CraftPad: Sustaining Teacher Professional Judgment in Human-AI Collaborative Lesson Design

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Abstract

As generative AI becomes increasingly embedded in educational practice, concerns have emerged about the erosion of teacher agency and the over-automation of teaching practice. We introduce CraftPad, an AI-enhanced lesson design tool grounded in principles of meta-design and teacher professional practice. CraftPad positions AI as a partner for reflective design: it scaffolds teachers' thinking, supports iterative design, and encourages pedagogical judgment throughout the design process. Through interviews with six teachers, we found that CraftPad supported multiple distributions of professional agency, expanded design repertoires, and deepened understanding of pedagogical framework. This study contributes empirical insights and design implications for educational AI tools that center teacher agency while augmenting professional knowledge and pedagogical design capacity.

Keywords

Teacher Agency, Teacher Professional Judgment, Human-AI Collaboration, Lesson Design, Meta-Design, AI in Education

1. Introduction

The rapid emergence of generative AI (GenAI) tools has transformed teachers' professional practices, including lesson planning. While AI offers efficiency gains for what has often been a time-intensive task, lesson planning is fundamentally a reflective, contextualized, and creative process through which teachers anticipate student learning trajectories and align instructional moves with pedagogical intentions [7, 8]. However, current AI-generated lesson plans risk promoting outdated pedagogies, rigid templated structures, and diminished opportunities for student agency and classroom dialogue [4]. Scholars therefore call for human-in-the-loop AI designs that treat teachers as active decision-makers [3]. To address this need, we developed CraftPad, a lesson design workspace grounded in "meta-design" [5]—design for design—that empowers teachers as reflective designers in collaboration with AI. Unlike conventional lesson plan generators that offer rigid and linear templates, CraftPad provides an infinite canvas for iterative lesson design. Teachers can modify and organize lesson components according to their pedagogical goals. In Fall 2025, we conducted the initial pilot of CraftPad with teachers participating in a professional learning program about Knowledge Building (KB) pedagogy [12]. This paper reports semi-structured interviews with six teachers who used CraftPad to design KB lessons. The research question guiding this study is: *How does CraftPad mediate teacher–AI collaboration and support the development of pedagogically aligned practice?*

2. Background

Teaching is a design practice where teachers construct and orchestrate learning experiences, making improvisational decisions and iteratively refining designs in response to classroom demands [2, 9].

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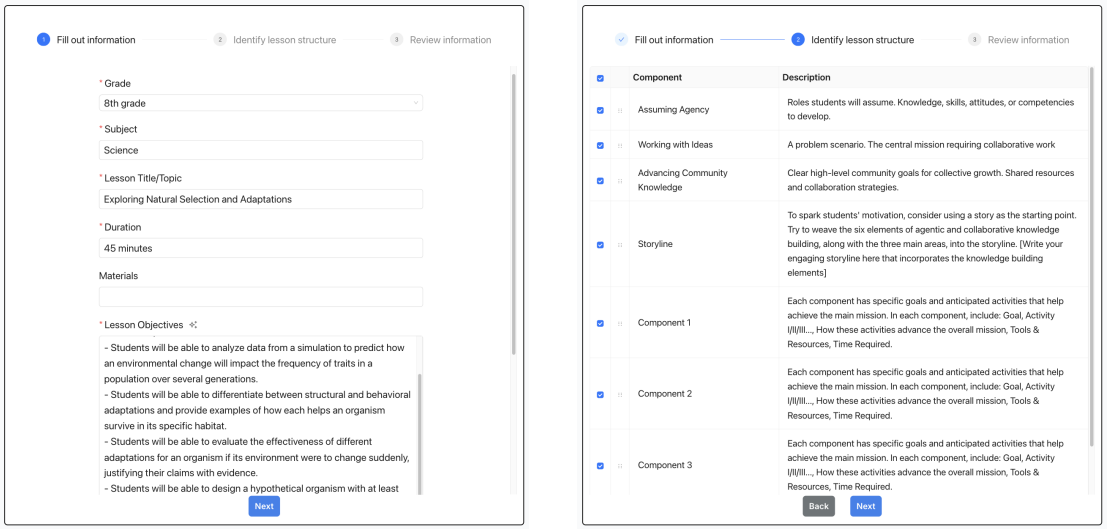
Teachers navigate "wicked" problems that require balancing constraints, student variability, and instructional goals, positioning them as active designers rather than mere curriculum implementers [2, 10]. Meta-design [5, 6] extends this framing to tool use: it positions users as co-designers and calls for systems intentionally under-designed to enable co-evolution through use. Applied to AI in education, Barricelli et al. [1] illustrate how meta-design combined with AI recommendation systems can position teachers as active designers with substantive control over content. While the system initially suggests sequences of learning objects, teachers can intervene throughout by adjusting topics and evaluating suggestions, contributing feedback that supports the system's ongoing co-evolution. This model aligns with the vision of AI as an augmentative scaffold rather than a substitute for professional expertise. However, such application of meta-design in educational technology remains scarce and under-explored. Critically, most contemporary AI lesson-design tools follow a linear, one-shot generation paradigm in which teachers provide parameters and receive a complete lesson plan with limited opportunities for component-level revision. In contrast, CraftPad's infinite canvas supports component-level prompting, allowing teachers to revise specific lesson elements. By treating AI-generated content as a starting point for professional deliberation rather than a finished product, CraftPad positions teachers as active co-designers who evaluate, adapt, and organize lesson components in ways that reflect their pedagogical values and intentions.

