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Design as Language Co-Construction: Toward Responsible, Transparent, and Adaptive AI Support for Educational Game Design

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Abstract

Despite proven benefits, educational games are rarely adopted in higher education due to the complexity of designing games that fit diverse teaching needs. Most instructors lack game design expertise or access to professional support. Advances in AI, particularly large language models (LLMs), now make it possible for instructors to design games with AI assistance. However, effective AI support must go beyond generating content; it should build trust, encourage instructor agency, and ensure the final game aligns with teaching goals. My dissertation explores an interactive framework where instructors and AI co-construct a shared design language, enabling collaborative, transparent, and context-aware game design. The in-development tool uses LLM-driven dialogue to transform course materials and pedagogical aims into game design artifacts such as mechanics outlines and design documents. Its text-based interface, supported by lightweight visual scaffolds, allows iterative refinement and explanation of AI suggestions, empowering instructors to create educational games suited to their classrooms.

Introduction

Educational games are well-documented for their ability to support students' critical thinking, collaboration skills, and learning outcomes (Zainuddin et al. 2020; Checa and Bustillo 2020). However, despite extensive evidence of their effectiveness (Crocco, Offenholley, and Hernandez 2016; Kaimara et al. 2021), their adoption in higher education remains low. This gap emerges not from a lack of interest but from significant barriers related to expertise, resources, and practical integration into diverse curricular contexts (Justice and Ritzhaupt 2015; McLaren et al. 2022). Designing effective educational games typically demands collaboration between educators and professional developersa partnership rarely feasible for university instructors (Bellotti et al. 2011; Justice and Ritzhaupt 2015; Kaimara et al. 2021).

Designing compact educational activities, or *mini-games*, enables instructors to transform traditional lessons into interactive, application-driven experiences that significantly boost engagement, deepen understanding, and promote higher-order thinking (Pesare et al. 2016; Khoo et al. 2025). Empirical research highlights that even brief, game-like interventions in higher education settings consistently improve problem-solving and reflective skills compared to passive instructional methods (Khoo et al. 2025; Van Galen, Jonker, and Wijers 2009). Moreover, when instructors design these mini-games themselves, they gain precise control over aligning game mechanics with learning objectives, can refine gameplay responsively based on student feedback, and maintain the flexibility to adapt to changing curricular contextsensuring each activity remains pedagogically coherent and institutionally relevant (Kwak et al. 2018; Gkogkidis and Dacre 2020; Abou Hashish et al. 2024).

Despite the appeal, instructors face significant barriers in practice. Most lack game design expertise and do not have access to development teams required for creating high-quality, curriculum-aligned games (Slootmaker et al. 2014; Alklind Taylor 2015). Without institutional support, expecting faculty to assume both creative and technical responsibilities for game development is unrealistic. Although no-code platforms and educational game engines, including eAdventure, uAdventure, EMERGO, and SGAME, have lowered programming barriers, they do not sufficiently support creative and pedagogically aligned game design (Slootmaker et al. 2014; Gordillo, Barra, and Quemada 2021; Harteveld et al. 2017; Jiménez et al. 2020). Many tools require familiarity with complex editors or restrict users to rigid templates, which limits instructors' ability to tailor games to specific teaching goals (Pérez-Colado et al. 2019; Gordillo, Barra, and Quemada 2021). Usability studies further show that instructors often encounter difficulties in the initial stages of design, as these platforms rarely provide structured guidance for translating educational objectives into engaging gameplay (Slootmaker et al. 2014; Gordillo, Barra, and Quemada 2021). Consequently, while existing tools offer technical access, they do little to bridge the gap between pedagogy and game mechanics, emphasizing the need for more flexible and creative design support (Harteveld et al. 2017; Jiménez et al. 2020).

Recent advancements in artificial intelligence, particularly large language models, present an opportunity to democratize educational game design. In entertainment contexts, AI already assists with content generation and level design (Todd et al. 2023; Deterding et al. 2017; Yang, Kleinman, and Harteveld 2024). In education, AI has the poten-

tial to serve as a design partner, supporting instructors in ideating, prototyping, and iterating on games tailored to their courses. However, applying AI to educational game design introduces several challenges. AI must generate content that is contextually relevant, trustworthy, and encourages instructor engagement.

AI may first ground its suggestions in the instructor's unique teaching context, including curricular goals, classroom realities, and the intended student audience, to ensure games are pedagogically sound and practically applicable. The design process must also empower instructors, providing a sense of ownership and agency rather than relegating them to passive recipients of AI-generated content. Building trust in the AI's contributions and confidence in the resulting games is essential for adoption.

