

HANDS-ON, SCREENS- ON, BRAINS-ON ACTIVITIES FOR IMPORTANT CONCEPTS IN HEAT TRANSFER

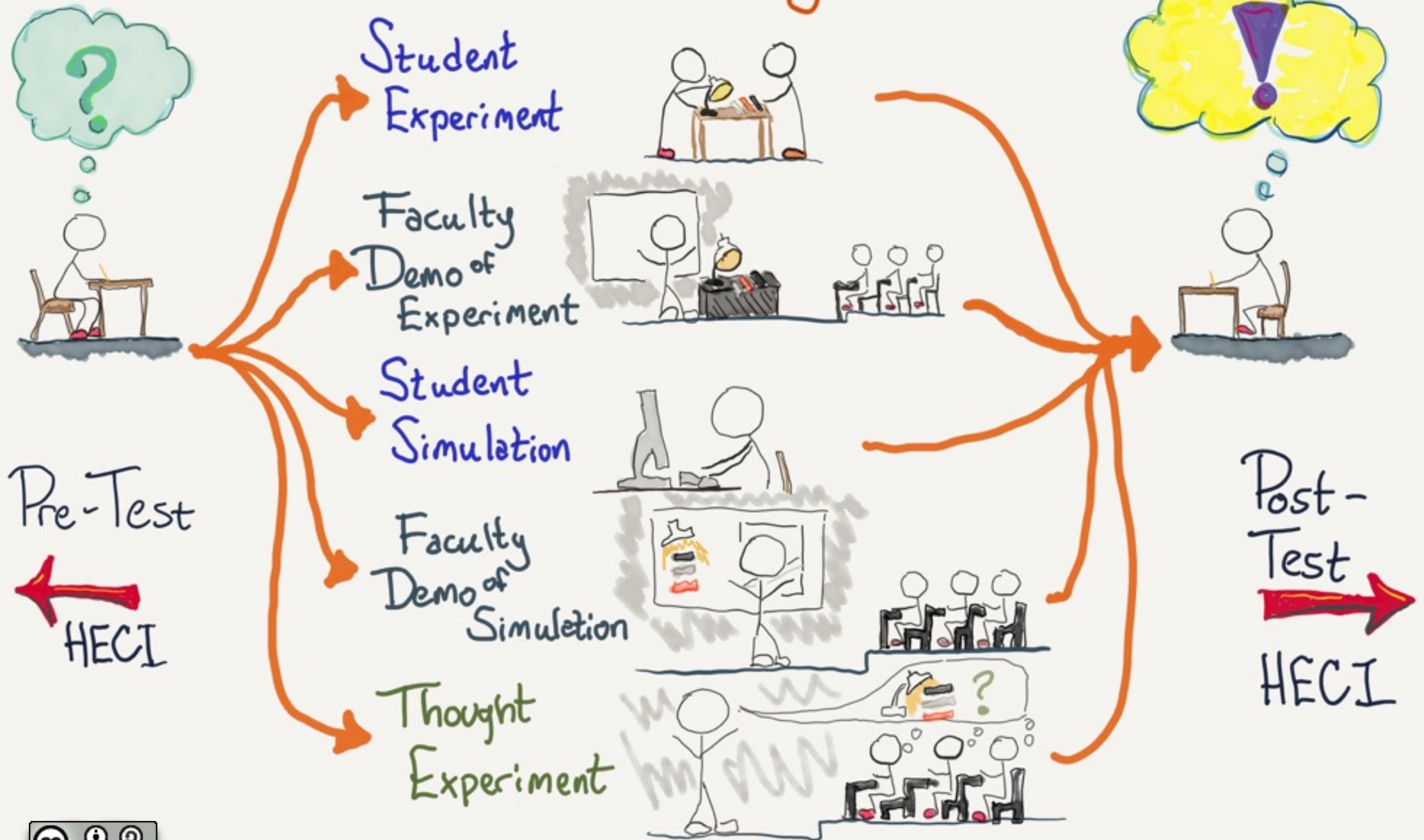
Margot Vigeant, Mike Prince, Katharyn Nottis,
Milo Koretsky, and Thomas Ekstadt

