Rethinking Engagement: Teaching and Learning with AI in CS Education

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Introduction

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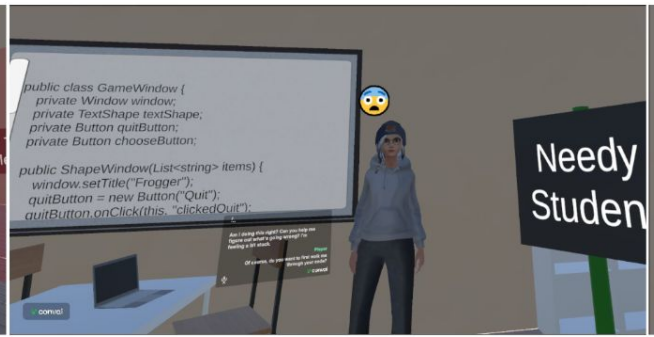
- **VISTA** (Virtual Interactive Simulation for Teaching Assistants)
- **Peer+** (Peer Instruction using Runestone e-books)
- **DURA** (Lightweight Framework for LLM Course Integration)

VISTA
Virtual Interactive Simulation for Teaching Assistants

Arezoo Sarshartehrani, Margaret Ellis, Denis Gracanin, Brett Jones, Christine Julien

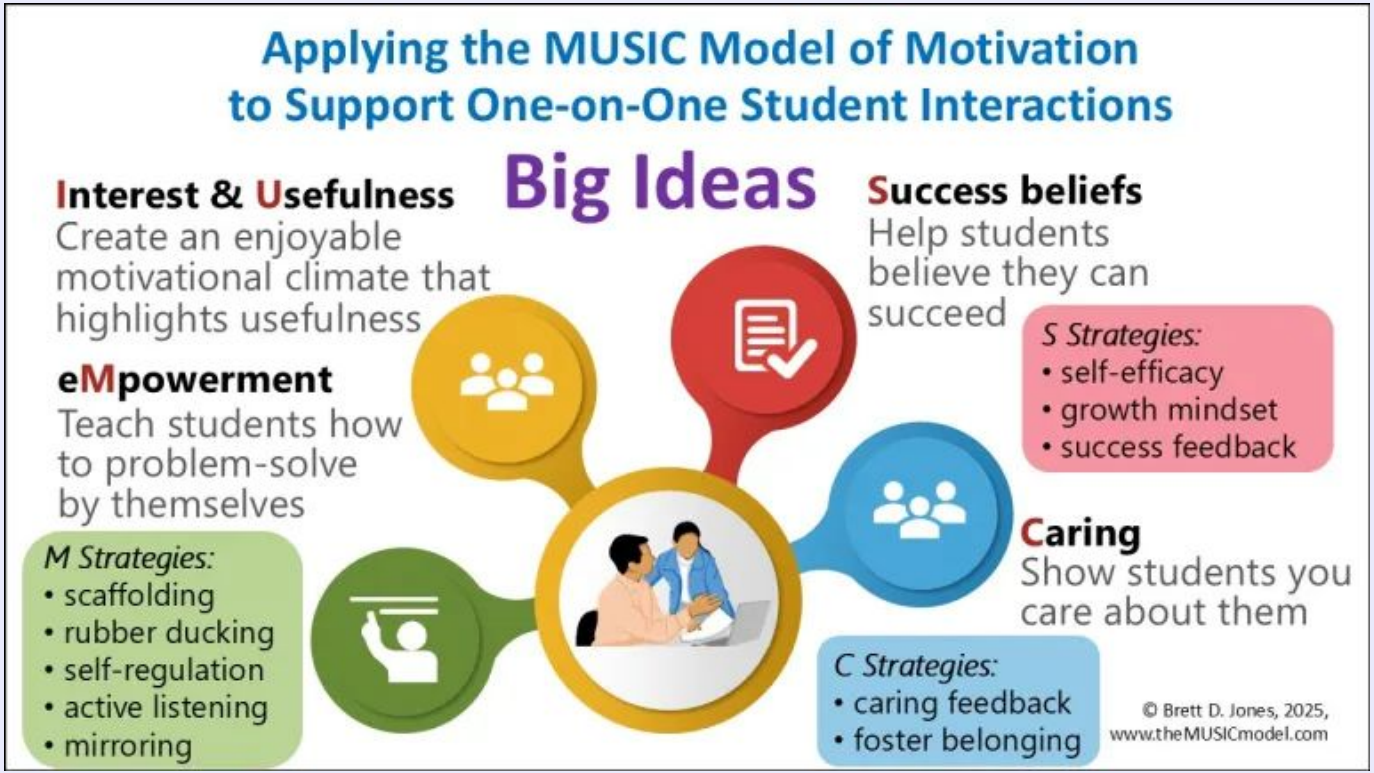


Background: MUSIC Model of Motivation

Instructors need to ensure that:

