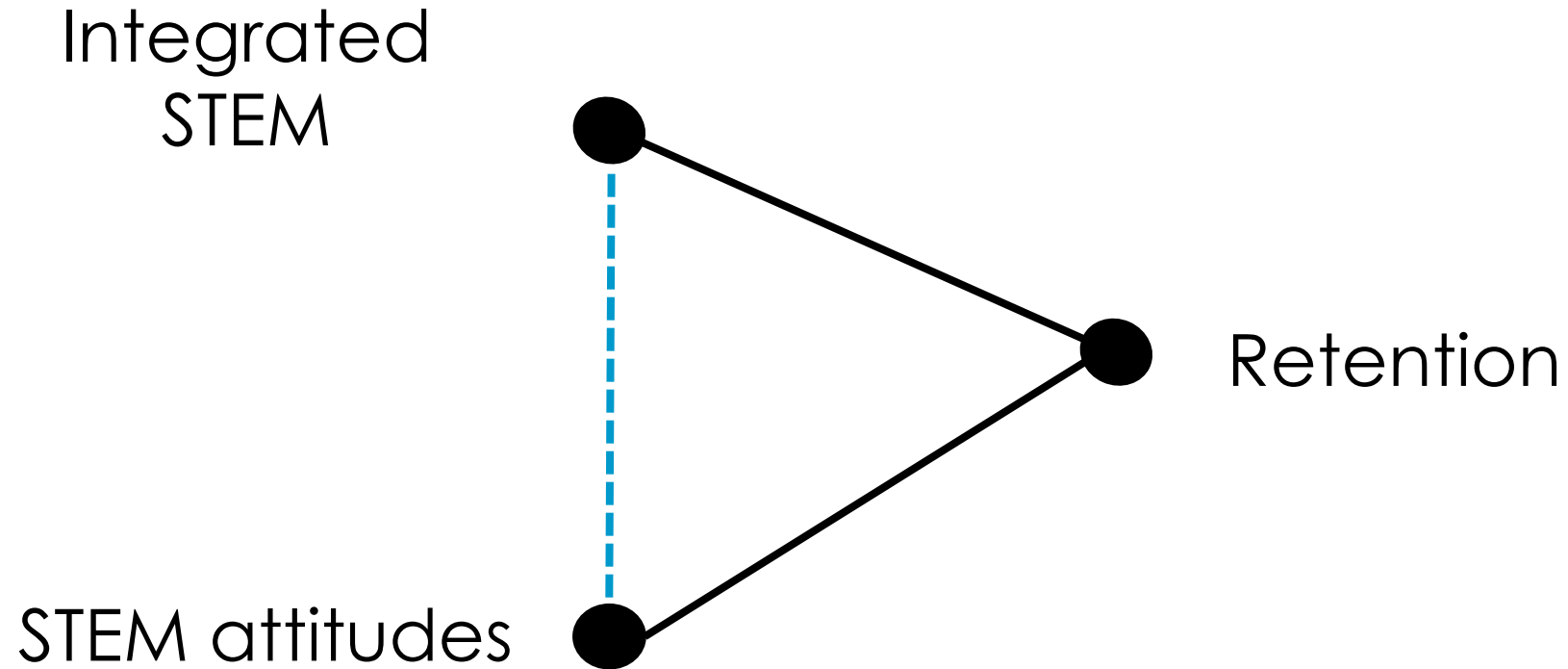


# Integrated STEM can be challenging to implement.

- Competing disciplinary agendas
- Methodological differences between disciplines
- Cohesiveness and coherence
- Identification of appropriate intersections
- Potential knowledge gaps for faculty



Research is needed to establish the effectiveness of integration.

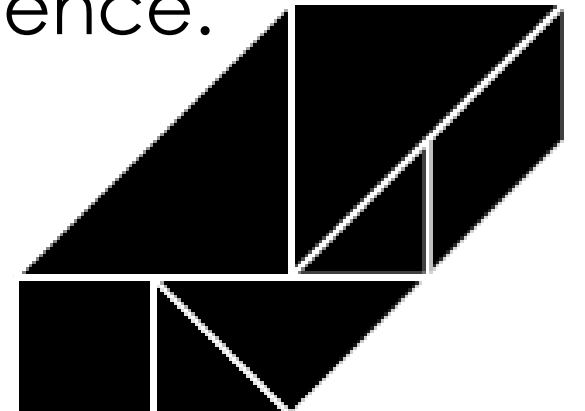


# Group Work: Finding connections (15min)

**Form groups of 4 with *people you don't know***

**Task 1:** Individually, select an activity in a course you teach that you want to integrate

**Task 2:** With one course activity at a time, brainstorm with the team how to infuse the disciplines represented in the group into that activity. Remember cohesiveness and coherence.



