Designing and Adapting Active Learning Activities

For Service Math Courses (and beyond...)

Active-Learning Tasks

- What qualities make an active-learning task "good/effective"?
  - (Think/Pair/Share) One feature you personally prioritize most, and one feature you wish you had time to build more consistently.
- Characteristics of Effectiveness
  - engaging,
  - conceptually challenging,
  - relevant context,
  - collaborative,
  - ...

Conceptual "vs." Procedural

Concepts are "a mental representation that embodies all the essential features of an object, a situation, or an idea…enable us to classify phenomena as belonging, or not belonging, together in certain categories."

Conceptual knowledge may be visualized as a connecting web of relationships.

- Between two previously learned concepts,
- Between a concept previously learned and a concept newly learned

Procedures are "a series of steps and/or actions employed to achieve a task or reach a goal"

Procedural knowledge is the capacity to follow steps in sequence to solve mathematical problems or reach a mathematical goal.

- "… a knowledge of the system of symbols to construct algorithms,… rules necessary to solve problems"

Westwood, 08; Rittle-Johnson & Schneider, 15, 17; Hurrell, 21

Conceptual <-> Procedural

- for each knowledge → possibility of superficial or deep.
- Which comes first?
  - "...although the relationship ... is bi-directional, it is not always symmetrical..."
  - Evidence suggests students taught conceptual understanding followed by a procedural understanding, outperform students taught other way
- Interference
  - Cognitive
  - Attitudinal

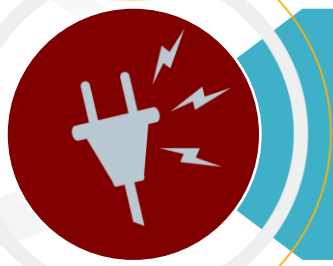
Pesek & Kirshner, 2000

Skillset vs. Mindset (T/P/S)

- Consider your own career. Out of 100%, what percentage of your success do you attribute to mindset vs. skillset?
  - What have been the most important mindsets (i.e., attitudes, awarenesses, behaviors, dispositions, habits of mind, etc.) that have led to your own success?
  - What other mindsets are you actively working to develop or considering developing (if any)?
- It takes time to develop a habit. Good habits often form through repeated exposure. For the courses you are teaching, which mindsets will help a student succeed and become more research/industry-ready?

Student Mindsets – The 3 Cs

Curiosity: Encourage exploring the unknown



Connections: Integrate diverse ideas & perspectives

Creating Value: Focus on meaning and benefits for others

Applying 3C in Calculus Tasks

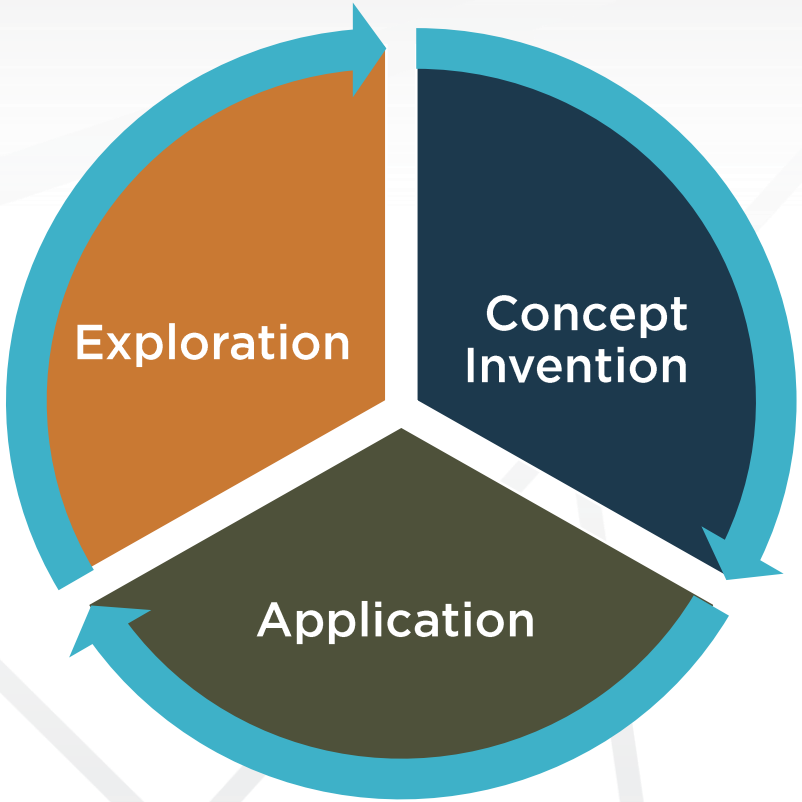
- Curiosity: “What happens if the rate changes sign unexpectedly? Investigate!”
- Connections: “Relate this integration problem to area in geography or probability.”
- Creating Value: “Explain why this calculus concept could help in a biology or economics scenario.”

- Brainstorm: What ‘curious’ question could we ask about the derivative of x^2?

Process Oriented

- Teamwork
- Critical Thinking
- Management
- Problem Solving
- Self+Peer Assessment
- Communication
- Information Processing
- Metacognition

Guided Inquiry Learning



Let's Try it!

Model: Runner position data

t (sec)	0	1	2	3	4
s (m)	0	2.75	5	6.75	8

Explore (Curiosity)

- Before calculating anything: is the runner speeding up or slowing down near t = 2? Why?
- Compute average velocity on [1,2], [2,3], [3,4]. What pattern do you notice?
- If you drew a tangent line at t = 2, would its slope be closer to the [1,2] slope or the [2,3] slope?

Invent (Connections)

- Define "instantaneous velocity at t = 2" using the idea of shrinking time intervals.
- What are the units of slope here? What does a negative slope mean?
- How is "instantaneous velocity" related to the slope of the tangent line?

Apply (Creating Value)

- Suppose $s(t) = 3t - 0.25t^2$ (meters). Compute $s'(2)$. Compare to your estimate from the table.
- "At t = 2, each additional 0.1 sec changes position by about ___ meters."
- What other situations in Calculus are "the same type of question" as finding $s'(2)$? (e.g., marginal cost, sensitivity analysis)

Let's Try it!

A cup of coffee is initially $90°C$ in a room at $20°C$.
After 5 minutes, the coffee is $70°C$.
When will the coffee reach $60°C$?

Explore (Curiosity)

- Without computing, will the coffee cool faster at the beginning or later? Why?
- Sketch a plausible temperature curve $T(t)$ .Should it cross $20°C$?
- If you define "difference from room temperature" as $D(t) = T(t) - 20$,what do you expect happens to $D(t)$over time?

Invent (Connections)

Introduce (or let students infer from prompts) the model:

$$\frac{dT}{dt} = -k\,(T - 20)$$

- what are the units of k? What does a larger k mean physically?
- Solve the DE. Use the data point $T(5) = 70$ to determine k.
- This is exponential decay in the difference from ambient, not in the absolute temperature.

Apply (Creating Value)

- compute/estimate time to $60°$.
- if the room were $25°C$ instead of $20°C$, would the wait time increase or decrease?
- If you used a ceramic mug instead of a paper cup, would $k$likely increase or decrease?
- List two other situations where the rate depends on difference from an equilibrium (drug concentration approaching baseline, charging a capacitor toward a steady voltage,
- population approaching carrying capacity??

Let’s workshop!

Thank you!