- Students feel empowered by having autonomy over some aspects of their learning
- Students understand why the instruction is useful for their goals in life
- Students believe that they can succeed if they put forth the effort
- Students are interested in and enjoy the content and instructional activities
- Students believe that others in the learning environment care about their learning and them as a person

CS TA Training Project



Jones, B. D., Ellis, M., Kim, I. . (August 1, 2023 to July 31, 2025; NSF Award #IUSE-2315574). *Training Computer Science Teaching Assistants to Motivate Students*. National Science Foundation

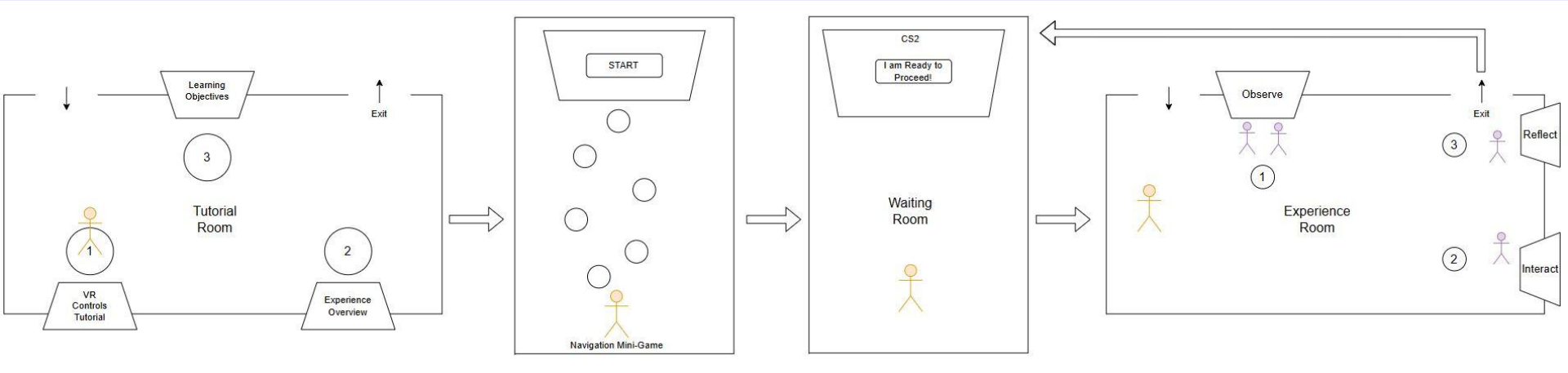

VIRGINIA TECH

Observe → Interact → Reflect

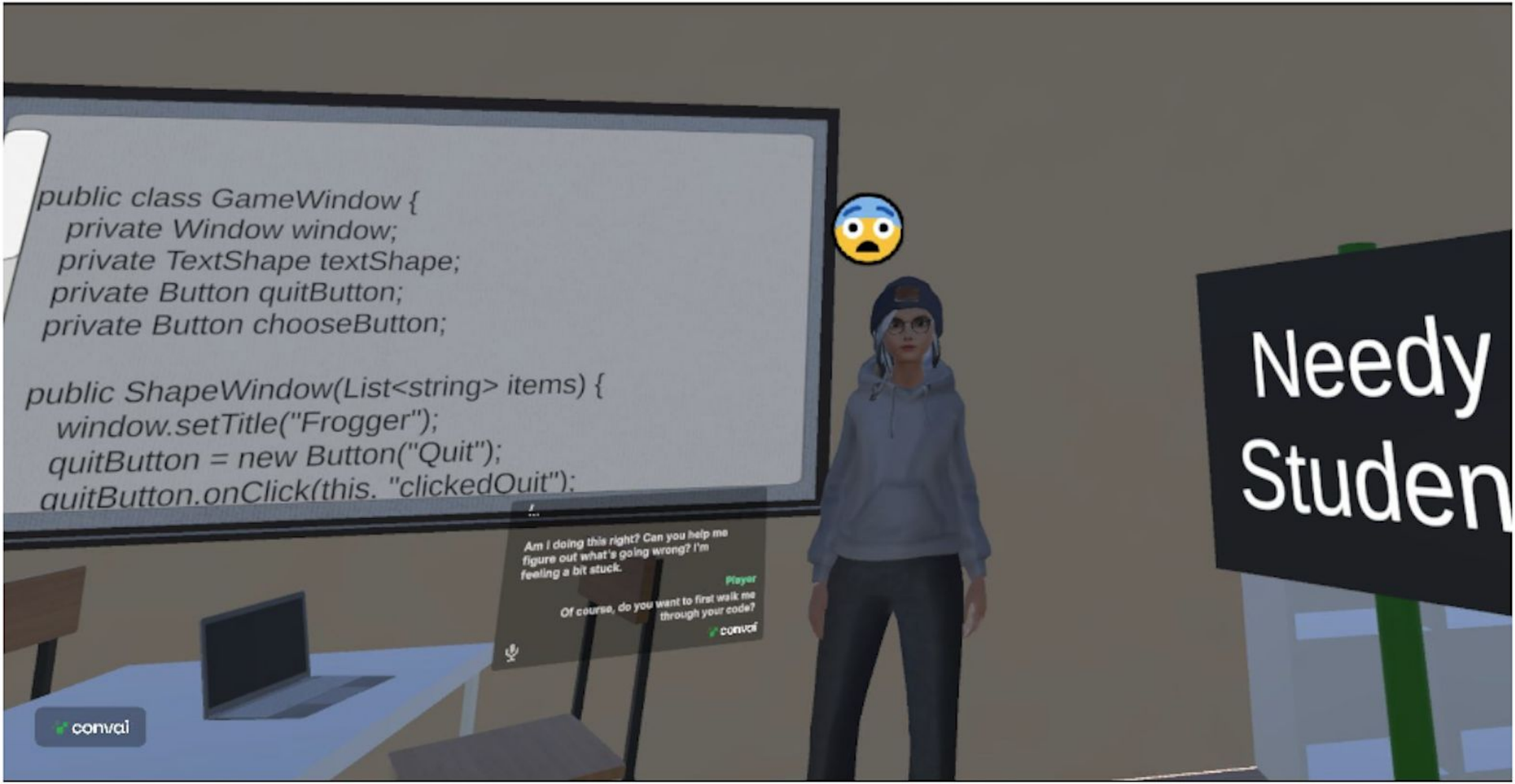
Supports deliberate practice

- Observe: watch expert interaction
- Interact: talk to AI student(created with TAs)
  - Cooperative and Successful
  - Unconfident
  - Impatient
  - Needy
  - Demanding
- Reflect: AI mentor feedback

System Flow


Learning Objectives
Exit
3
Tutorial Room
1
VR Controls Tutorial
2
Experience Overview
START
Navigation Mini-Game
CS2
I am Ready to Proceed!
Waiting Room
Observe
Exit
3
Reflect
1
Experience Room
2
Interact


Oh, I don't know — there are so many nested objects there.
Observe: Ideal TA-Student Interaction
convai


public class GameWindow {
private Window window;
private TextShape textShape;
private Button quitButton;
private Button chooseButton;
public ShapeWindow(List<string> items) {
window.setTitle("Frogger");
quitButton = new Button("Quit");
quitButton.onClick(this, "clickedQuit");
Am i doing this right? Can you help me figure out what's going wrong? I'm feeling a bit stuck.
Player
Of course, do you want to first walk me through your code?
convai
convai
Needy
Studen


TA
Mentor
by using more mirroring techniques, such as restating her concerns to ensure she feels heard and understood. While you guided her to explain her code, you could have provided partial hints to help her progress further, such as suggesting areas she might want to double-check, like the initialization of the `window` object.
convai

VT 2025 Pilot Study

- Iterative development with faculty and TA feedback

- Fall 2025: CS Department
  - 24 CS TAs
  - 2 sessions (4 weeks apart)
  - 5 persona interactions per session

- Key Results
  - Performance improved across sessions
  - Strong gains for difficult personas
  - Better confidence calibration
  - AI scoring aligns with human raters