TL; DR

STUDENTS GET SMARTER

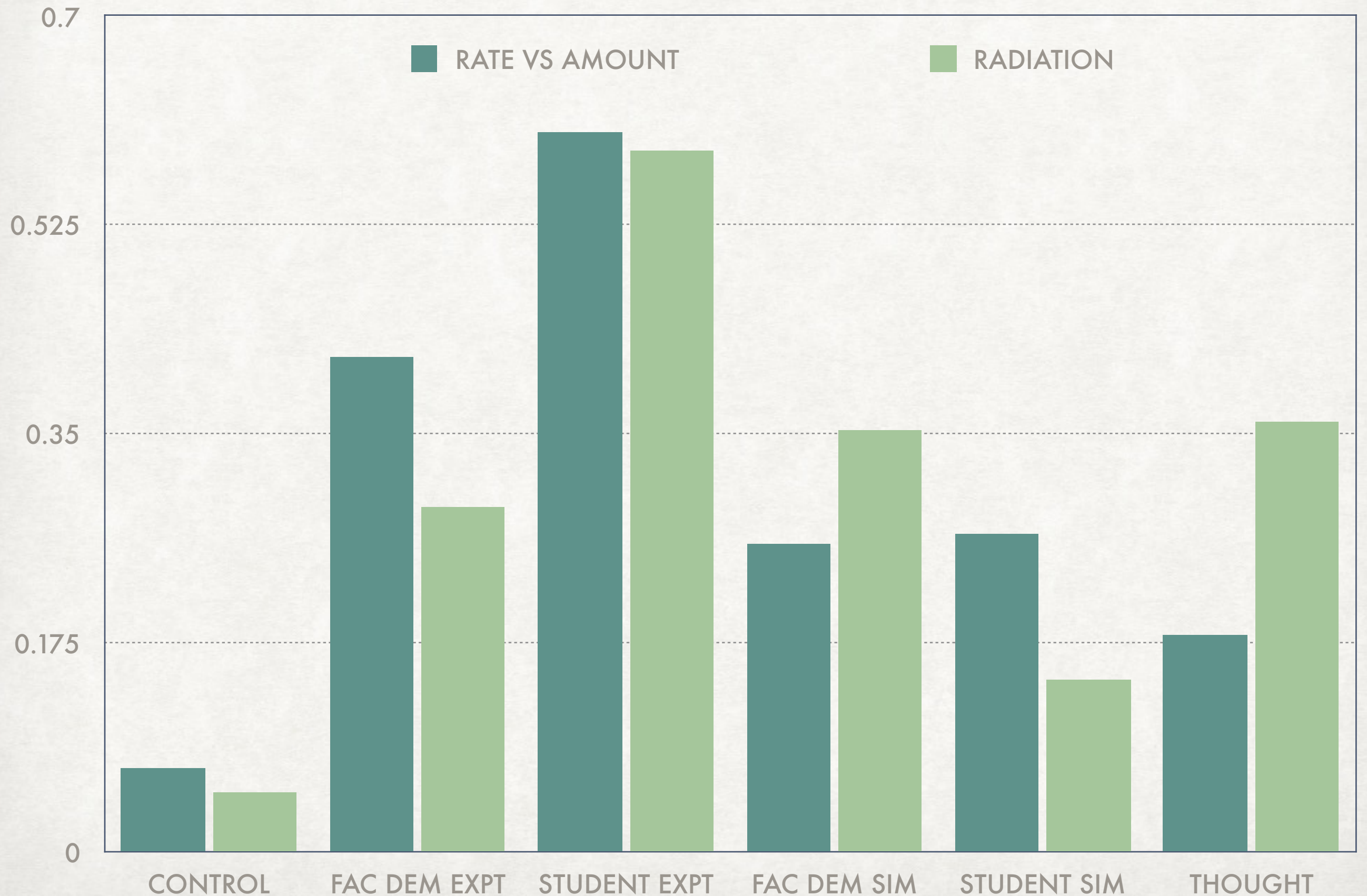
- Students start class with misconceptions that can persist through normal instruction;
- Educational materials for “rate vs. amount” and “radiation” misconceptions in heat transfer;
- Five variations, all of which perform significantly better than “no activities classes;”
- Available for free, now, through the AIChE Concept Warehouse!