3. CraftPad System Design

CraftPad pursues the objective of empowering teachers as reflective designers and preserving their professional judgment through an intentionally underdesigned infinite canvas [5, 6]. In CraftPad, three interaction mechanisms embed AI as a collaborative design partner. **(1) AI-Assisted Initial Generation**: teachers complete a lesson information form, select pedagogically aligned lesson components, and review a metadata summary before requesting AI generation (see Figure 1). This lowers barriers to lesson design while positioning output as a flexible starting point rather than a final product. **(2) Iterative Refinement**: the canvas displays green (AI-generated), blue (teacher-prompted), and grey (notes) textboxes (see Figure 2). Teachers select components and request suggestions, alternatives, or elaborations at the component level. By supporting localized refinement rather than one-shot generation, CraftPad embodies meta-design principles [5, 6], which call for systems that empower teachers as designers, help spark ideas while leaving room for teachers to decide the final design, and support ongoing co-evolution of lesson designs. **(3) Pedagogical Coach**: a custom AI chatbot supports conceptual understanding and reflective practice. Teachers ask questions about the target pedagogical framework, request feedback on draft designs, and reflect on the alignment between pedagogical intentions and design artifacts (see Figure 3). Together, these mechanisms ensure that teachers remain the reflective authors of their pedagogical decisions, retaining professional judgment [14], accumulating design insight, and maintaining agency throughout the creative process.

4. Study Design

Following an online professional development workshop introducing CraftPad, six teachers (see Table 1) completed individual semi-structured interviews over Zoom, ranging from 60 to 90 minutes. Five teachers were relatively new to KB pedagogy, while one teacher (Cary) had prior classroom experience with KB. Interviews were conducted in Mandarin, auto-transcribed, translated with ChatGPT 5.0 assistance, and proofread by two bilingual researchers. Data were analyzed using an iterative and inductive thematic analysis approach. First, two researchers independently conducted open coding on two transcripts to identify emergent themes guided by the research question. The researchers then met to discuss and align their interpretations. Next, each researcher independently coded two additional transcripts to ensure comprehensive coverage and familiarity with the dataset. Following two rounds of open coding, the researchers collaboratively developed a codebook (see Table 2). To assess coding reliability, both researchers independently applied these codes to one interview and compared the



(a) (b)

Figure 1: CraftPad scaffolds for initiating lesson design: (a) Lesson information form; (b) Lesson structure selection.

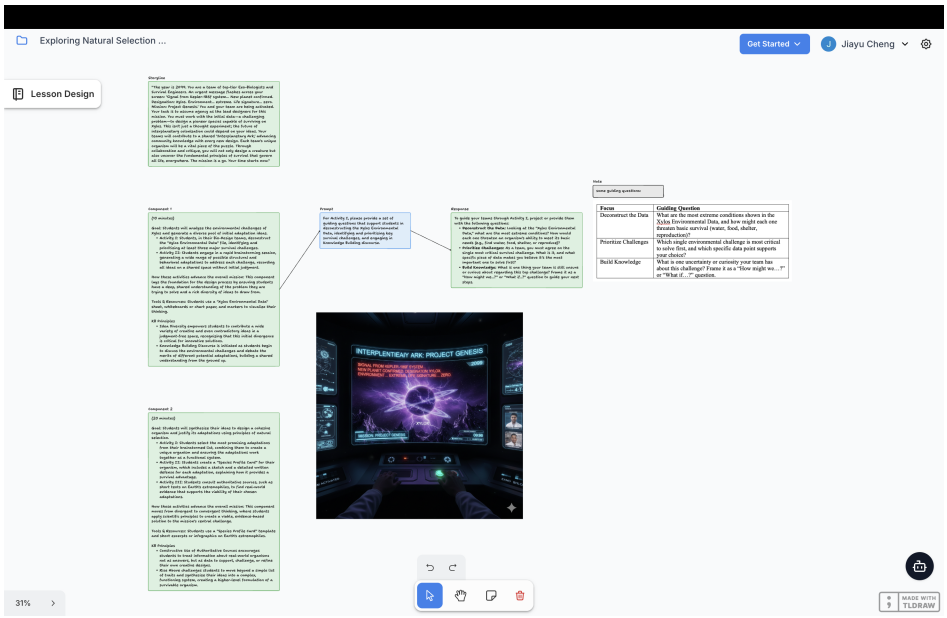


Figure 2: CraftPad's design canvas.

