

Active Learning: Engaging Students in the Engineering Classroom

Stephanie Kusano, PhD
University of Michigan

November 3, 2022

As we wait to get started reflect on the following question:
Why should students attend your class?

Goals for Today

- Identify reasons why using active learning could be a useful approach for your classes
- Describe methods of active learning used in Engineering courses
- Identify at least one method of active learning to incorporate into an upcoming course

What is Active Learning?

PollEverywhere Link: pollev.com/stephaniekus997

Text: STEPHANIEKUS997 to 37607



Active Learning is...

“... generally defined as any instructional method that engages students in the learning process.

Active learning requires students to do meaningful learning activities and think about what they are doing.”

Prince, 2004

Why should students attend your class?

PollEverywhere Link: pollev.com/stephaniekus997

Text: STEPHANIEKUS997 to 37607



Let's list some assumptions

- Personal connection to content leads to learning
- Best understanding happens when learner actively manipulates, uses, or does something
- People learn best when they interact; learning is a social process
- Effective teachers monitor and guide student learning by providing timely structure, scaffolding, and feedback

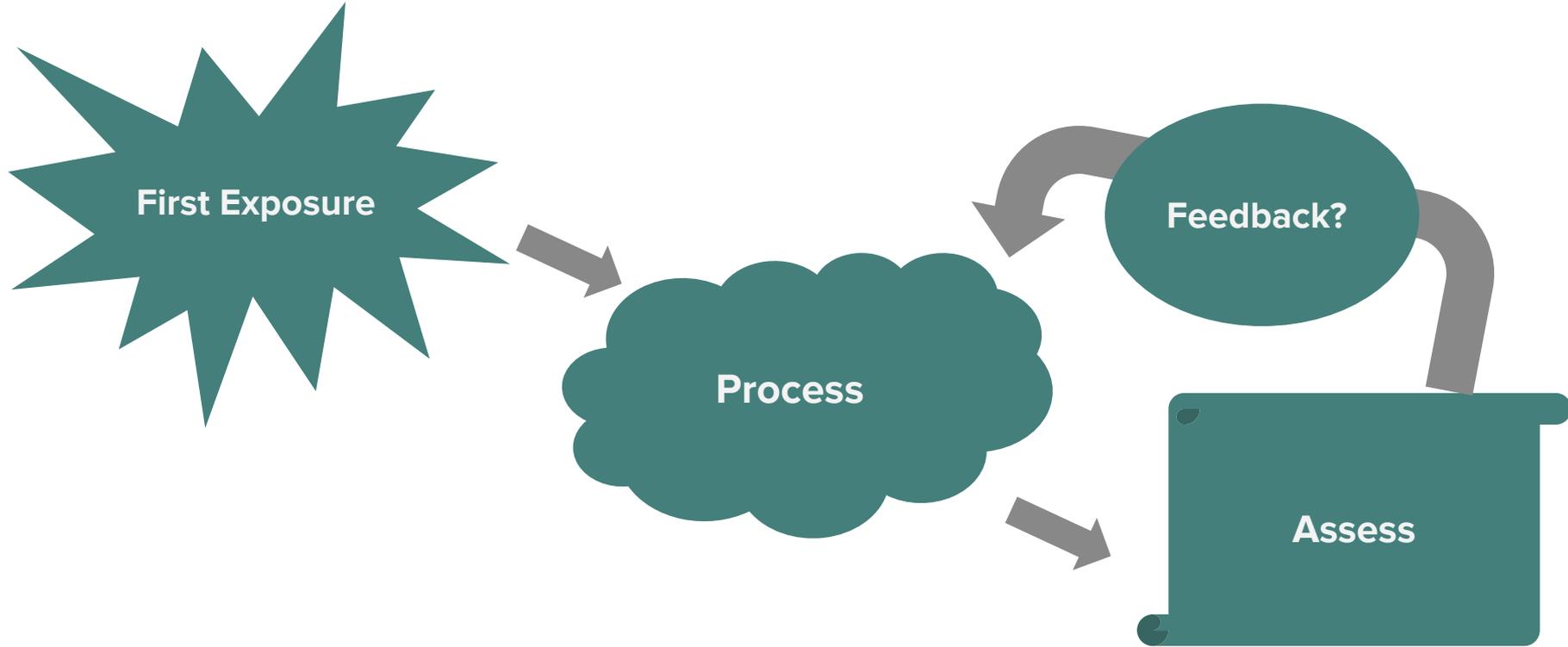
Cognitive constructivist theory of learning that grounds active learning