# A small cross-disciplinary infusion was the revision of module titles.

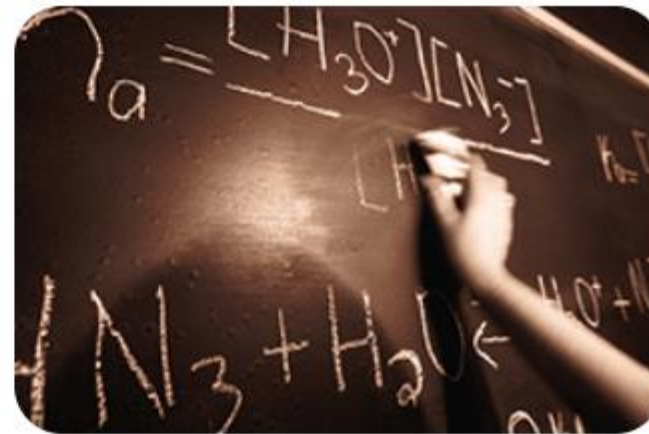
|  |   |   |
|--|---|---|
| Introduction to Chemistry                                  | → | Bacon and Gunpowder                         |
| Electron Configuration                                     | → | From Fireworks to Nebula                    |
| Ionic and Covalent Compounds                               | → | The Give and Take of Bonding                |
| Chemical Reactions and Stoichiometry                       | → | Quantifying Reactions                       |
| Solubility, Intermolecular Forces, and Oxidation-Reduction | → | “Water, water, everywhere ...”              |
| An Overview of Thermodynamics, Kinetics, and Equilibrium   | → | Dynamic Reactions: Energy, Speed, & Balance |
| Gas Laws   | → | Law & Order                                 |
| Solution Chemistry   | → | The Liquidation of Witches                  |
| Electromagnetic Spectrum and Nuclear Chemistry             | → | “Wave” Goodbye!                             |

# Revision of module overview and wrap-up pages included a multi- and interdisciplinary approach.


## Overview

Roger Bacon, an English philosopher born in 1220 and the first to detail the process of making gunpowder, stated that

“Mathematics is the door and key to the sciences.” Math and deciphering word problems will be a key component throughout this course and CHEM 141, which is the co-requisite laboratory portion of this course. For this reason, the first module focuses on the Math of Chemistry (the name of one of the chapters in this module's reading, in fact) and provides an overview of the foundations of chemistry: matter and atoms.



# Some discussion prompts were tweaked to show real-world engineering applications.



The industrial manufacture of medical devices like anesthesia machines and respiratory ventilators requires close attention to detail. Small design deviations can cause the instrument to fail, with potentially life-ending consequences. In an anesthesia machine, a plastic fitting that is just millimeters off from the specified manufacture size can result in a gas leak, either delivering insufficient oxygen or anesthetic gases (mixture of nitrous oxide and/or desflurane, isoflurane, sevoflurane).

💡 **Consider:** The terms accuracy and precision are often confused. In your own words, distinguish between these two terms. Explain how the measurements for the scenario above relate to accuracy and/or precision. Explore how significant figures reported for the instrument component dimensions relate to accuracy and/or precision.

A humanistic perspective was added to two discussions by creating videos on alchemy.

[https://erau.instructure.com/courses/96312/discussion\\_topics/1501556](https://erau.instructure.com/courses/96312/discussion_topics/1501556)

“The Alchemist”  
painting by Cornelius  
Pietersz Bega (1663)

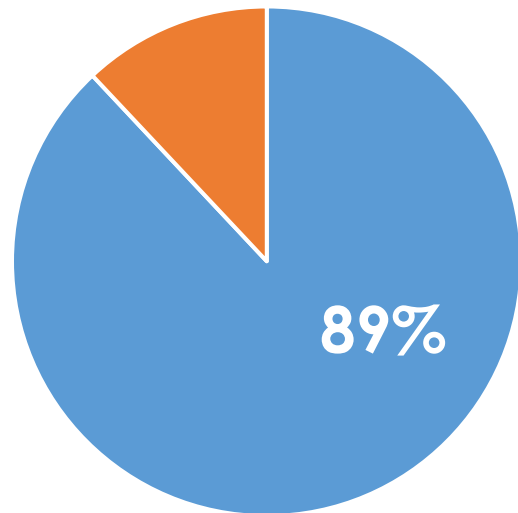


Does the infusion of cross- and interdisciplinary concepts influence student perceptions of the course connections to other **STEM** disciplines?

