Teaching and Learning Theories and Learning Engineering

ISEA Session 4

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2.14.2025

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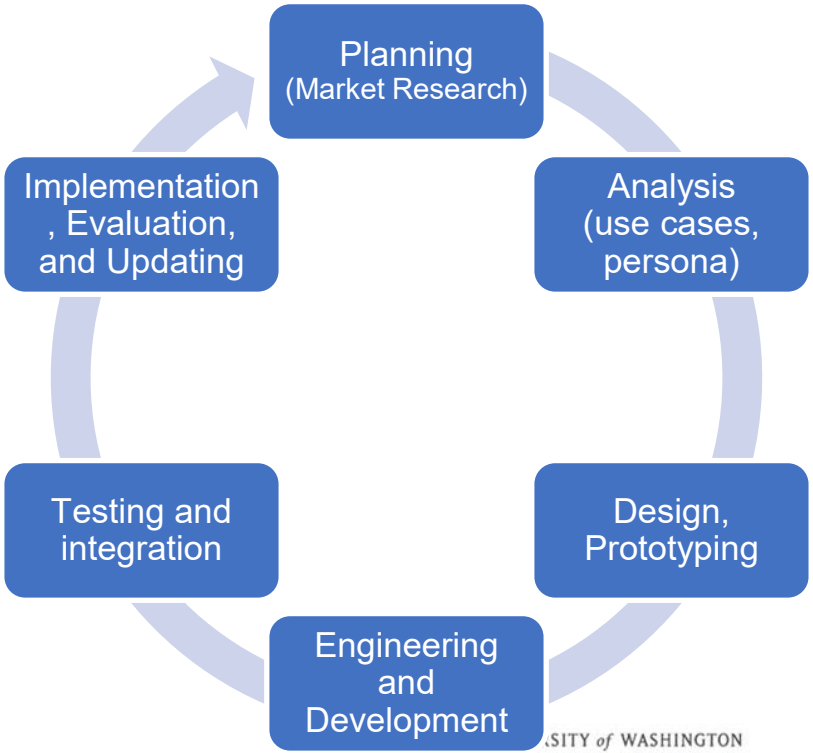
Overview of today

1. Useful learning/educational theories informing ed tech development and data analytics?
   - Nudging
   - Effective math teaching/learning
   - Participatory codesign→ Design-based implementation research→COALESCE (Collaborative Adaptive Learning Ecosystem for Systems Creation and Enhancement)
2. Use Colleague AI's design as examples to illustrate

Educational Software Development Cycle

Learning science concepts can inform each step of this process



Example User Stories from Session 2

User Story 1: David is a Project Manager with the Government Relations team at Curriculum Associates. His role requires him to understand and communicate data reporting and compliance requirements from state education departments to the Analytics team and deliver said requirements. This also involves gathering district, school, and student IDs from the company's database to indicate whose data should be included in reports. However, David is not very technical and does not have much direct experience working with databases. He often struggles to adequately gather the information he needs to give to the Analytics team and ensure accurate reporting. He wants a tool that would allow him to perform a simple search for district and school names, select relevant fields, and click a button to generate an Excel spreadsheet.

User Story 2: Stephanie is a special education teacher for students in grades 9 and 10 whose performance in math and reading are below their grade-level. Her students are using the i-Ready Diagnostic and Personalized Instruction to determine their current proficiency-level and identify the specific skills they need more practice in. Stephanie can view their diagnostic results in the i-Ready Connect system for educators, but because the population of high school students using i-Ready is so small, there are currently no official growth targets designed for students in high school grades like there are for K-8. There is documentation with instructions for calculating generalized growth targets for grades 9-12, but Stephanie finds using this document time-consuming and not very helpful for tracking students' performance. As a busy educator, she wants to be able to view an easily accessible visual in the i-Ready Connect system that allows her to monitor her students' progress. She wants a feature in the user interface that allows educators to opt in to generalized growth targets for high school students so that she can easily view their data and visualize their progress.

User Story 3: Jared is a 5th grade teacher who has his students complete the i-Ready Diagnostic. He is in his second year of teaching and this is his first year using the i-Ready platform with his students so he does not have much experience with the online system for educators. He also has a large class of 29 students. He has experienced issues with several of his students rushing through the diagnostic assessment which results in these students receiving a Rush Flag (a feature that alerts educators to rushing behavior). Jared is able to view which students have received Rush Flags on their diagnostic assessments in the i-Ready Connect system for educators, but has to click on each student individually to check, which he finds cumbersome. Jared wants a feature in the user interface that acts as a filter and allows educators to quickly and easily view which students exhibited rushing behavior so that appropriate next steps can be taken more efficiently.