Prediction → Activity → Reflection



	Rate vs. Amount, Pre-	Rate vs. Amount, Post-	Effect Size (Cohen's d)	Radiation, Pre-	Radiation, Post-	Effect Size (Cohen's d)
No intervention	36.9% n=373	42.6% n=373	Small, d=0.19	44.4% n=373	49.5% n=373	Small, d=0.16
Experiments, Student	35.0% n=59	74.1% n=56	Very large, d=1.53	41.9% n=59	76.0% n=56	Very large, d=1.62
Experiments, Faculty	27.5% n=133	57.5% n=124	Large, d=1.00	37.1% n=79	55.3% n=73	Large, d= 0.80
Simulation, Student	41.3% n=67	56.9% n=60	Large, d=0.92	42.6% n=88	50.8% n=81	Medium, d=0.40
Simulation, Faculty	38.0% n=88	54.0% n=81	Medium, d=0.57	43.6% n=121	63.5% n=111	Large, d=0.80
Thought experiment	39.3% n=133	50.3% n=124	Medium, d=0.32	40.4% n=178	61.8% n=191	Large, d=0.77

NORMALIZED GAIN, BY TYPE AND CONCEPT AREA



AIChE[®]
Education Division
**CONCEPT
WAREHOUSE**



https://jimi.cbee.oregonstate.edu/concept_warehouse/



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Class : default

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☒ Inquiry Based
Activities

Heat Transfer - Rate vs. Amount IBAs

This instructional tool contains two inquiry based activities that address the following misconception, identified as both prevalent and persistent among undergraduate engineering students:

Students often cannot distinguish between those factors which affect the rate of heat transfer and those which affect the amount of energy transferred in a given physical situation. For example, students frequently believe that factors that increase the rate of heat transfer also increase the amount of heat transferred and vice versa.

-  Introduction and Overview
-  Pre-term and post-term Heat Transfer Concept Inventories
-  Activity 1 (Cooling Beverages) Delivery Options
-  Activity 2 (Melting Ice) Delivery Options
-  Faculty Evaluation

Heat Transfer - Radiation IBAs

This instructional tool contains two inquiry based activities that address the following

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 Introduction and Overview

 Pre-term and post-term Heat Transfer Concept Inventories

Heat Transfer Concept Inventory assessments should be performed at the beginning and end of the term to determine to what extent these inquiry based activities have corrected the students' original misconceptions.

☐ I have already assigned Heat Transfer CIs with an inquiry based activity this term.

[Assign pre-term Heat Transfer Concept Inventory](#)

[Assign post-term Heat Transfer Concept Inventory](#)

Note: you only need to assign the above Concept Inventories once per term, even if you assign the inquiry based activities to the class multiple times in that term.

 Activity 1 (Cooling Beverages) Delivery Options

 Activity 2 (Melting Ice) Delivery Options

 Faculty Evaluation

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Click an Option # below for details and setup instructions.

