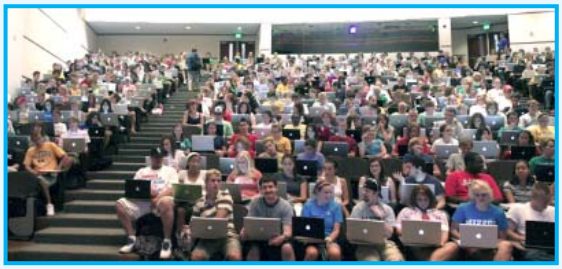
No More Lecturing! What John Falconer Has Done for Student Learning

Milo Koretsky



Concept Warehouse

Cyber-enabled infrastructure for conceptual questions

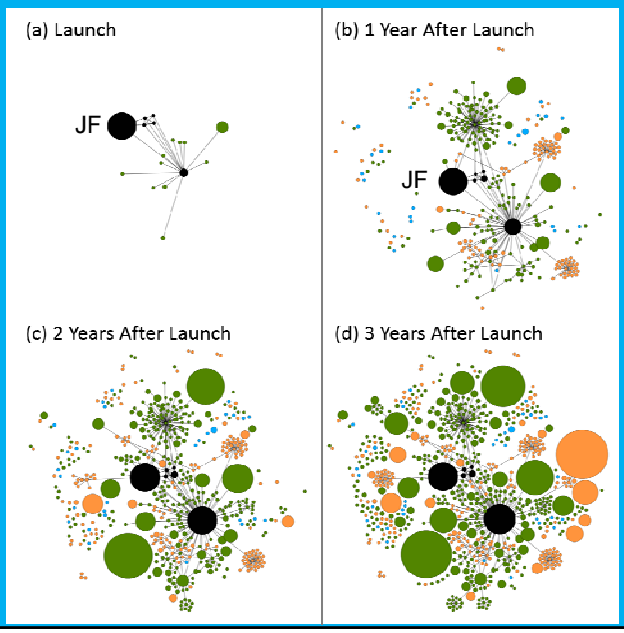
- Create a community of Learning focused on concept-based instruction
- Lower the activation barrier to promote implementation of concept-based instruction and active learning

The AIChE Concept Warehouse

AIChE Education Division
CONCEPT WAREHOUSE

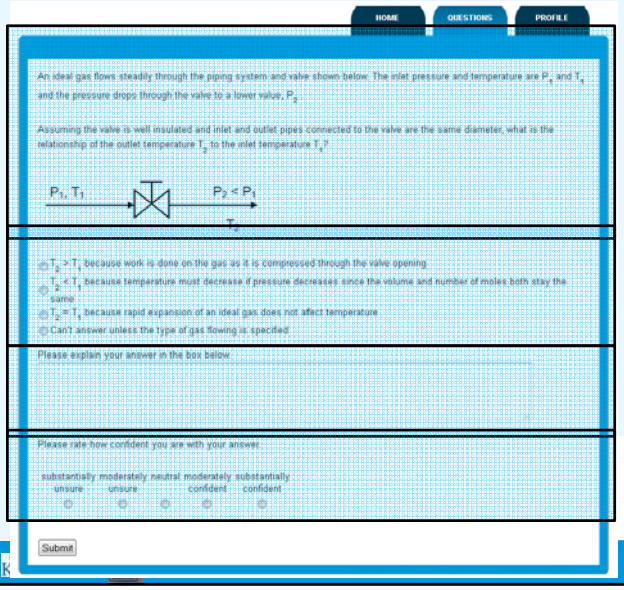
At Launch,
2012 ChE Summer School

Concept Warehouse: Propagation of ConcepTests



Gilbuena, Smith, and Koretsky, *Educational Technology Research and Development* (2016)

Example Question: What students see when you assign online



Question text

Plus Figure

Multiple Choice Answer Selections

Written Reflection (optional)

Confidence (optional)

Instructional Design

Instructional Sequence

Lecture / Reading

↓

Homework Due

↓

ConcepTests in Class (Peer Instruction)