Colleague's Persona

"I think I could speed up lesson planning"

PERSONAL INFO

Age: 35
Identifies as: Female
Occupation: Science teacher
Level: Middle school
Experience: 6 years
Location: NYC School district

BIO

Alex is an 8th-grade teacher in a school in Queens. She uses multiple online platforms to plan, create, deliver, and measure instruction. She constantly tailors lessons to the class' needs while making sure that content aligns with standards. In case of having to adopt new technology, she has to learn it by herself.

GOALS

- Find educational content that aligns with national, district, and school standards.
- Customize material for my lesson plans so that it is tailored to the needs of my students.
- Create interactive lessons to increase engagement with my students.

PAINPOINTS

- Wasting time and energy vetting content to complement district-provided material.
- Switching between multiple platforms to find and create lesson plans.
- Cumbersome to customize material for tailoring to class needs.

DEVICES

School-issued laptop

TECH SKILLS

Tech-savvy

TOOLS/PLATFORMS

Uses multiple online platforms in her day-to-day work to search for content, plan lessons, customize lesson content, grade students, report grades, and communicate with parents and students.

G Suite CANVAS SKYWARD Microsoft Outlook

MOTIVATIONS

- Improve student's learning by providing customized lesson plans.
- Efficient workflow to prioritize activities that support students' learning.

NEEDS

- Filter & review the lesson plan's content so I can provide standard-aligned quality material for students' learning.
- Modify lesson plan's content so I can deliver instruction that meets the needs of my students.
- Complement lessons with interactive content so I can engage my students in their learning.
- Connect lessons to other platforms so I can make them accessible to my students and other teachers.

COALESCE Framework Powering Colleague AI's Design and Development

Purpose:

- A framework extending DBIR principles to develop AI-powered educational technologies

Core Goal:

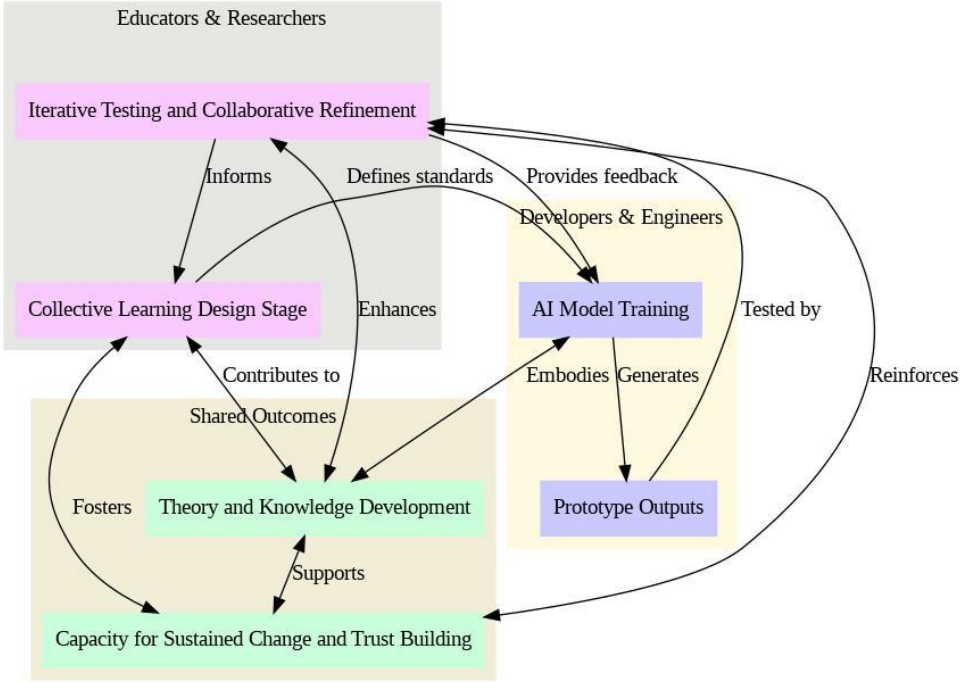
- Transforms educators from passive end-users to active co-creators