Future Work

- Fall 2026: UIUC Graduate Academy
  - Comparison of learning gains and user experience among modalities
    - Immersive (VR)
    - Desktop
    - Chat
  - CS GTAs in coordination with Center for Innovation in Teaching & Learning
- Extend scenarios and course topic materials
- Enhance rubrics

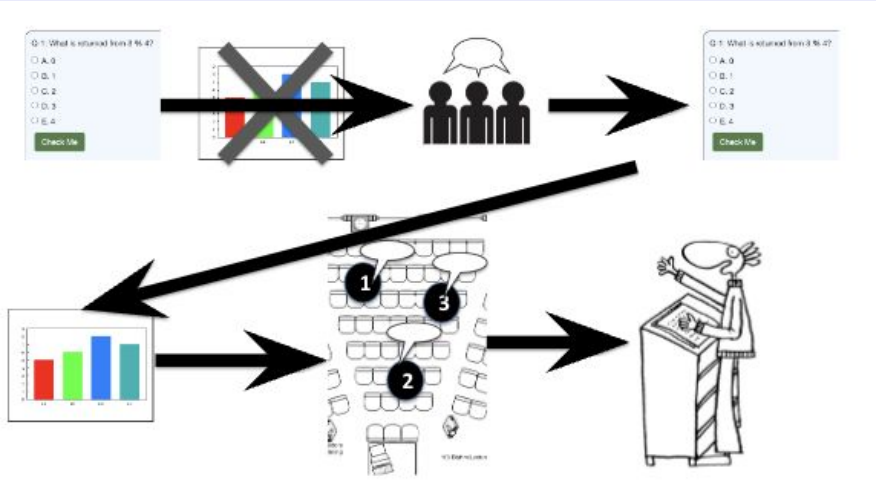
Peer+
Peer Instruction Tool in Runestone

Testing the Effects of Peer Discussion, NSF iUSE Level II

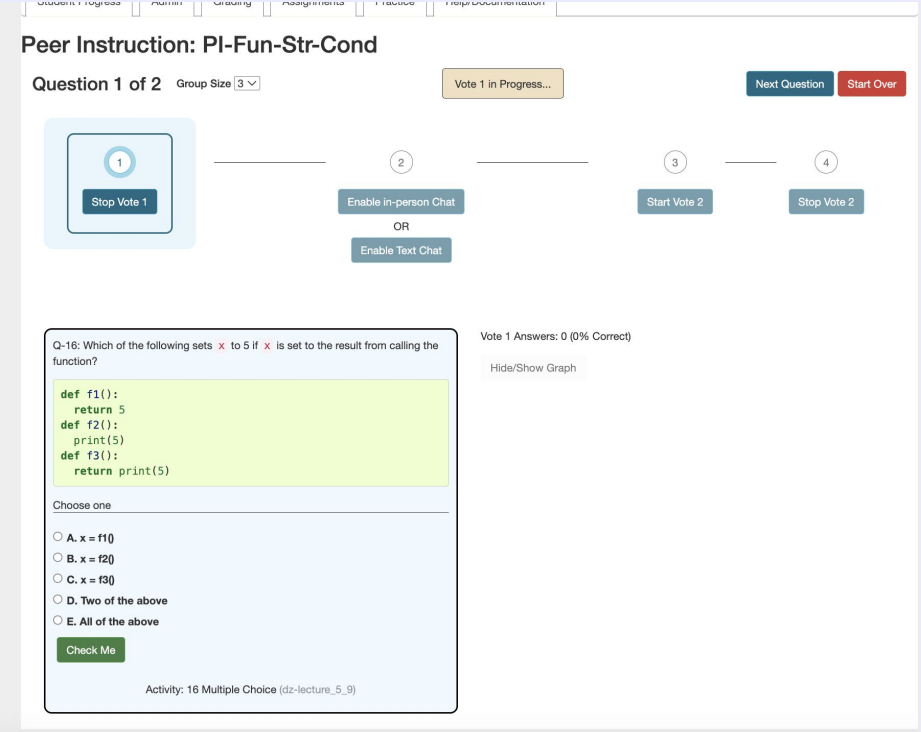
Barbara Ericson, Associate Professor, University of Michigan
Jan Pearce, Professor and Chair, Berea College
Susan Rodger, Professor of Practice, Duke University
Yesenia Velasco, Lecturer, Duke University
Margaret Ellis, Professor of Practice, Virginia Tech
Brad Miller, Runestone

What is Peer Instruction?