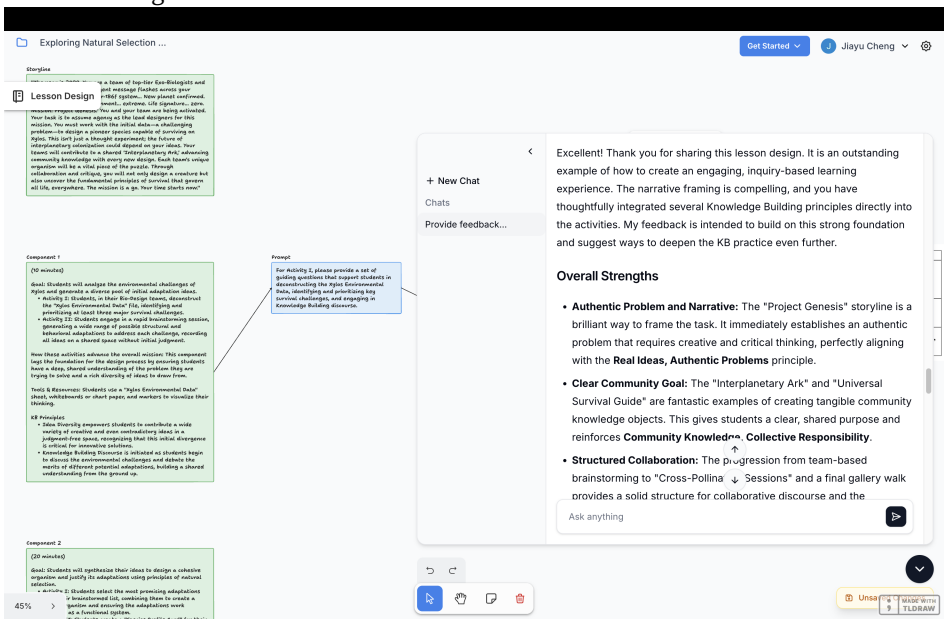


Figure 3: Pedagogical Coach: A custom AI chatbot for teacher reflection.

coding results (Cohen's kappa = .95). All discrepancies were discussed and resolved through consensus. After establishing a shared understanding of the coding scheme, each researcher coded half of the remaining data.

Table 1: Participants' demographics and teaching background

Pseudonym	Role	Teaching Experience	Teaching Context
Sylvia	Pre-service	None	Not yet assigned
Wendy	Pre-service	1 year	Primary – Information Technology (IT)
Heather	In-service	0.5 year	Secondary – Chinese
Anna	In-service	5 years	Primary – Health & Social Studies
Cary	In-service	10 years	Secondary – Math & IT
Grace	In-service	28 years	High School – Math

Table 2: Coding scheme of participants' usage, perceptions, and outcomes.

Dimension	Code	Definition
Usage	Feature Use	Teachers describe using specific CraftPad features (e.g., KB Coach, Notes)
	Design Iteration	Teachers engage in iterative cycles of generating lesson ideas with AI.
	Pedagogical Reasoning	Teachers explain pedagogical or KB-related reasoning guiding how they view, evaluate, adopt, or modify AI outputs.
	Distributing Agency	Teachers describe exercising judgment over AI suggestions, including selecting, modifying, rejecting, or delegating ideas.
Perceptions and Outcomes	Aligning KB Principles	Teachers perceive increased alignment of their lesson designs with KB principles.
	Enhancing Design Capacity	Teachers perceive improved lesson design capability as AI provides structured, high-quality ideas that prompt reflection, augment pedagogical knowledge, and support strategic instructional thinking.
	Deepening KB Knowledge	Teachers describe learning, clarifying, or deepening their understanding of KB principles.
	Increasing Confidence	Teachers report increased confidence, reduced anxiety, or willingness to engage in KB lesson design.

Dimension	Code	Definition
	Reducing Cognitive Load	Teachers perceive CraftPad as reducing mental effort by simplifying and streamlining lesson design, making planning more convenient and efficient.