To address the challenges of integrating educational games in higher education, this dissertation introduces a collaborative humanAI interaction framework grounded in the co-construction of a shared design language. In this context, **design as language** encompasses a systematic process through which instructors and AI partners jointly construct, negotiate, and refine a vocabulary and set of conceptual tools for game design. Building on Dongs theory of shared design language (Dong 2008), this framework positions game design as an iterative, dialogic process. Here, the articulation of intentions, clarification of meanings, and critique of design choices can support a more nuanced translation of pedagogical aims into game mechanics, and may also contribute to developing trust, mutual understanding, and transparency that can be helpful for co-design (Lowgren and Stolterman 2007).

Central to this approach is the ongoing development of a mutually intelligible knowledge base. Both instructor and AI contribute to and revise this evolving repertoire through reflective exchange, with each partys input critically assessed and integrated into the design. This reciprocal process supports the emergence of shared understanding, reduces ambiguity, and keeps instructors in a position of agency throughout, enabling them to direct both the design process and the educational intent of the final product.

The aims of this dissertation are to:

1. Support instructors in articulating and translating their educational objectives into concrete game design elements by co-creating a transparent and context-sensitive design language with AI;
2. Enhance instructor engagement, trust, and agency by making the AIs design rationale explicit and positioning instructors as central, empowered decision-makers within the design process;
3. Provide empirical evidence that a reflective, language-based co-design framework can meaningfully lower practical and conceptual barriers, resulting in educational games that are both pedagogically robust and responsive to the specific needs of higher education contexts.

Adopting language as both metaphor and design scaffold, this dissertation contends that collaborative language development enables interdisciplinary synergy between instructors and AI. By fostering a process of ongoing vocabulary construction, structured dialogue, and critical negotiation, the framework facilitates co-creation that leverages both human expertise and computational adaptability.

Ultimately, this research investigates how such a framework can diminish the practical, technical, and epistemic barriers that have historically hindered instructor-driven educational game design. It further aims to advance the field by establishing principles for responsible, transparent, and adaptable co-design practices within educational technology.

Work to Date

Interview Study

The first phase of this dissertation involved a semi-structured interview study with 22 higher education instructors from diverse disciplines to identify their requirements and expectations for AI-assisted educational game design tools. Thematic analysis of these interviews identified nine key requirements, grouped into four higher-level categories:

- **Infused with Game Design and Pedagogy Knowledge:** Instructors expected the tool to possess expertise in both game development and pedagogy, including context-aware insight for tailored teaching experiences.
- **Equipped with Scaffolds and Automation:** Participants highlighted the need for actionable, pedagogy-centered design suggestions, as well as technical scaffolding and automation for repetitive or complex development tasks.
- **Trained to Adapt to Teaching and Interaction Styles:** The tool should support a range of educational games and adapt to different instructor preferences, workflows, and collaborative needs.
- **Built with Instructors Concerns in Mind:** Instructors expressed concerns about trust in AI-generated content, the need for clear and effective communication with the tool, and the educational effectiveness of games designed with its support.

These findings indicate that instructors seek a tool that combines expertise in game design and pedagogy and can flexibly adapt to diverse teaching contexts. Achieving this presents technical challenges, as current AI systems often require substantial customization to provide the necessary depth and contextual sensitivity for higher education. Instructors needs are varied and dynamic, so the ideal AI partner should offer guidance, generate creative ideas, learn from feedback, and adjust to individual preferences over time. The study also reveals a tension between powerful, personalized features and ease of use; instructors want tools that save time, not add complexity. Addressing these needs may involve intuitive design and robust instructor communities for sharing resources. Ultimately, success will depend on balancing technical innovation with user-centered design, transparency, and trust, ensuring the tool is both a capable collaborator and an accessible, efficient partner.

Wizard of Oz (WOZ) Study

Based on insights from the interview study, the ongoing Wizard of Oz (WOZ) study involves collaboration with a research team and five higher education instructors from various disciplines, who co-design educational mini-games by interacting with a simulated AI assistant. During multiple design sessions, instructors conceptualize, develop, and refine mini-games, while researchers manually simulate an AI capable of providing both design guidance and programming assistance.

Preliminary observations confirm that instructors require AI tools that integrate pedagogical strategies and game design knowledge, offer structured scaffolding, and adapt to different instructional styles. The study also underscores the importance of instructor-AI interaction dynamics, such as instructors expectations of AI capabilities, receptiveness to AI suggestions, and the types of support most frequently sought. The WOZ study will yield key design considerations and interaction patterns to inform future AI tool development and subsequent evaluation phases.