Aligning Instructional Approaches to Outcomes

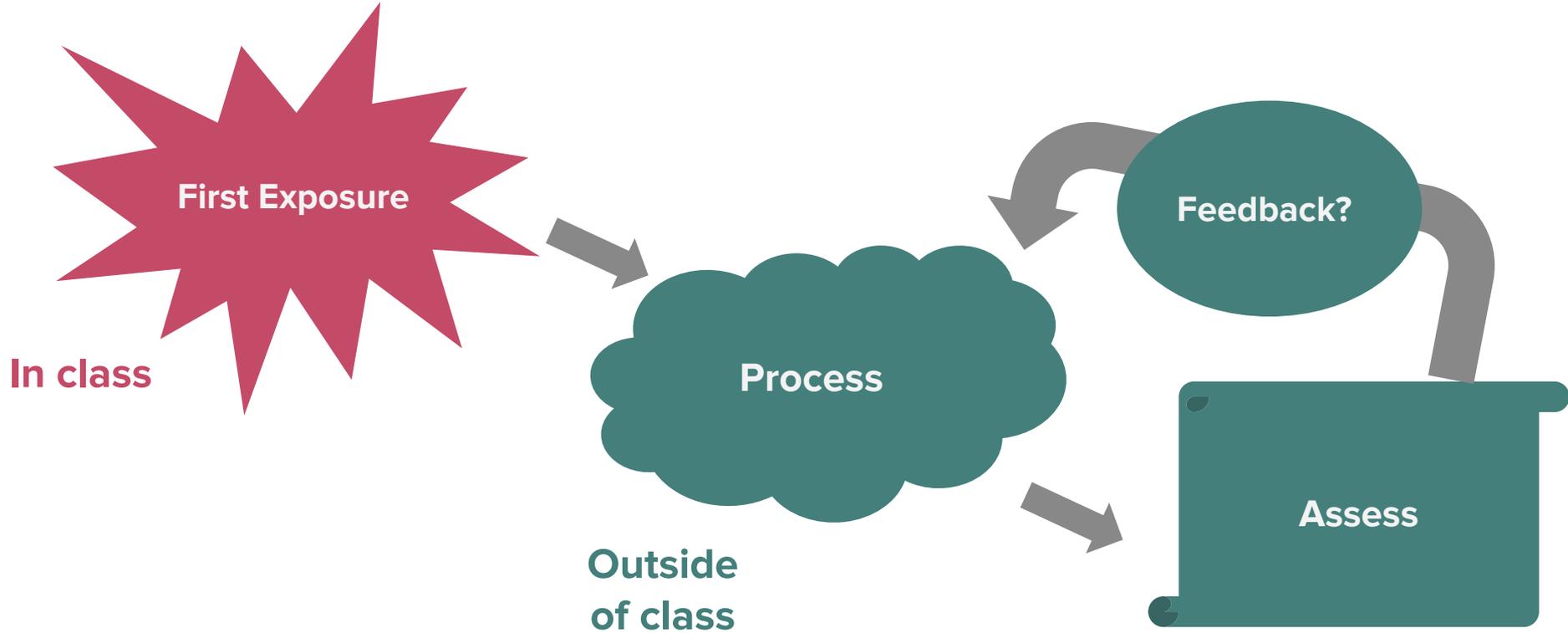
Your Department Outcomes

- 1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- 2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- 3) An ability to communicate effectively with a range of audiences.
- 4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- 5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- 6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- 7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

