An Integrated Approach to Learning Solutions: UCD + LS&D + AIEd

Kristen S. Herrick[1(✉)], Larisa Nachman[1], Kinta D. Montilus[1], K. Rebecca Marsh Runyon[1], Amy Adair[2], and Lisa Ferrara[1]

[1] Educational Testing Service (ETS) AI Research Labs ™, Princeton, USA
kherrick@ets.org
[2] Rutgers University, New Brunswick, USA

Abstract. User-centered design (UCD), learning science and instructional design (LS&D), and AI in education (AIEd) can be powerful, yet siloed practices when developing educational products. This paper describes our Agile ways of working in the ETS® AI Labs™ and how we are taking an integrated approach to educational product development. We discuss lessons learned and ways we can bridge the gap between learning theories and practices, artificial intelligence, and user experience/research to craft effective learning solutions.

Keywords: User-Centered Design (UCD) · Product Development Lifecycle (PDLC) · Agile

1 Challenges Applying AIEd

Leveraging artificial intelligence in educational contexts dates back to the 1970s with the emergence of Computer-Aided Instruction or what is now often called Intelligent Tutoring Systems [5]. Fifty years later, there are still many potential issues around AI applications to educational contexts. Given what we know or can surmise about the promises and pitfalls of AI in education (AIEd), are there approaches we can take to reduce the negative and enhance the positive impact on educational product design and development? We believe so!

The intersections of practice and theory—although trepidatious—are at the heart of the educational product design lifecycle. User-centered design (UCD), learning science and instructional design (LS&D), and AI in education (AIEd) can be powerful, yet siloed practices when developing educational products that facilitate learning (i.e., learning solutions). Thus, in the ETS® AI Labs™, we've spent the past two years applying these practices contemporaneously to develop learning solutions.

This paper aims to ignite discourse about our Agile ways of working in the ETS® AI Labs™ and how we are taking an integrated approach to educational product development. We discuss lessons learned and ways we can bridge the gap between learning theories and practices, artificial intelligence, and user experience/research to create effective learning solutions.

M. M. Rodrigo et al. (Eds.): AIED 2022, LNCS 13356, pp. 94–98, 2022.
https://doi.org/10.1007/978-3-031-11647-6_16

2 An Integrated Approach to Educational Product Development: UCD + LS&D + AIEd & an Applied Example

The learning solution development process is a nuanced recipe calling for equal parts lived, human experiences and scientific learnings. Moreover, creating high-quality, innovative learning solutions not only requires application of evidence based **AIEd** and **LS&D**, but also engagement in **UCD** to ensure we accurately and adequately address user wants, needs, and pain points. By taking this approach, we ensure that we expose the AIEd meaningfully within the learning context, leveraging capabilities as technological affordances to enhance the solution experience and best meet user needs.

- **User Centered Design (UCD)** is an iterative process that involves users throughout the ideation, design, prototyping, and testing phases of learning solution development to understand the whole user experience and subsequently create highly effective solutions for users [8]. UCD is important given research has emphasized the need for user engagement in the development and implementation of AIEd [10].
- **Learning sciences** is an interdisciplinary field focused on furthering our understanding of how learning happens in real-world settings and designing educational experiences that maximally support learning [4]. **Instructional Design** is a dynamic field focused on the design and management of various learning experiences, as well as supporting the pedagogical efforts of teachers and other educators [2]. Inputs from the fields of learning science and instructional design are referred to as **LS&D**.
- **Artificial Intelligence** has been described as "computing systems capable of engaging in human-like processes such as adapting, learning, synthesizing, correcting, and using various data required for processing complex tasks" [3]. AI has intersected with educational product development in many ways including use of NLP to interpret texts and conduct semantic analysis; use of NLP to enable speech to text and chat bot features; and use of AI in intelligent tutoring systems [7].

UCD, LS&D, and AIEd are uniquely poised to positively impact learning solution design and development. Within the ETS® AI Labs™, we develop learning solutions in cross-functional teams that work together to leverage expertise in each of these areas (i.e., UCD, LS&D, AIEd), apply it iteratively to learning solution design, and collaboratively address issues as they arise upon consistent engagement with users. Working together in this way not only helps ensure we're leveraging each practice appropriately to address user wants/needs/pain points, but also combining them to complement one another and optimize implementation within our learning solutions. The following provides an applied example of this integrated UCD + LS&D + AIEd approach and lessons learned from within the ETS® AI Labs™.

For example, we wanted to deliver an effective, delightful feedback experience for users within our solution. However, sometimes user, learning science, and AIEd perspectives don't lend themselves to the same solution design or development decisions:

- *User perspectives.* We heard from teachers that they want to be able to give students high quality feedback on their writing, but this is very time consuming so it can create a pain point for them. Students need clear and specific information about suggested

revisions to their writing in order to improve it and earn high marks. Teachers and students appreciate and value immediate feedback. However, both understandably expressed mistrust of automated feedback coming from a computer system or online solution. Many educators share these same concerns [1].

- *LS&D research.* We found that LS&D best practices included use of specific types of feedback (i.e., mastery-oriented, explanatory, strengths-based). However, there is somewhat conflicting research about the timing of feedback delivery to learners. That is, the effectiveness of feedback delivery often depends on various factors including student ability level, type of feedback, and learning contexts [6, 10]. Moreover, if users do not value and trust feedback, their motivation to understand and apply feedback may diminish, which would likely impair their ability to revise and improve.
- *AIEd applications.* AI affords the opportunity to further personalize the feedback experiences for users, meeting them within their individual learning needs by leveraging factors such as user interests, proficiency levels, writing self-efficacy, or learning motivations. However, developing AI capabilities has historically required large amounts of data to build models, which can take months to years to acquire, clean, engineer, and test, delaying evaluating the usefulness and impact of an AI-driven experience with users.