Tool Development

Guided by insights from the interview and WOZ studies, as well as foundational theories in collaborative design, I have developed an AI-powered educational game design system that frames the design process as a co-construction of shared language between instructors and AI. Central to this approach is Dongs theory of shared design language (Dong 2008), which highlights collaborative design as an iterative, dialogue-driven activity where participants continuously articulate, negotiate, and refine concepts to establish mutual understanding. Leveraging this perspective, the system treats game design as an ongoing exchange between instructors and AI, fostering transparency and reducing ambiguity through explicit communication and reflective dialogue.

Complementing Dongs theory, Paperts constructionist learning theory (Papert 1980) provides additional theoretical grounding. It asserts that deep learning occurs through active creation and the externalization of personally meaningful artifacts. In this context, the act of collaboratively constructing a design language requires instructors to explicitly articulate, evaluate, and refine their pedagogical intentions. This engagement enhances instructors design literacy, ownership, and responsibility, ultimately increasing their agency and commitment to the educational game design process.

The foundational vocabulary of the shared design language builds upon the mechanics, dynamics, and aesthetics (MDA) framework (Hunicke et al. 2004), providing an accessible entry point that allows instructors, typically novices in game design, to clearly map teaching intentions to concrete game elements. Although MDA has limitations, its terminology and structured approach may offer a basis for the reflection, negotiation, and refinement processes described in Dongs theory for instructors designing educational games.

The developed system structures instructor-AI collaboration into three main phases: requirement abstraction, iterative design, and document generation. In *requirement abstraction*, the AI assistant elicits detailed pedagogical context through reflective dialogue. During *iterative design*, instructors and AI collaboratively propose, negotiate, and refine game elements using MDA-based vocabulary. Finally, in *document generation*, the collaboratively built language and decisions are consolidated into a comprehensive game design document.

By integrating Dongs theory as the guiding framework, supported by Paperts insights on active knowledge construction, this system places instructors in an empowered position as active co-creators rather than passive recipients of AI-generated outputs. Ongoing development focuses on iterative prototyping and instructor-driven refinements, with future evaluations planned to assess usability, co-creative dynamics, and pedagogical efficacy in real-world educational contexts.

Future Work and Contribution

The next phases build on the theoretical insights, empirical findings, and tool development described above. Future work has two interrelated phases that expand and evaluate the co-constructive humanAI framework for educational game design.

The first phase will evaluate the developed AI-powered design tool. Instructors from various disciplines will co-design games tailored to their courses with the AI system. The evaluation will examine how constructing a shared design language shapes instructorAI interaction and roles, how linguistic co-construction supports transfer and appraisal of pedagogical and game design knowledge, and how these interactions affect instructors mental models, self-efficacy, and long-term ability to articulate and create educational game designs. Qualitative analyses of design dialogues and reflective interviews, together with quantitative measures of usability and self-efficacy, will yield a nuanced understanding of humanAI co-design.

Building on these findings, the next phase will expand and refine the language co-construction framework into an end-to-end design and development platform. The system will support meaningful co-creation and enable instructors to develop, prototype, test, and iterate games with AI assistance. It will facilitate classroom use and enable evaluation of educational effectiveness, allowing instructors to refine games based on classroom feedback and student interactions.

Expected contributions include a deeper theoretical understanding of humanAI co-design, practical methodologies for language-based collaborative design, and a robust, adaptive technological solution tailored to instructors in higher education. By bridging theory and practice, this work will establish principles and guidelines for creating AI-assisted educational tools that empower educators, foster pedagogical innovation, and enhance student learning. It will also contribute a novel, interdisciplinary perspective on how AI can augment human creativity and expertise in educational technology.

References

Abou Hashish, E. A.; Al Najjar, H.; Alharbi, M.; Alotaibi, M.; and Alqahtany, M. M. 2024. Faculty and students perspectives towards game-based learning in health sciences higher education. *Heliyon*, 10(12).

Alklind Taylor, A.-S. 2015. The Active Instructor: Benefits and Barriers to Instructor-Led Serious Gaming. In *2015 7th International Conference on Games and Virtual Worlds for Serious Applications (VS-Games)*, 1–8.

Bellotti, F.; Ott, M.; Arnab, S.; Berta, R.; de Freitas, S.; Kiili, K.; and De Gloria, A. 2011. Designing serious games for education: from pedagogical principles to game mechanisms. In *Proceedings of the 5th European Conference on Games Based Learning*, 26–34. University of Athens Greece.

Checa, D.; and Bustillo, A. 2020. A review of immersive virtual reality serious games to enhance learning and training. *Multimedia Tools and Applications*, 79(9): 5501–5527.

Crocco, F.; Offenholley, K.; and Hernandez, C. 2016. A Proof-of-Concept Study of Game-Based Learning in Higher Education. *Simulation & Gaming*, 47(4): 403–422.