- May have a pre-reading/quiz
- In lecture show a hard multiple-choice question
  - Students answer individually
  - Discuss their answer with peers
  - Students answer individually again
  - Instructor leads discussion of the question and answers



Runestone Peer+ Interface



1. Starts first vote automatically (planning to add a button to start)
   a. Constantly updates the number of votes cast
   b. "Stop Vote 1" to end the first vote
2. Enable in-person chat or text chat with assigned groups
   a. Can set the size of the group for the chat (near the top) before starting a vote
   b. In text-chat see message count
3. Start vote 2
4. End vote 2
   a. Show the histogram of the two votes
   b. Discuss as a class

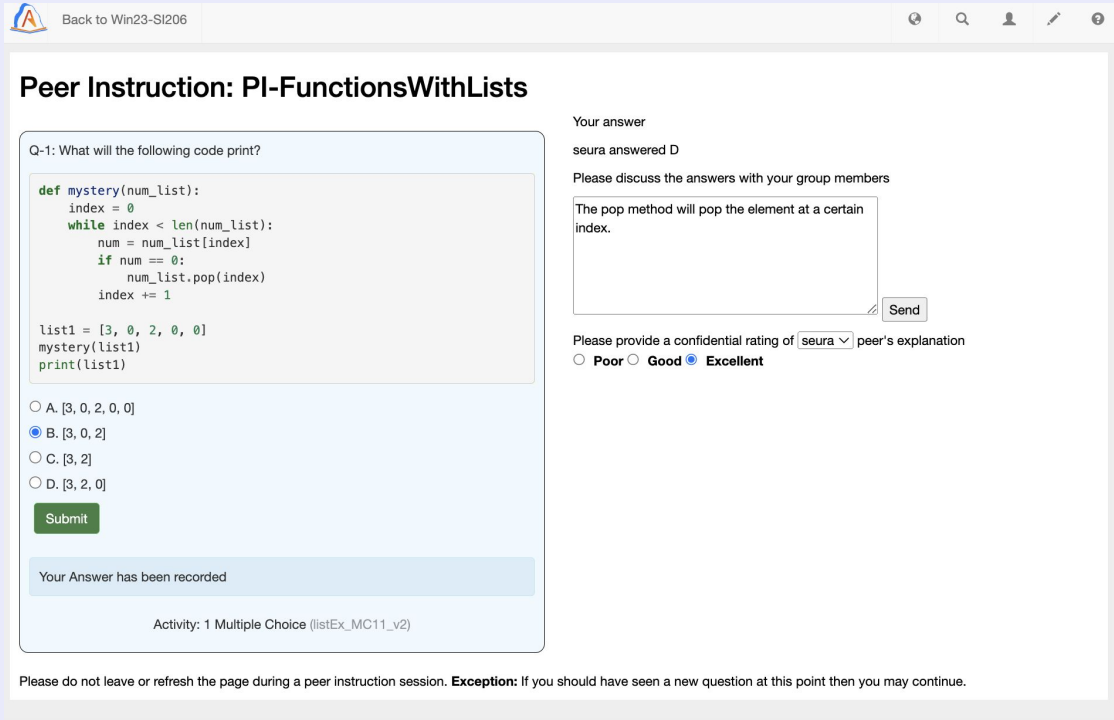
Peer Instruction Study

- Text-Chat in Peer+
  - Assign groups based on different answers
  - Maximize disagreement in groups
  - Supports verbal + text-chat discussion
  - Keeps same PI cycle
- Evaluating Text-Chat vs Verbal Discussion
- Multi-institutional study
- Focus: How Peer Instruction works

Synchronous Text Chat for Discussion

If you click the *"Enable text chat"* button students will get a text chat window.

- Discuss the answers with peers
- Tries to maximize the number of groups with members with different answers



Key Findings

- Text-chat groups showed higher learning gains
- Students still prefer verbal discussion
- Preference ≠ effectiveness
- Design of interaction matters most

