Engaging Teachers in Mixed Model Lesson Study for Integrating Human-Centered Design in Geometry Problem-based Instruction

Gloriana González & Saadeddine Shehab
University of Illinois Urbana-Champaign

Purpose

- The project targets DKR-12's Teaching Strand and addresses the question, "How does the innovation or approach improve instructional practices and increase students' learning and outcomes?"
- We investigate whether and how our innovation supports teachers in integrating Human-Centered Design (HCD) in problem-based geometry lessons (PBGL).

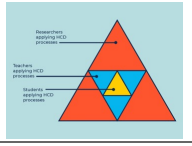
Research Questions

RQ1. How do teachers design and implement HCD-PBGLs using the HCD framework through lesson study?

We ask: How did teachers adapt lesson prototypes during the planning phase of lesson study?

Background

- Lesson study promotes teacher learning through implementing a research lesson following four steps: Study, Plan, Teach, and Reflect (Lewis et al. 2006).
- HCD is a problem-solving approach that uses design thinking to identify the needs of a population to collaboratively and iteratively develop solutions (Brown, 2008).
- Teachers can learn and apply HCD processes during lesson study to design a research lesson.



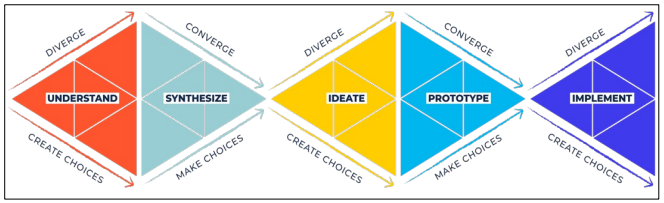


Figure 1. The Human-Centered Design Taxonomy (Lawrence, Shehab, & Tissenbaum, 2024)

Lesson Study Phase	Study				Plan				Teach	Reflect
Purpose	Study Lesson Prototypes to define opportunities to create a Research Lesson				Brainstorm and plan a Research Lesson				Prototype the Research Lesson	Reflect on students' thinking during Research Lesson
Session #	1	1.5	2	2.5	3	3.5	4	4.5		5

Figure 2. HCDxLS Journey Map

Methods

- We held six HCD-Lesson Studies (HCDxLS) online with middle and high school mathematics teachers.
- Each HCDxLS started with the Study step where teachers analyzed three lesson prototypes that included geometry, design, and community dimensions.
- Each lesson prototype included an Overview of the design problem and a student worksheet with three lesson phases: Engage, Experiment, and Explain.
- We compared the selected lesson protype to the research lesson taught and analyzed the changes.

LS No.	Level	Lesson Prototype	Logo	Math	Design	Community
1	HS	Designing a Poster about Cultural Values		Transformations	Empathizing, Narrowing concepts, Prototyping	Accept and share cultural values
2	HS	Designing a School Learning Space		Scaling, Area, Perimeter	Empathizing, Brainstorming, Creating, Prototyping	Accessibility to learning
3	MS	Designing Zero-Waste Patterns		Area, 2D to 3D Visualization, Reflections	Creating, Prototyping	Sustainable fashion
4	MS	Designing a Water Conservation Solution		Solids	Empathizing, Brainstorming, Creating, Prototyping	Water accessibility
5	HS	Designing a Water Conservation Solution		3D Modeling, Surface Area and Volume of Solids	Empathizing, Brainstorming, Creating, Prototyping	Water equity
6	MS	Designing Community Garden Plots		Measurement, Area, Unit Rate, Estimation	Empathizing, Ideating	Food insecurity

Findings

Table 1. Type of changes to the lesson prototypes

Type	RL1	RL2	RL3	RL4	RL5	RL6
Add	36%	50%	67%	39%	71%	42%
Modify	57%	0%	3%	17%	29%	23%
Delete	7%	50%	30%	44%	0%	35%

Table 2. What changed?

Content	RL1	RL2	RL3	RL4	RL5	RL6
Contexts	14%	13%	11%	31%	43%	44%
Math	7%	13%	11%	14%	29%	5%
Scaffolds	71%	50%	72%	28%	29%	40%
Deliverables	0%	0%	0%	22%	0%	12%
Other	7%	25%	6%	6%	0%	0%

Table 3. Changes per lesson phase

Section	RL1	RL2	RL3	RL4	RL5	RL6
Overview	29%	13%	28%	38%	21%	56%
Engage	14%	13%	28%	31%	36%	11%
Experiment	50%	50%	39%	31%	43%	33%
Explain	7%	24%	5%	0%	0%	0%

- The teachers changed the lesson prototypes significantly to meet the students' needs.
- The middle school lessons had more changes (M=38) than the high school lessons (M=15).
- Most changes were to the scaffolds (M=48%) contrasting few changes to the deliverables (M=6%).
- Context changes framed the design problem differently (Dorst, 2015) as reflected in the Overviews.
- Changes to the Explain phases were minimal as the teachers focused on HCD processes during the Experiment phases.

References

- Brown, T. (2008). Design thinking. *Harvard Business Review, 86*(6), 1–9.
- Dorst, K. (2015). *Frame innovation: Create new thinking by design*. MIT.
- Lawrence, L., Shehab, S., & Tissenbaum, M. (2024). Understanding non-designers' practices and processes in a human-centered design course. *International Journal of Innovation in Education, 9*(5), 1-27.
- Lewis, C., Perry, R., & Murata, A. (2006). How should research contribute to instructional improvement? The case of lesson study. *Educational Researcher, 35*(3), 3-14.

Acknowledgment

Research supported by a National Science Foundation's grant to Gloriana González (Principal Investigator) and Saadeddine Shehab (Co-Principal Investigator) for the project, "Engaging Teachers in Integrating Human-Centered Design for Geometry Problem-based Instruction," Grant No. DRL-2300689. Opinions, findings, conclusions, or recommendations are those of the authors and do not necessarily reflect the views of the National Science Foundation.