Framework Components:

- Collective Learning Design Stage
- Iterative Testing & Collaborative Refinement
- Theory & Knowledge Development
- Capacity Building for Sustained Change

Unique Feature:

- Creates reciprocal learning environment between educators, researchers, and developers



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COALESCE Framework Powering Colleague AI's Design and Development

Table 1. A brief overview of DBIR principles adaptation by COALESCE

DBIR Principles	COALESCE Implementation and Adaptation
Persistent problems of practice	Educators identify and address limitations in AI's transparency and contextual adaptation, directly influencing lesson planning features and aligning AI models with instructional practices.
Iterative, collaborative design	Educators, researchers, and developers foster a reciprocal, mutual learning space where they learn alongside one another.
Theory, knowledge, and technology development	The dual-direction knowledge exchange generates new knowledge around lesson quality standards and develops technology solutions (e.g., domain-specific AI models).
Capacity for sustaining change	Educator involvement in defining and refining AI systems promotes trust, ownership, and ensures relevance and adaptation.

COALESCE Framework Powering Colleague AI's Design and Development

"With Colleague AI, my math expertise now matters… AI generates an engaging math activity, giving me a starting point. It literally takes seconds to generate, rather than the 30 or 40 minutes it would have taken me to design the activity myself. This technology makes the professional learning I've done in person actionable."

"I would definitely recommend it to other colleagues" and noting that "this would benefit a variety of teaching contexts." Educators valued their roles as co-creators, observing that the design process gave them a meaningful sense of ownership and relevance. They regarded the tool as "something that actually feels applicable to real classrooms."

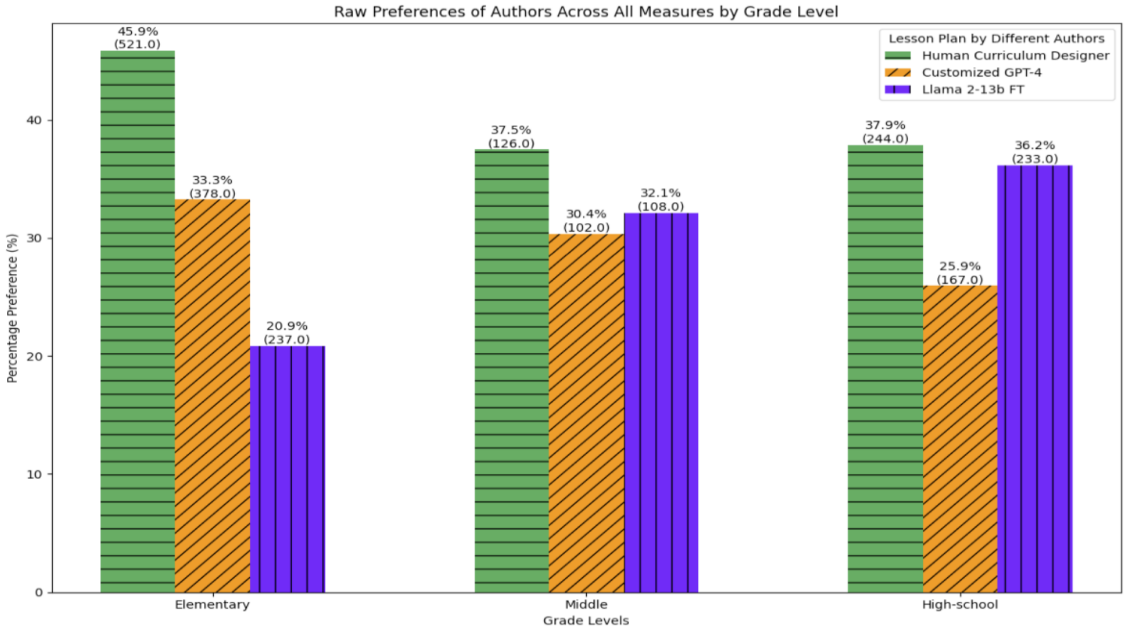

Fig. 4. Educators' grade-level preferences by lesson plan type

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Two-Round Breakout Discussion Structure for PlayLab AI Evaluation Framework

Opening (1 minute)
- Context: PlayLab needs an AI tool evaluation framework
- Goal: Define scope, identify stakeholders, select framework components

ROUND 1: Problem Scoping & Stakeholder Integration (8 minutes)
Discussion Structure
1. Problem Identification (3 minutes)
- What specific aspects of AI tools need evaluation?
- Which COALESCE principles are most relevant?
- What are current gaps in evaluation?