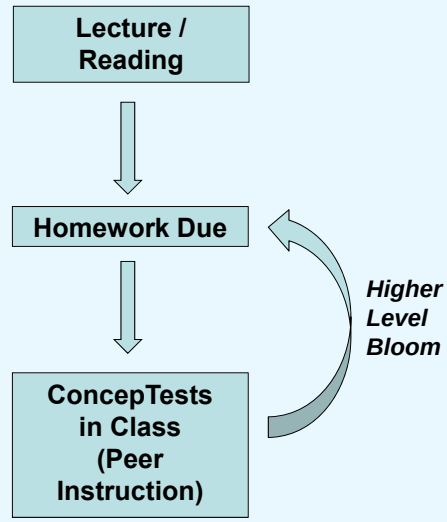
Peer Instruction

Instructor assigns a conceptual question → Students answer individually → Students discuss in groups → Instructor reassigns the question → ructor s class nse and usses

Falconer's Advantages – Peer Instruction

- Students teach/learn from fellow students
  - -- encourage cooperation
  - – more engaged class
  - – students hear alternate explanations
- Students determine how well they understand
- Instructor gets feedback from everyone
- Students motivated to be prepared; attendance higher
- Students articulate reasoning

Instructional Sequence



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Imbedded Assessment

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Instructional Sequence (Assessment)

Lecture / Reading

↓

Homework Due

↓

ConcepTests in Class (Peer Instruction)

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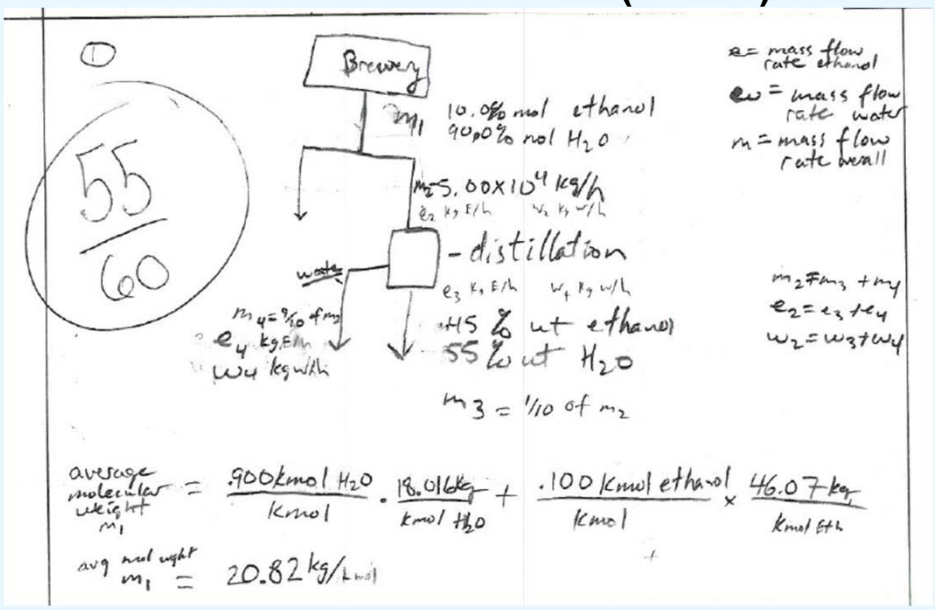
Homework – traditional (Year 1)



Homework – electronic (Year 2)

On a warm summer day in Oslo, the temperature is 21°C and the relative humidity is 70%.

What is the absolute humidity?

Number ☐ kg / kg Dry Air

What is the humid volume of the air?

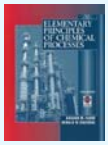
Number ☐ m^3 / kg Dry Air

What is the specific enthalpy of the air, taking H_2O (L, 0°C, 1 atm) as a reference state?