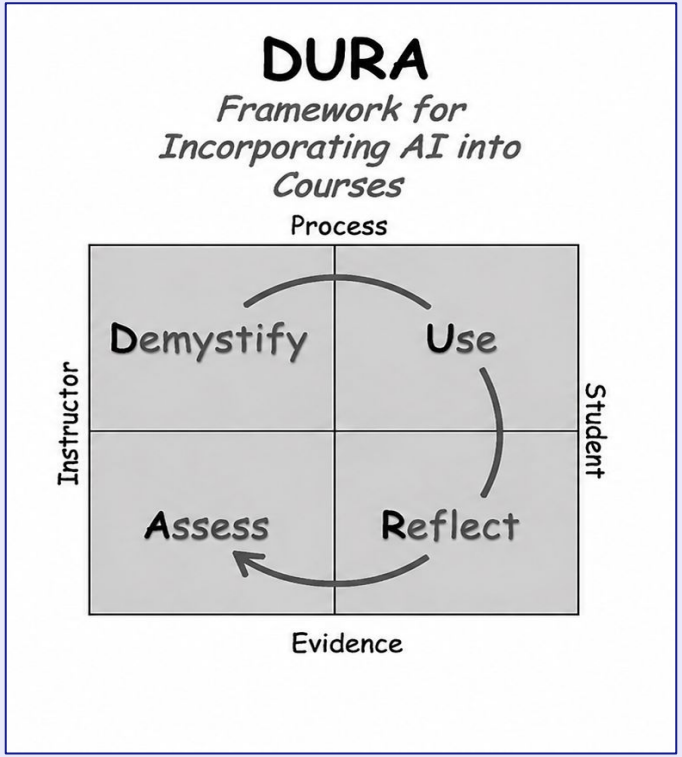
Ongoing and Future Work

- Large collections of searchable Peer+ questions available
- Updates to user interface for class and question building
- LLM based after lecture text-chat feature
- Incorporation of Study Clues in Runestone books
  - Creation of pools of Peer+ questions
  - LLM tutor

Runestone and Peer+ Workshops

Workshop Sign Up (led by Barbara Ericson): https://forms.gle/gtMJbnZPvi2gw2on6.

1. Monday July 6th, 1:00pm - **Getting started with Runestone**
2. Tuesday July 7th, 1:00pm - **Instructor interface: creating a custom book for your students**
3. Wednesday July 8th, 1:00pm - **Instructor interface continued**
4. Thursday July 9th, 1:00pm - **Peer Instruction** *We will also show the new LLM based after lecture text-chat feature!*



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DURA Framework Overview

- Demystify – Use – Reflect – Assess
- Integrating AI while maintaining critical thinking
- Lightweight framework for course redesign
- Supports ethical and effective LLM use

CS2104 Problem Solving Course Schedule

Spring 2025

LLM Topics Across Weeks(W) to Classwork (CW) Homework (HW) and Lectures (L)

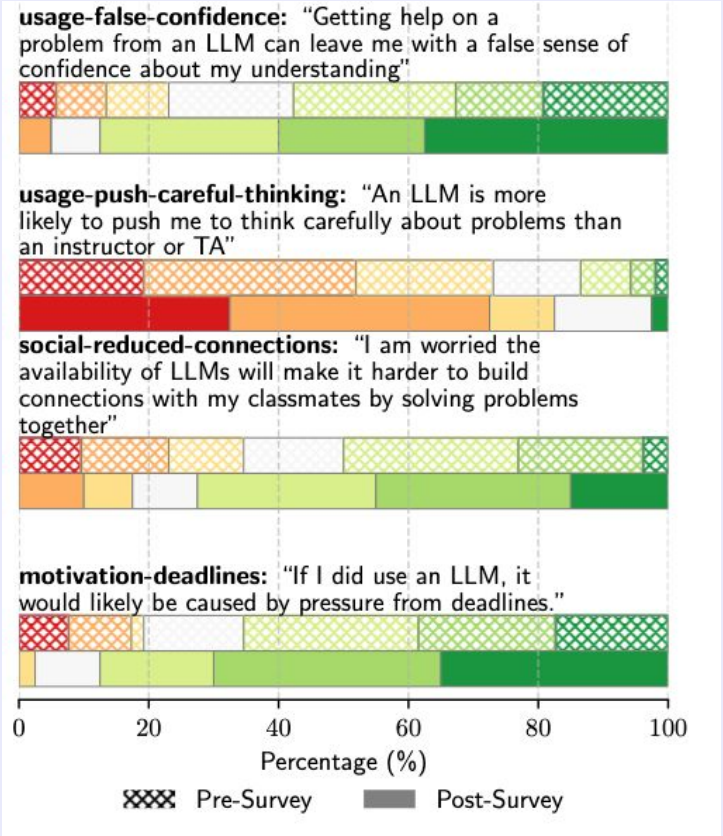
		LLMs		*Algorithms*		*Soft. Eng.*		*Networking*		*HCI*		*Data Science*	
Goals	**Approaches**	W1	W2	W3	W4	W5	W6	W8	W9	W10	W11	W12	W13
Demystify LLMs	How LLMs Work	CW	L					L					
	Current Resources	HW	CW	HW		HW							HW
LLM Usage Skills	Demos			L	L	L		L		CW	L		
	Semi-LLM-Resistant				HW	HW	HW		HW				HW
Reflective and Responsible LLM Use	Risks and Benefits		L			CW, L	L		L		L		
	Reflection on Use			L		HW, L	L						HW