***This course made clear connections between science, technology, engineering, and/or mathematics.***

Pre-Intervention

Post-Intervention



*[to be determined]*

■ Positive    ■ Neutral & Negative

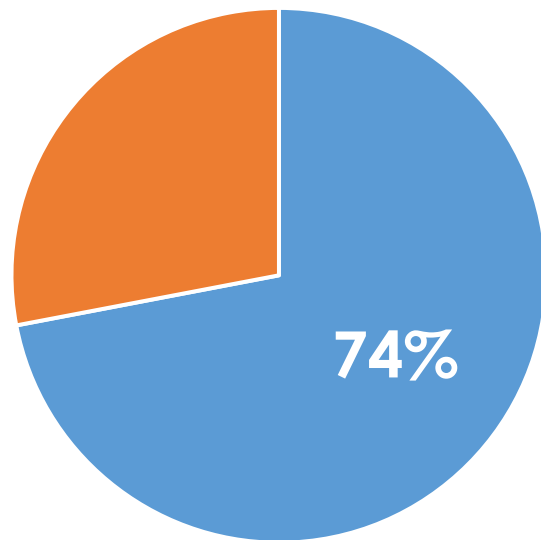


Does the infusion of cross- and interdisciplinary concepts influence student perceptions of the course connections to **non-STEM** disciplines?

***This course made clear connections between science and non-science topics and issues, like art, history, and the humanities.***

Pre-Intervention

Post-Intervention



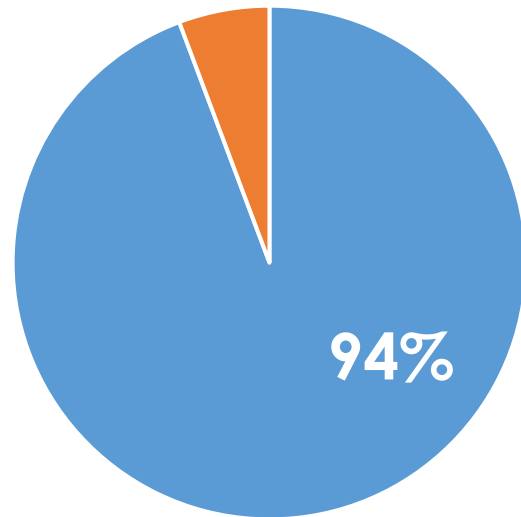
[to be determined]

■ Positive ■ Neutral & Negative

Does the infusion of cross- and interdisciplinary concepts influence student perceptions of the course connections to the **real world**?

***This course made clear connections between science and the world around me.***

Pre-Intervention



■ Positive ■ Neutral & Negative

Post-Intervention

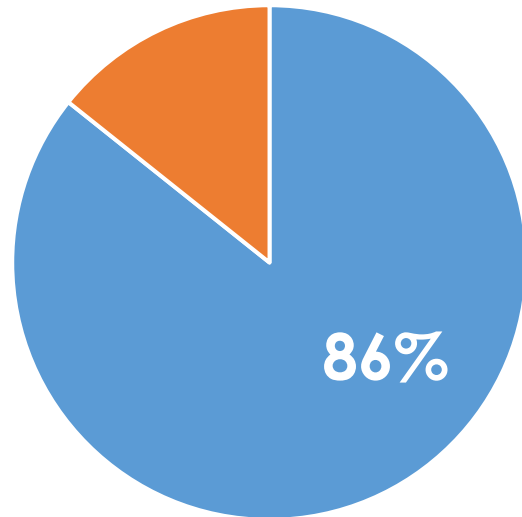
*[to be determined]*

Does the infusion of cross- and interdisciplinary concepts influence student perceptions of the course connections to their **academic path**?

***This course has widened my perceptions of how science connects to other courses in my degree program.***

Pre-Intervention

Post-Intervention



*[to be determined]*

■ Positive ■ Neutral & Negative

If the interventions move the needle, the implications to consider are:

- Forming faculty partnerships to increase disciplinary perspectives and fill knowledge gaps
- Faculty collaboration time
- Curriculum redesign time and resources
- Professional development to bolster faculty self-efficacy

**More research on the connections between integrated STEM and STEM attitudes will be needed**

# Questions?

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Discipline: \_\_\_\_\_

Discipline: \_\_\_\_\_

Course Activity:

Discipline: \_\_\_\_\_

Discipline: \_\_\_\_\_