Number ☐ kJ / kg Dry Air

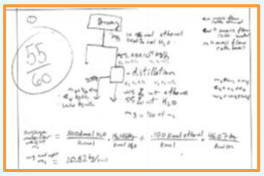
Instructional Sequence

Lecture / Reading

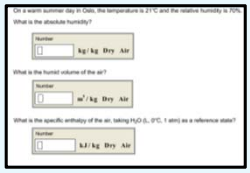


Homework Due

Year 1



Year 2



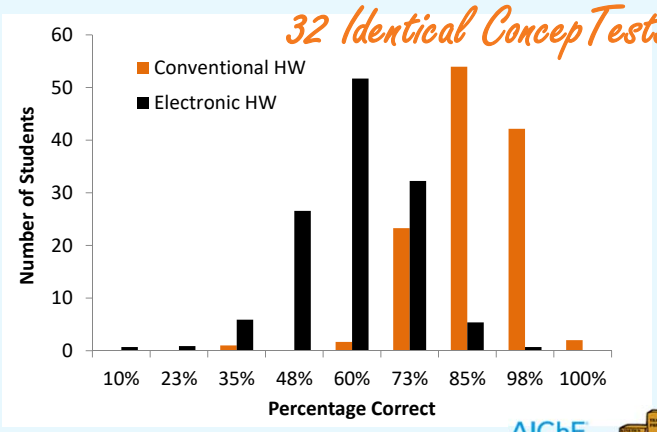
ConcepTests in Class (Peer Instruction)

Collect Data Here

Responses to ConcepTests in Matirial and Energy Balances

Year 1

Year 2



Prof. Adam Higgins

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Learning Research

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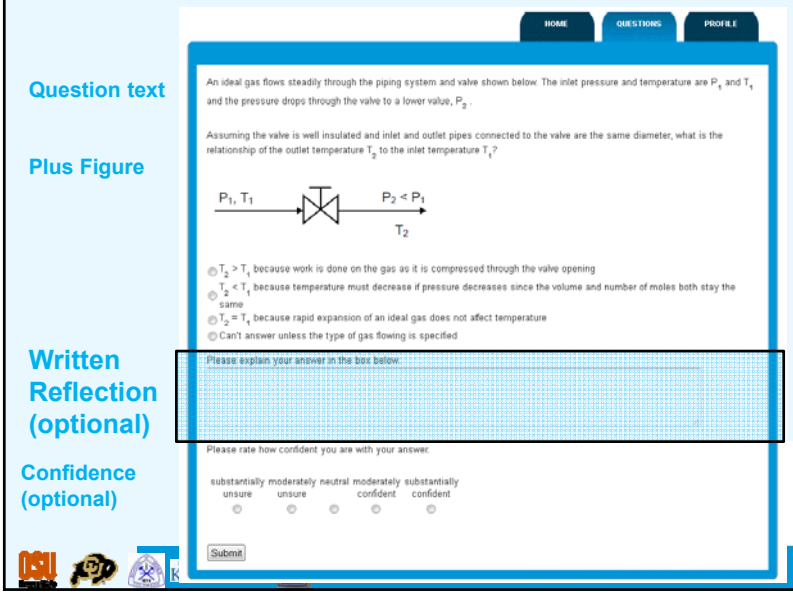
Example Question:
What students see when you assign online



Question text

Plus Figure

Multiple Choice Answer Selections

Written Reflection (optional)

Confidence (optional)

Influence of Writing Justifications (Tr) vs. not (Com)

- Split, Crossover Design
  - Same lecture
  - Two large recitation sections
    - One section writes explanation = Treatment (Tr)
    - One section does not = Comparison (Com)
    - Alternate sections every 2 – 3 weeks
  - Compare answers to 39 ConcepTests across two cohorts
  - Chi-squared test, $\alpha = 0.05$
  - For Com group, qualitatively code reasoning (1= poor; 4 = well reasoned)

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Influence of Writing Justifications (Tr) vs. not (Com)

Effect	n questions Expected
Tr > Com	~1
Tr = Com	~37
Tr < Com	~1

If the treatment had no effect, we would expect:

39 Questions
$\alpha = 0.05$

Koretsky, Brooks, and Higgins, *International Journal of Science Education* (2016)

Influence of Writing Justifications (Tr) vs. not (Com)

Effect	n questions	Treatment	Comparison	Treatment	Comparison
		<%>	<%>	<n students>	<n students>
Tr > Com	15	65%	50%	66	68
Tr = Com	19	58%	57%	66	67
Tr < Com	5	56%	69%	69	69

39 Questions
$\alpha = 0.05$

Koretsky, Brooks, and Higgins, *International Journal of Science Education* (2016)

How Many Students Can Justify Their Answer?