To help mitigate these varying perspectives and develop an effective learning solution, we integrated best practices from UCD, LS&D, and AIEd.

- **UCD.** We interviewed teachers to more deeply understand how they feel about automated or solution-generated feedback on student work. We're also learning from teachers about things that would help increase their trust in automated feedback provided by AI in a learning solution. We've asked students how they feel about solution-generated feedback as well. We'll engage in user journey mapping to better understand student and teacher thoughts and feelings across each major segment in our learning solution. As we develop visual depictions of the automated feedback aspects of the learning solution, we'll share these with teachers to determine how we can best meet their needs and continue to improve our designs before developing the solution further. Additionally, we'll engage in co-design with teachers and students so that their needs/pain points related to automated feedback can be prioritized and addressed as we develop specific content and/or features of our solution.
- **LS&D.** Given LS&D research suggests that the effectiveness of feedback delivery depends on various factors, we have adopted learning frameworks and theories that help facilitate feedback that can be personalized to each student's learning behaviors, previous accomplishments, and sentiments. We're also designing feedback using a strengths-based methodology that factors in a student's unique talents, capabilities, and previous accomplishments to make feedback more personalized and trustworthy. We're aiming to provide feedback that is trustworthy by ensuring it is specific and actionable. The solution will also help students see how their effort to understand and use feedback helped them improve over time, which should engender more trust.
- **AIEd.** Because we're already engaging with subject matter experts (i.e., teachers) on solution design and experience, we leverage the signals they already trust and use for evaluating and generating feedback as a starting point for defining and designing

our model, ensuring that system- or solution- generated feedback aligns with user expectations in the specific context of the solution experience. Next, we identify initial logic that combines the user response data with behavioral data, in this case identifying how to combine natural language processing (NLP) signals extracted from student writing with student usage of system tools like a graphic organizer with their identified writing strength to inform how to package those inputs into meaningful and actionable representation to the user. Finally, we build initial models leveraging existing data sets (from similar products, user profiles, etc.) to create solution prototypes that we can get in front of users in a more timely manner, leveraging user feedback to highlight and therefore prioritize the targeted development, training, or refinement a model needs in the specific context. By treating the AI development iteratively, much like many other assets and components within a user experience, the initial models can be used in the early prototypes, allowing for target user data to be collected, allowing further refinement of the model over time.

Taking an integrated UCD + LS&D + AIEd approach is novel, and achieving optimization is difficult. We're learning valuable lessons about how/when we can integrate UCD, LS&D, and AIEd throughout learning solution design and development:

- We must be agile. Thinking big, but building light, testing, and continuously iterating the solution will help us appropriately integrate users, learning science, and AI.
- We must work in cross-functional teams that sprint together and communicate effectively to leverage and weigh/balance perspectives from UCD, LS&D, and AIEd.
- We must ensure that designs are innovative enough to bring value to our users. Feedback helps our cross-functional team stay accountable to innovation.
- We must be user-obsessed. First versions of models may include incorrect judgments. UX design can account for potential errors, allowing for user-driven choice if they feel feedback is incorrect, or an algorithm to detect mistakes in the models and allow for correction early on, based on subsequent performance or behavior data.

References

1. Anson, C., Filkins, S., Hicks, T., O'Neill, P., Pierce, K.M., Winn, M.: Machine scoring fails the test. NCTE Position Statement on Machine Scoring (2013)
2. Beirne, E., Romanoski, M.P.: Instructional design in higher education: Defining an evolving field. OLC Research Center For Digital Learning & Leadership (2018)
3. Chatterjee, S., Bhattacharjee, K.K.: Adoption of artificial intelligence in higher education: a quantitative analysis using structural equation modelling. Educ. Inf. Technol. **25**(5), 3443–3463 (2020)
4. Fischer, F., Goldman, S.R., Hmelo-Silver, C.E., Reimann, P.: Introduction: evolution of research in the learning sciences. In: International Handbook of the Learning Sciences, pp. 1–8. Routledge (2018)
5. Guan, C., Mou, J., Jiang, Z.: Artificial intelligence innovation in education: a twenty-year data-driven historical analysis. Int. J. Innov. Stud. **4**(4), 134–147 (2020)

6. Mathan, S.A., Koedinger, K.R.: An empirical assessment of comprehension fostering features in an intelligent tutoring system. In: Cerri, S.A., Gouardères, G., Paraguaçu, F. (eds.) ITS 2002. LNCS, vol. 2363, pp. 330–343. Springer, Heidelberg (2002). https://doi.org/10.1007/3-540-47987-2_37
7. Miao, F., Holmes, W., Huang, R., Zhang, H.: AI and education: Guidance for policy-makers. UNESCO (2021)
8. Norman, D.A., Draper, S.W.: User Centered System Design: New Perspectives on Human-Computer Interaction. L. Erlbaum Associates (1986)
9. Shute, V.J.: Focus on formative feedback. Rev. Educ. Res. **78**(1), 153–189 (2008)
10. Zawacki-Richter, O., Marín, V.I., Bond, M., Gouverneu, F.: Systematic review of research on artificial intelligence applications in higher education–where are the educators? Int. J. Educ. Technol. High. Educ. **16**(1), 1–27 (2019)