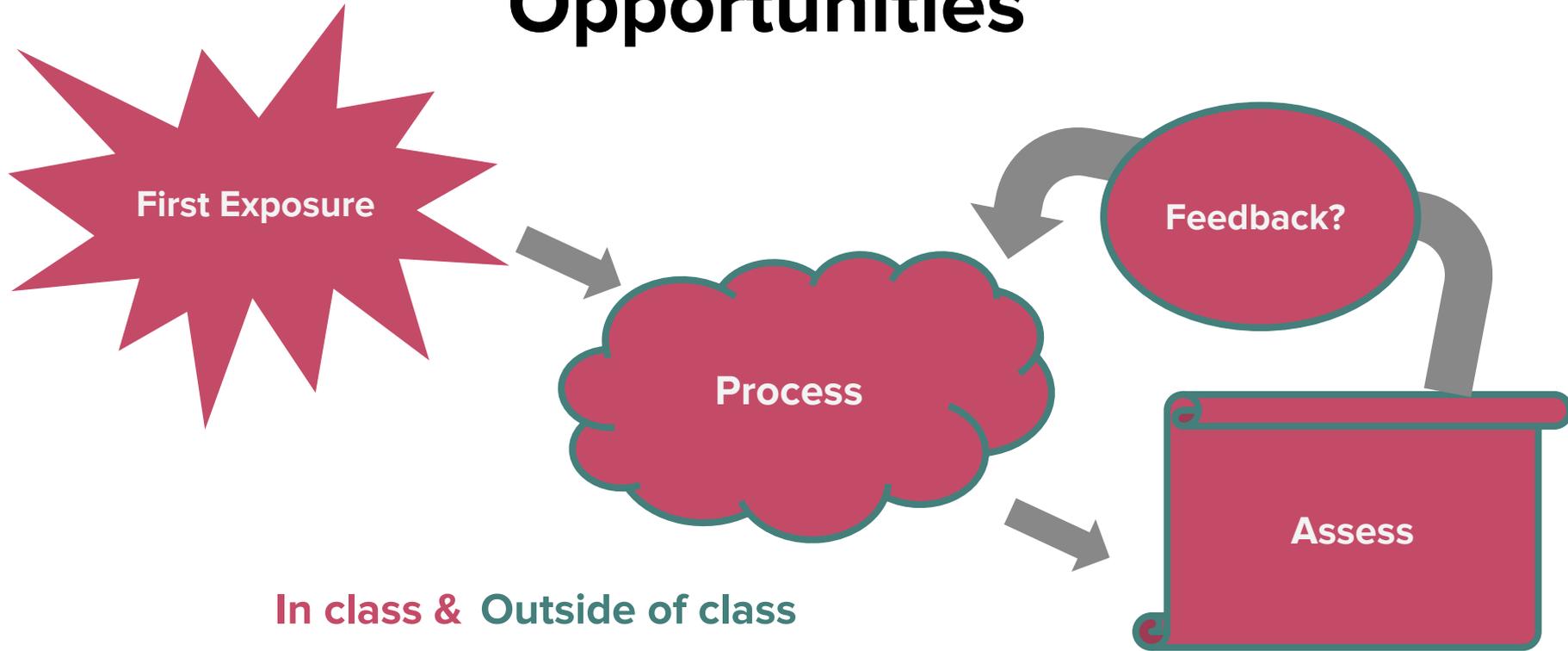
Student Learning Process



Relying on Lecture Limits **Class Time**



Active Learning Expands In-Class Opportunities



Does Better Engagement Mean Better Learning?

- Active learning significantly increases course grades (when compared to didactic methods) (Freeman, 2014)
- Active learning positively affects student motivation (Owens et al., 2017)
 - Motivation moderates key learning characteristics such as attention and memory consolidation (Cavenagh, 2016)
- Hands-on, integrative, and collaborative learning experiences lead to high levels of student achievement and personal development (Kuh et al., 2017)
- Students learn more when taking part in classrooms that employed active-learning strategies, despite students feeling as though they learn more in traditional lectures (Deslauriers et al., 2019)

Active Learning Examples

- **Clarification Pause:** Students are given time to go over lecture material, think about it, and ask if they have questions.
- **Polling:** Students are given a quiz-like multiple choice question, and are asked to submit their choice either by raising hands or using technology like iClicker or mobile apps.
- **Think-Pair-Share:** Students are asked to work individually on a problem, then pair up to compare answers, then explain/share answers with the rest of class.
- **Cooperative Groups:** Students are given handouts with multiple problems to work on in groups of 3-5. They are asked to discuss together and come up with solutions all members agree on.
- **Simulations:** Students observe and investigate simulations that apply concepts covered in class.