Option	Type	Delivery Mode	Effectiveness (Explanation)	Ease of Use (Explanation)
1	Physical Experiment	Performed by students	High (details)	Higher Effort (details)
2		Instructor demonstration	Medium (details)	Moderate Effort (details)
3	Simulation	Performed by students	Medium (details)	Low Effort (details)
4		Instructor demonstration	Medium (details)	Low Effort (details)
5	Thought Experiment	Instructor-led discussion	Low (details)	Low Effort (details)

-  Activity 2 (Melting Ice) Delivery Options
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Overall post-test improvement relative to pre-test score:

Normalized gain above 50%

Post-test improvement relative to control (no activity):

More than 3X the improvement of a typical class

Effect size for post-test improvement relative to pre-test score:

Cohen's d above 1.0

-  Activity 2 (Melting Ice) Delivery Options
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Instructor prep time: An hour or more
 Cost: Free, assuming common equipment availability
 Time in class/lab: About 45 mins
 Total student time: (activity + analysis) About 2 hours or more

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Heat Transfer - Rate vs. Amount IBAs -- Activity 1 (Cooling Beverages)

Delivery Option 3: Simulation - Performed by Students

[Faculty Instruction Sheet](#)[Laboratory Setup and Technical Analysis](#)[Cooling Beverages Simulation Preview](#)[Activity Assignment Sheet](#)[\(add to class\)](#)[\(use offline\)](#)[Analysis Assignment Sheet](#)[\(add to class\)](#)[\(use offline\)](#)[Close](#)

Heat Transfer - Rate vs. Amount IBAs -- Activity 1 (Cooling Beverages)

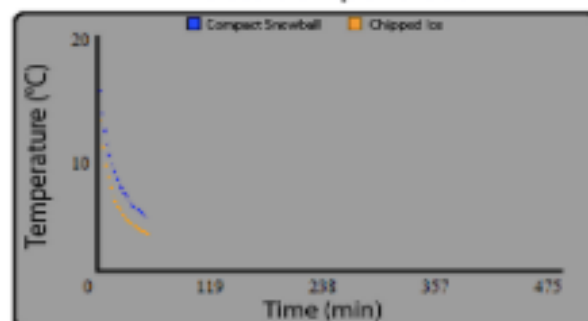
Delivery Option 3: Simulation - Performed by Students

[Faculty Instruction Sheet](#)[Laboratory Setup and Technical Analysis](#)[Cooling Beverages Simulation Preview](#)

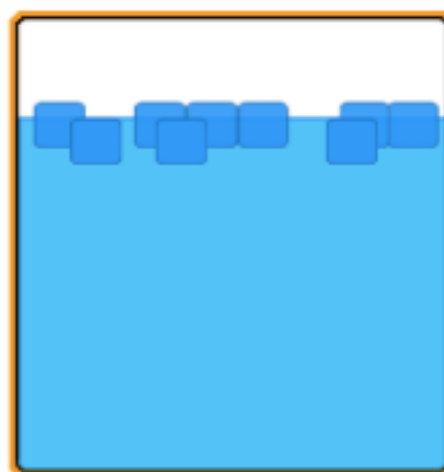
[Click here for a functional preview \(popup/new tab\) of the Cooling Beverages simulation](#)

Ice Block vs Ice Chips

Water Temperature



Beaker 1



Beaker 2

students:

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Instructors should complete this evaluation each time an assignment of the activities is completed, independent of which delivery option was used.

[Complete the Faculty Evaluation Survey](#)

Earn \$50 -- For a limited time, instructors who try one or more activities in class and complete the above Faculty Evaluation Survey are eligible for a \$50 honorarium, which will be awarded on a first-come, first-served basis. **Be sure to indicate your interest in the honorarium by answering question 20 of the survey.**

Note: this offer is available only to instructors at institutions located in the United States.

Heat Transfer - Radiation IBAs

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CONCLUSION

THESE WORK REALLY WELL! YOU SHOULD TRY ONE!

- Students significantly Improve in all cases.....
- They improve more if activities are included.
- Choose an activity based on your available time, space, and target outcome!
- Thanks to our partners!
- We gratefully acknowledge the support of the National Science Foundation #1225031