Deterding, S.; Hook, J.; Fiebrink, R.; Gillies, M.; Gow, J.; Akten, M.; Smith, G.; Liapis, A.; and Compton, K. 2017. Mixed-Initiative Creative Interfaces. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, CHI EA '17, 628635. New York, NY, USA: Association for Computing Machinery. ISBN 9781450346566.

Dong, A. A.-S. 2008. *The language of design: Theory and computation*. Springer Science & Business Media.

Gkogkidis, V.; and Dacre, N. 2020. Co-creating educational project management board games to enhance student engagement. In *European Conference on Games Based Learning*, 210–219. Academic Conferences International Limited Brighton, UK.

Gordillo, A.; Barra, E.; and Quemada, J. 2021. SGAME: An Authoring Tool to Easily Create Educational Video Games by Integrating SCORM-Compliant Learning Objects. *IEEE Access*, 9: 126414–126430.

Harteveld, C.; Manning, N.; Abu-Arja, F.; Menasce, R.; Thurston, D.; Smith, G.; and Sutherland, S. C. 2017. Design of playful authoring tools for social and behavioral science. In *Companion Proceedings of the 22nd International Conference on Intelligent User Interfaces*, 157–160.

Hunicke, R.; LeBlanc, M.; Zubek, R.; et al. 2004. MDA: A Formal Approach to Game Design and Game Research. In *Proceedings of the AAAI Workshop on Challenges in Game AI*, volume 4, 1722. San Jose, CA.

Jiménez, C.; Ars, N.; Magren Ruiz, . A.; and Orcos, L. 2020. Digital Escape Room, Using Genial.Ly and A Breakout to Learn Algebra at Secondary Education Level in Spain. *Education Sciences*, 10(10).

Justice, L. J.; and Ritzhaupt, A. D. 2015. Identifying the Barriers to Games and Simulations in Education: Creating a Valid and Reliable Survey. *Journal of Educational Technology Systems*, 44(1): 86–125.

Kaimara, P.; Fokides, E.; Oikonomou, A.; and Deliyannis, I. 2021. Potential barriers to the implementation of digital game-based learning in the classroom: Pre-service teachers views. *Technology, Knowledge and Learning*, 26(4): 825–844.

Khoo, Y. Y.; Ramdan, M. R.; Abdullah, N. L.; Abd Aziz, N. A.; and Mahjom, N. 2025. The Impacts of Game-Based Learning on Thinking and Learning in Higher Education Context: A Scoping Review. *International Journal of Education in Mathematics, Science and Technology*, 13(3): 623–637.

Kwak, M.; Koohang, A.; Floyd, K.; and Choi, A. 2018. An educational adventure game for teaching information literacy and student engagement.

Lowgren, J.; and Stolterman, E. 2007. *Thoughtful interaction design: A design perspective on information technology*. Mit Press.

McLaren, B. M.; Richey, J. E.; Nguyen, H.; and Hou, X. 2022. How instructional context can impact learning with educational technology: Lessons from a study with a digital learning game. *Computers & Education*, 178: 104366.

Papert, S. 1980. *Mindstorms: Children, Computers, and Powerful Ideas*. Basic Books.

Pérez-Colado, V. M.; Pérez-Colado, I. J.; Freire-Morán, M.; Martínez-Ortiz, I.; and Fernández-Manjón, B. 2019. UAdventure: Simplifying narrative serious games development. In *2019 IEEE 19th international conference on advanced learning technologies (ICALT)*, volume 2161, 119–123. IEEE.

Pesare, E.; Roselli, T.; Corriero, N.; and Rossano, V. 2016. Game-based learning and gamification to promote engagement and motivation in medical learning contexts. *Smart Learning Environments*, 3(1): 5.

Slootmaker, A.; Kurvers, H.; Hummel, H.; and Koper, R. 2014. Developing scenario-based serious games for complex cognitive skills acquisition:: Design, development and evaluation of the EMERGO platform. *Journal of Universal Computer Science*, 20(4): 561–582.

Todd, G.; Earle, S.; Nasir, M. U.; Green, M. C.; and Togelius, J. 2023. Level Generation Through Large Language Models. In *Proceedings of the 18th International Conference on the Foundations of Digital Games*, FDG '23. New York, NY, USA: Association for Computing Machinery. ISBN 9781450398558.

Van Galen, F.; Jonker, V.; and Wijers, M. 2009. Designing educational mini-games. In *5th Annual Conference of the International Society for Design and Development in Education, Cairns, Australia (September 2009)*.

Yang, D.; Kleinman, E.; and Harteveld, C. 2024. GPT for Games: An Updated Scoping Review (2020-2024). *arXiv preprint arXiv:2411.00308*.

Zainuddin, Z.; Chu, S. K. W.; Shujahat, M.; and Perera, C. J. 2020. The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review*, 30: 100326.