5. Findings

The findings are organized around three emergent themes that together address the research question. The first theme, iterative design and the exercise of pedagogical reasoning, captures how teachers enacted professional judgment through component-level interaction with AI. The second theme, distribution of professional agency, examines how generative responsibility was distributed between teacher and AI and how different patterns of agency emerged across participants. The third theme, pedagogical alignment and design capacity, addresses how CraftPad's pedagogical framework-grounded scaffolds shaped teachers' reflective practice over time. These three themes collectively illuminate how CraftPad mediated teacher–AI collaboration and support the development of pedagogically aligned practice.

5.1. Iterative Design and the Exercise of Pedagogical Reasoning

Teachers engaged in component-level iterative refinement rather than entire regeneration of lesson plans. This allowed teachers to exercise pedagogical reasoning at each step when interacting with AI. For instance, Heather iterated repeatedly to anticipate potential classroom challenges, adjusting specific lesson components based on her professional judgment about student needs. Sylvia's process with a lesson on "unseen discriminatory language" illustrated how teacher-initiated iteration shaped AI output: after receiving an initial draft, Sylvia recognized it lacked concrete examples and added contextual details to her prompt. CraftPad then produced a revised activity with specific student data collection strategies, demonstrating how teachers' pedagogical input steered the AI toward more actionable and contextually grounded designs. This iterative dynamic positioned teachers as active pedagogical reasoners who used the AI as a responsive design partner, refining rather than simply accepting generated suggestions.

5.2. Distribution of Professional Agency

CraftPad afforded distinct distribution of professional agency shaped by how generative responsibility was distributed between teacher and AI. Wendy reflected on a pattern of delegated agency, noting that CraftPad *"automatically generates content, which reduces the cognitive load…"* but also that "*the more convenient and powerful it becomes, the more I rely on it,*" expressing desire for scaffolds supporting intentional reflection alongside efficiency. Cary demonstrated strong and intentional agency: explicitly welcoming extensive AI output and framing abundance as a resource for professional judgment. He explained *"I want AI to keep giving me things, and I need to have the ability to judge them."* However, Heather sometimes felt *"led by the nose"* by CraftPad's focused KB-aligned options, noting that a more open tool like ChatGPT offered greater room for pedagogical choice. These varied accounts illustrate that while CraftPad's meta-design architecture enables various modes of human-AI collaboration, the built-in lesson structure can constrain pedagogical choice.

5.3. Pedagogical Alignment and Design Capacity

CraftPad's grounding in a specific pedagogical framework provided alignment and clarity that generic GenAI tools lacked. In this study, the KB-configured Pedagogical Coach helped teachers connect AI-generated content to pedagogical principles. Wendy noted that clear explanations of KB principles reduced doubt about whether she was *"using KB correctly."* Sylvia used AI-generated designs as reference

to verify pedagogical alignment, making abstract principles more concrete and reducing design anxiety. Moreover, CraftPad expanded teachers' design repertoires. Grace appreciated how the tool broke down instructional time and mapped components clearly to pedagogical principles and classroom activity. Others emphasized how CraftPad introduced innovative ideas beyond habitual patterns. For example, Wendy described how CraftPad's suggestion to allow students to explore first before guided intervention shifted her instructional logic: *"I hadn't thought about how to address student misconceptions through exploration… That made me realize this approach could increase their curiosity and make the lesson more memorable."* CraftPad's archived design history was valued for reflection and expanding design capacity. For instance, Sylvia returned to earlier lesson versions while working on a new unit, comparing past and current iterations and integrating prior insights into new designs. This highlights an ongoing development in her repertoire of design strategies.

6. Discussion and Conclusion

The findings showed how CraftPad and key meta-design principles it embodies supported teacher–AI collaboration and design practice [5, 6]: (1) teachers acted as designers by iteratively adapting or rejecting AI suggestions at the component level; (2) AI prompts functioned as catalysts for pedagogical exploration while teachers retained decision-making control; and (3) teachers co-evolved lesson artifacts through use in response to contextual demands. Importantly, findings reveal that human-AI agency distribution is not uniform. Teachers enacted delegated, constrained, or expansive agency distributions shaped by their own orientations toward efficiency, exploration, and control. This enriches human-in-the-loop AI discourse [3] by showing how tool architecture shapes but does not determine collaboration patterns. Future work should extend CraftPad to other pedagogical frameworks, incorporate document-grounded AI responses, and examine teachers' evolving design capacity longitudinally. CraftPad represents a promising direction for integrating GenAI into teaching without displacing teacher expertise.

7. Declaration on Generative AI

ChatGPT 5.0 was used to assist with Mandarin-to-English translation of interview transcripts. The authors reviewed and edited all content and take full responsibility for the publication.

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