2. Framework Selection (2 minutes)
- How to integrate COALESCE with existing evaluation methods?
- Which assessment approaches work best for educational AI?

3. Stakeholder Mapping (2 minutes)
- Who needs to be involved?
- What are their primary concerns?
- How will they contribute?

4. Documentation (1 minute)
Create a simple template with:
- Top 3 problems identified
- Selected framework components
- Key stakeholders and their roles

5. Discussion Prompts for Facilitators:
- Round 1: "How does this problem affect different stakeholders?"

ROUND 2: Quality Standards Development (10 minutes)
New groups with mixed participants from Round 1
1. Knowledge Transfer (3 minutes)
- Each member shares key insights from Round 1
- Quick summary of identified problems and stakeholders

2. Quality Standards Discussion (7 minutes)
1. Learning Impact (2 minutes)
   - What metrics measure educational effectiveness?
   - How to align with effective teaching and learning?
2. Technical Performance (2 minutes)
   - What defines good AI performance?
   - How to measure reliability and accuracy?
3. User Experience (3 minutes)
   - What indicates successful user engagement?
   - How to measure accessibility and inclusivity?

Final Synthesis (1 minute): Create an evaluation checklist with:
- 3 key quality indicators

Discussion Prompts for Facilitators
- Round 2: "How can we measure success in ways that matter to all stakeholders?"

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Apps/Tech Solution Built on Learning Science Theories

- Nudge[4]
- READY4K!
- Colleague
- Elinor's Talking to me! Conversational AI into Children's Narrative Science Programming
  - Ask questions stimulates thoughtful responses
  - Feedback continues the conversation around the particular topic
  - Scaffolding helps children better participate

Nudging Theory Key Components

- **Insufficient information**
  - **The limited information processing capabilities of the human mind. In the face of cognitively demanding tasks—such as tasks requiring a substantial amount of choice and continuous, ongoing tasks—individuals tend to make choices based on faulty heuristics, or they avoid making decisions altogether (Mullainathan and Thaler 2000).**
- **Limited time, limited attention**
- **Self-control and inconsistency**
- **Hard to see the benefit in the near term**

Examples of the texts

- A “Fact” text designed to inform and motivate parents.
- FACT: Letters are the building blocks of written language. Children need to know the letters to learn how to read & write.
- A “TIP” text that aimed to minimize the cognitive, emotional, and tie burdens of engaged parenting by providing parents with highly specific activities that build on existing family routines;
- TIP: Point out the first letter in your child’s name in magazines, at the store & on signs. Have your child try. Make it a game. Who can find the most?
- “GROWTH” text, which provides parents with encouragement and reinforcement as well as a follow-up tip
- GROWTH: Keep pointing out letters. You’re preparing your child 4K! Now when you point out a letter, ask: What sound does it make?

Gen-AI Prompt Design

- How to write effective prompts. The video recording.
  - Zero shot Prompting
  - One or two shot prompting
  - Chain of thought

Resources to learn more about prompt engineering:

1. https://www.deeplearning.ai/short-courses/chatgpt-prompt-engineering-for-developers/
2. https://www.youtube.com/watch?v=dOxUroR57xs&ab_channel=ElvisSaravia

Prompt Design (2 minutes)

Write your own prompt, building on this:

- **The AI's role**: You are a coach or school principal
- **Context**: Nudging teachers in your school to implement depth of knowledge because 60% of students are below grade-level standards.
- **Information**: Offer information about Depth of knowledge
- **Action**: [Ask AI to generate nudge message and strategy that ultimately lead to actions among your staff]

Assignment 1. Write Up into a Document to Flesh Out Your Ideas

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Assignment 2: Prepare for Next Week's Session

1. **Beef up with your coding skills**
2. **Set up Colab or python or jupyter notebook**

Learning about the basics of python programming and Colab environments:

- https://pandas.pydata.org/Pandas_Cheat_Sheet.pdf
- https://jakevdp.github.io/PythonDataScienceHandbook/
- https://colab.research.google.com/
- https://www.statlearning.com/