

# Adaptive Learning Technology to Teach Background Material in Intro STEM

Colleen Richardson  
University of Pennsylvania – Center for Teaching & Learning  
STEM Education Postdoctoral Fellow

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## In your experience...

- What are common challenging background topics in your field?
- How would you confirm/identify them in a course?

# Finding Topics

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## Finding Topics

- personal experiences
  - professor input
  - previous experiences in course and related courses
- course data
  - existing exams
  - entry/exit assessments

Question						Total
S12 – Q17	a	b	c			
	67%	88%	86%			80%
S15 – Q6	a	b	c	d	e	
	95%	82%	89%	60%	74%	81%

## Finding Topics: Neuroscience

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## Finding Topics: Neuroscience

- diffusion
- membrane permeability
- electrical properties

## Finding Topics: Chemistry

### Entry Assessment

- using Avogadro's number (24% correct)
- limiting reactant (6%)
- electrostatic energy scaling with charge and distance (<5%)
- multiplication and division of measurements (<5%)
- using ideal equation of state (10%)

### Exams

- unit conversion (20% correct)
- molecular formula from elemental analysis (32%)
- ideal gas model and law (60%)
- lattice energy (50%)

## Finding Topics: Chemistry

- unit conversion / dimensional analysis
  - using Avogadro's number
  - limiting reactant
  - multiplication and division of measurements
- ratios / direct and inverse relationships
  - ideal gas law / ideal equation of state
  - electrostatic energy scaling
  - lattice energy



# Understanding Challenges

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## Continuing the discussion...

- Thinking about the background topics you identified earlier, select one topic and think about what could be the underlying difficulties/missing pieces?
- How would you distinguish the underlying problems?

## Understanding Challenges

- how vs. why
  - Can a student set up and solve the problem? Does a student remember the correct answer?
  - Does a student understand why they used a given setup to solve the problem? Can a student explain why they gave a certain answer?
- context: original vs. new
  - Can a student recognize and solve the problem in the context they originally learned it?
  - Does a student recognize the previously learned material when it appears in a new setting?

- Q3: During the process of diffusion, particles will generally move from
  - **high to low concentration. (98%)**
  - low to high concentration.
- Q4: The reason for my answer is because
  - crowded particles want to move to an area with more room.
  - **the random motion of particles suspended in a fluid results in their uniform distribution. (31%)**
  - the particles tend to keep moving until they are uniformly distributed and then they stop.
  - there is a greater chance of the particles repelling each other.

## Understanding Challenges: *How vs. Why* Neuroscience

## Understanding Challenges: *Context* Chemistry

- dimensional analysis / unit conversion
  - unit conversion (g  $\leftrightarrow$  mol) / using Avogadro's number: 20%
  - *simplify ratio / quotient rule: >90%*
- ratios / direct and inverse relationships
  - ideal gas law / lattice energy: 50-60%
  - *direct and inverse relationships: ?*

# Design & Deployment

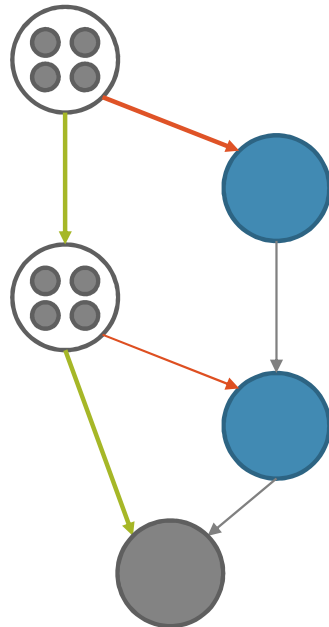
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## Design & Deployment

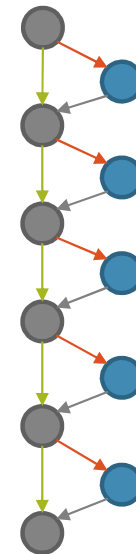
- technology concerns
  - branching pathways
  - in-house design and control
  - ease of use