CS2114 Data Structures and Software Design

Component	*Our CS2 Implementation*
Demystify	Demystify how LLMs work, how they can affect learning and performance.
Use	Use LLMs with guidance and attribution.
Reflect	Reflect on LLM use and problem-solving process.
Assess	Assess programming assignment skills through proctored assessments and allow retakes.

DURA in Physics

Collaborators: Jake O'Brien, Alma Robinson, John Simonetti



Pre-Planning

1. Define learning outcomes (with/without AI)
2. Establish AI usage policies
3. Consider student access to tools
4. Align with prerequisite & downstream courses

Demystify

- Teach how LLMs work
- Explain impact on learning
- Introduce real-world AI use
- Address ethics

Use

- Student roles from user to developer
- Tasks: coding, debugging, research
- Guided instruction and scaffolding
- Tool policies and constraints

Assess

- Assess with and without AI
- Assess frequently, allow retakes
- Consider: *explanation-based tasks, open-ended projects, process, design*

Reflect

- Supports metacognition
- Reflect on process and AI use
- Evaluate effectiveness and tradeoffs
- Consider ethical implications

CS2114 MUSIC Motivation Components

Term	Weeks	*n*	*N*	%	M	U	S	I	C
2025 Fall	15	235	442	53.2	4.6	5.0	4.9	4.4	**5.3***
2024 Fall	15	329	597	55.1	4.6	5.0	5.0	4.2	**4.7**

Note. n = number of respondents; N = total enrollment; % = response rate. * $p < .001$

Thank you!

Questions?

Contact: Margaret Ellis, maellis1@vt.edu

Reviewing Peer Instruction Results

Description:

Question 1

Previous Next

Question Effectiveness
Percent Correct Votes in Vote 1: **55%**

Normalized Change
69%

Q-1: What does the following code evaluate to?

```
(1!=1) or (0 == 1/0)
```

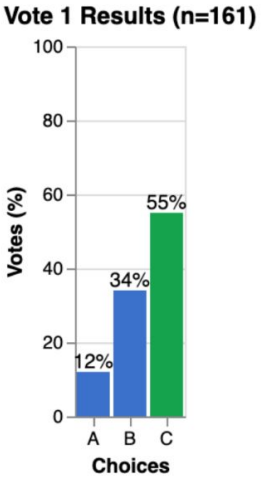
Choose one

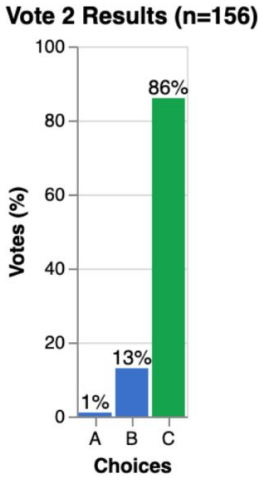
- **A. True**
- **B. False**
- **C. Error**

✓ Correct! The first expression (1!=1) evaluates to False, making it so we must evaluate the second expression. The second expression (0 == 1/0) causes a divide by zero error.

Activity: 1 Multiple Choice (duke101_sc_not_equal_divide_using_or)

Show Question in the Book





Takeaways

- - XR + AI supports interpersonal skill training
- - Enables scalable feedback
- - Improves metacognitive awareness

- Future: more personas, adaptive systems

Memorable Student Quote

“I don’t trust AI as much at all anymore, I didn’t know they were probability machines”

System Overview

- - XR virtual office hours (Meta Quest 2)
- - AI student avatars (LLM-driven)
- - Real-time dialogue + feedback
- 16-item rubric used for evaluation
  - - Empowerment (scaffolding)
  - - Success (growth mindset)
  - - Caring (empathy)

- Goal: Develop interpersonal + pedagogical skills