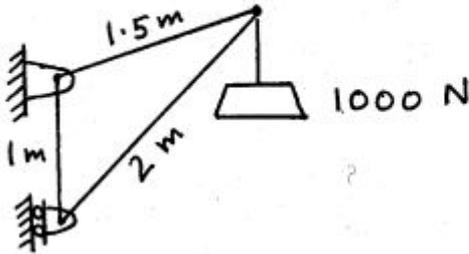
Increasing Complexity

Clarification Pause
Polling
Think-Pair-Share

Question: Part of a nail (4 cm long) is sticking out of the wall at A in the y-direction, and force F is applied to the nail, as shown in the figure. It is possible to determine: (select all correct choices)

- a) The angle between the force and the nail.
- b) The amount of deflection (bending) of the nail.
- c) The magnitude of the force pushing the nail in the wall.
- d) Maximum bending moment at A.
- e) The insertion distance of the nail in the wall.

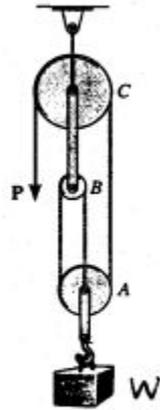
Question: Determine the forces in the members and select sizes of the wooden members so the truss is safe and costs the least.



Think-Pair-Share
Cooperative Groups

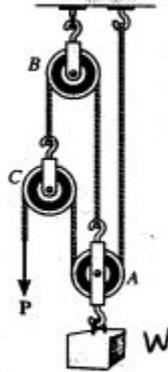
Cooperative Groups Simulation

Question: Design an arrangement of three pulleys to lift heavy loads with the least effort.



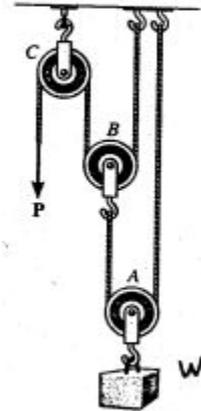
$$P = W/3$$

(R)



$$P = W/4$$

(S)



$$P = W/4$$

(T)

Let's Explore Active Learning Strategies

First, independently:

1. Review the example strategies (pages 1 & 2)
2. How might you already be using active learning strategies in your courses?
3. Pick 1-2 strategies you would like to try
How could you effectively implement that strategy in one of your courses?
What challenges concern you?
4. Which strategies raise questions for you?

Let's Explore Active Learning Strategies

Now, discuss in your group:

1. Which strategies have you effectively used in your courses?
What has worked well?
What has been challenging?
2. Which strategies would you like to talk through as a group?
How could you effectively implement that strategy in one of your courses?
What challenges concern you?

Debrief

What are some ideas your group talked about?

What questions do you have?

Common Concerns

Does it work?

Common Concerns

Does it work? Yes, it promotes wider range of learning and can improve student performance

Common Concerns

Does it work? Yes, it promotes wider range of learning and can improve student performance

Does it always work?

Common Concerns

Does it work? Yes, it promotes wider range of learning and can improve student performance

Does it always work? No, especially if designed and implemented poorly. Just like lecture.

Common Concerns

Does it work? Yes, it promotes wider range of learning and can improve student performance

Does it always work? No, especially if designed and implemented poorly. Just like lecture.

What makes it work well?

Common Concerns

Does it work? Yes, it promotes wider range of learning and can improve student performance

Does it always work? No, especially if designed and implemented poorly. Just like lecture.

What makes it work well? Careful, goal-driven planning & purposeful implementation.

Common Active Learning Challenges

- Plunge into active learning with no explanation
- Expect all students to eagerly form groups the first time you ask
- Make activities trivial
- Make activities too long
- Call for volunteers after every activity
- Fall into a predictable routine

Give It A Go!

- What is one thing you would like to try next semester*?
- How can you establish expectations and guidelines for participation on the first day of class?

**Proceed carefully if you are eager to start something right away in one of your current classes*

Final considerations

- It's OK to start small
- Begin early and transparently
- Use frequently
- Give clear instructions
- Explain your reasoning
- Reflect on the experience afterwards
- Continue to share ideas with colleagues

Thank you!

Stephanie Kusano, Ph.D.

Assistant Director

Center for Research on Learning & Teaching

University of Michigan

skusano@umich.edu