# Design & Deployment: Storyboard

quiz-based

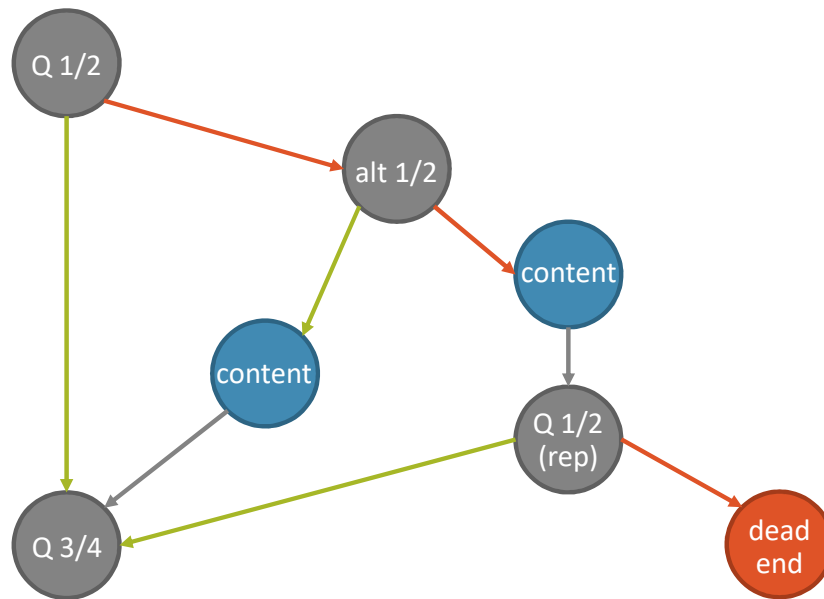


question-based





## Design & Deployment: Example



# Design & Deployment

The screenshot shows a learning management system interface. At the top, there is a dark blue header with the Penn State logo on the left, the text "BBB 109 - BACKGROUND MODULE" in the center, and "Force Adaptivity" and a user profile for "Colleen Richardson" on the right. A sidebar on the left contains a "Screen List" with 20 items, where "4. Q 1/2 - simple diffusion" is highlighted in yellow. The main content area features a red banner with "PART 1" and a question: "If a small amount of salt (1 tsp) is added to a large container of water (4 liters or 1 gal) and allowed to sit for several days without stirring, the salt molecules will". Two radio button options are provided: "be more concentrated at the bottom of the water." and "be evenly distributed throughout the container.". Below this, a text prompt asks "The reason for my answer is because" followed by four radio button options: "salt is heavier than water and will sink.", "salt dissolves poorly or not at all in water.", "there will be more time for settling.", and "there is movement of particles from a high to low concentration.". At the bottom, there is a dark blue footer with a red "NEXT" button and a "HELP" button with a question mark icon.

BBB 109 - BACKGROUND MODULE

Force Adaptivity Colleen Richardson

Screen List

1. intro
2. biology understanding
3. diffusion topic understanding
4. Q 1/2 - simple diffusion
5. alt 1/2 - simple diffusion
6. tutorial A - ions into solution
7. tutorial B - diffusion
8. Q 1/2 (repeat) - simple diffusion
9. alternate end point
10. Q 3/4 - semi-permeable membranes
11. alt 3/4 - semi-permeable membranes
12. tutorial C - semi-permeable membranes
13. Q 7/8 - membranes
14. Q 9/10 - membranes
15. Q 11/12 - membranes
16. tutorial D - diffusion of different molecules
17. Q 13/14 - plasma membranes
18. tutorial E - plasma membranes and ions
19. Q 15 - plasma membranes
20. ...

**PART 1**

If a small amount of salt (1 tsp) is added to a large container of water (4 liters or 1 gal) and allowed to sit for several days without stirring, the salt molecules will

- be more concentrated at the bottom of the water.
- be evenly distributed throughout the container.

The reason for my answer is because

- salt is heavier than water and will sink.
- salt dissolves poorly or not at all in water.
- there will be more time for settling.
- there is movement of particles from a high to low concentration.

NEXT HELP

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## Design & Deployment: Your Turn

- How would you design a module for the topic you identified earlier?
- What would your storyboard look like?

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## Lessons Learned (so far)

- plan everything (as much as possible) before building
- consider what type of data you want at the end
- let someone try to break it
- (if applicable) add in questions about student background, confidence, perceived help from module

Questions?