Effect		Easy	Moderate	Difficult
		$\bar{x} > 75\%$	$75\% > \bar{x} > 50\%$	$\bar{x} < 50\%$
Tr > Com	(% correct)	(85%)	(65%)	(23%)
	$N_{correct}$	72	39	18
	$N_{code=4}$	53	21	7
Tr < Com	(% correct)	NA	(59%)	(22%)
	$N_{correct}$		47	16
	$N_{code=4}$		11	1

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Influence of Writing Justifications (Tr) vs. not (Com)

Effect	n questions	Treatment	Comparison	Treatment	Comparison
		<%>	<%>	<n students>	<n students>
Tr > Com	15	65%	50%	66	68
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39 Questions
$\alpha = 0.05$

Koretsky, Brooks, and Higgins, *Journal of Engineering Education*, forthcoming

Expanding Piston (Falconer)

Balloon Rising (Someone else)

Isomorphic Questions

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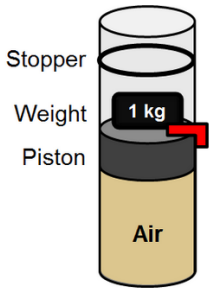
Expanding Piston (Falconer)

Air at high pressure and ambient temperature is contained in a perfectly insulated piston-cylinder device. If the locks holding the piston in place are removed, the piston moves upwards to a stopper. The temperature of the air _____.



- increases
- remains the same
- decreases
- need more information

Please explain your answer in the box below.

Balloon Rising

A perfectly insulated balloon filled with an ideal gas rises into the sky. As the balloon rises, the external pressure decreases, causing the balloon to expand. What happens to the temperature of the ideal gas inside the balloon?

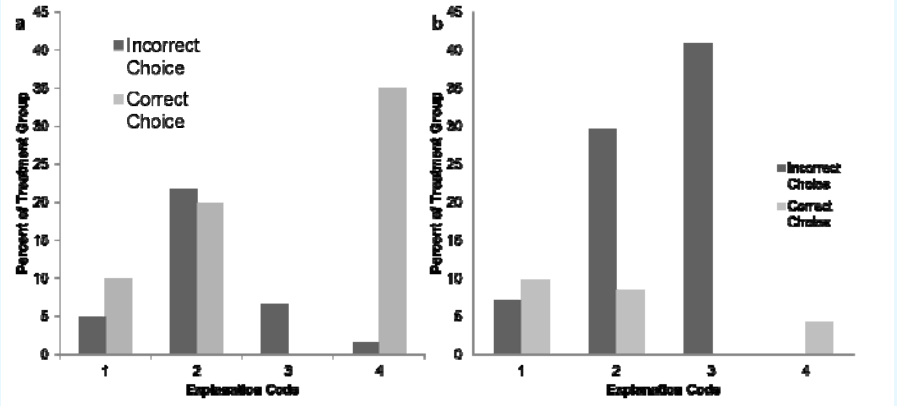
- increases
- decreases
- remains the same
- need more information

Please explain your answer in the box below.

Submit

Looking at the Explanations

Expanding Piston (Falconer) **Balloon Rising**



Koretsky et al., *Journal of Engineering Education* (2016)

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An ideal gas at high pressure and ambient (room) temperature is contained in a perfectly insulated piston-cylinder device. The locks holding the piston in place are removed, and the piston moves upwards against ambient atmosphere to a stopper. What happens to the temperature of the ideal gas inside the piston-cylinder device?

- increases
- decreases
- remains the same
- need more information

Please explain your answer in the box below.

Submit

Expanding Piston (*Modified*)

Koretsky et al., *Journal of Engineering Education* (2016)

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