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Co-Design a Logic Model for Inclusive AI-Powered Learning Application with Primary School Teachers

Ariel Han, Seth Corrigan, Shenshen Han, Kylie Peppler
hanjy3@uci.edu, scorrig1@uci.edu, shenshh@uci.edu, kpeppler@uci.edu
University of California, Irvine

Abstract: This study explores the development of a logic model to guide the design and implementation of an AI-powered story-authoring platform tailored for young learners, particularly those facing literacy challenges, such as English language learners, students with disabilities (e.g., dyslexia), and people with low socioeconomic status (SES). Amidst the rise of Generative AI tools, there's a need to bridge the gap between AI advancements and their practical use in K-12 educational settings. To address this, the researchers collaborated with primary school teachers, and synthesized insights from the literacy education literature. We conducted a co-design process, involving six educators, to identify the platform's potential users, features, functionalities, and desired outcomes. The findings emphasized the importance of making writing more accessible, with a focus on engaging students and motivating them to write. The proposed logic model underscores strategies like gamified elements, culturally-responsive imagery, and AI-generated mentor texts tailored to individual student needs.

Introduction

Used in the context of a backward design framework (Wiggins & McTighe, 2008), logic models can provide valuable guidance for the development of innovative educational technologies - clarifying a technology's target audience, functionality and desired impacts. The purpose of the current study is to report on development of a logic model that informs the design and development of a cutting-edge AI-powered story-authoring platform for young learners. The design process incorporated classroom teachers in order to understand their unique perspectives and needs. Furthermore, we incorporated current research on literacy education, in order to inform the final inputs and outputs of the resulting logic model (Graham et al., 2012). Lastly, we aimed to integrate inclusive design elements, utilizing diverse learner variability navigators provided by Digital Promise in order to meet the unique needs of individual learners (Digital Promise., 2023).

The recent launch of Generative AI (i.e., ChatGPT, Dall.E3) sparked educational discourse, raising both fears and hopes of adapting the cutting-edge platforms in education (Han et al., 2024; OpenAI, 2023; Kasneci et al., 2023). However, there is a gap in the field's understanding of how to best leverage AI technologies for improved student learning. We utilize a combined backward design and co-design approach in concert with logic model development in order to bridge this gap. A key part of our strategy involves collaborations with primary school teachers to build logic models in order to specify well the desired input, activities, outputs, and outcomes associated with the eventual technology. Through the process, teachers' expertise in existing methods for teaching and learning literacy skills is integrated with the development team's understanding of the affordances and limitations of current AI platforms.

We co-design a logic model as a collaborative effort of six educators (K-12 classroom teachers) to identify who might be users and what context these new systems can fit in, and what features and functionalities are needed for desired outputs for an AI-powered story-authoring platform. We recorded co-design sessions and analyzed the resulting qualitative data to elicit teachers' intended goals, needs, and their suggestions. We also drew the insights from synthesizing several lines of scholarly literature including literacy education to identify desirable outputs (what learners achieve) (Graham et al., 2012). Additionally, we leveraged the learner variability navigator as we developed inputs and activities (features and interventions) for inclusive design. As a result of our findings, we were able to identify the target users, desired behaviors and activities, what users learn, and the ultimate purpose of the tool (Digital Promise, 2023).

The contribution of the study to the learning science community is two-fold: first, we collaborated with classroom teachers (K-12) to understand their opinions, with the aim of developing a logic model to inform designing learning applications tailored to their specific needs and motivations. As a first step towards designing and developing a teacher-centered AI-powered educational platform that meets their unique needs. This collaboration underscores an opportunity to foster joint efforts between researchers, educators, AI, and NLP specialists to design a AI-powered platform for K-12 education. Second, we present the process of constructing a causal pathway, incorporating strategies to achieve desired outcomes, in the creation of innovative educational technology, focusing on the development of creative AI-powered learning tools—a logic model that offers

valuable insights to learning designers and researchers alike to find features and functionalities of integrating such emerging tools for educational purpose.

Background

Logic model

A logic model is a conceptual framework that specifically highlights the causal pathways leading to desired outcomes (Stegemann & Jaciw, 2018). The logic model provides guidance on the big picture of how key features are intended to achieve the goals of a given product or intervention. Logic models have been a long term feature in educational research and design (Stegemann & Jaciw, 2018). Their utility derives from their ability to systematically map out the expected functionality and impact of a product and guide design decisions. Logic models identify the expected context and users, inputs and activities (i.e., features and functionality), and describe how these influence the user's experience, the users' outputs (i.e., user experience data), and the expected outcomes (i.e., potential benefits of using the product).

AI-powered literacy development

The rapid advancement of Generative Artificial Intelligence (GAI) models, such as Large Language Models (LLMs) and Text-to-Image (TTI), make it possible for them to learn patterns and structures from existing data and to generate new content. These breakthroughs have led to a new generation of storytelling systems that enable open-ended conversation and create pedagogically beneficial text and images (Han & Cai, 2023; OpenAI, 2023). In these ways, GAI models expand the ability of teachers to facilitate open-ended discussions with underserved youth (Han et al., 2024). This new technology opens up new possibilities for developing literacy education platforms built on top of the new technology capabilities - such as creating artificial intelligence agents to facilitate human-to-AI communication (Brusilovsky, 2023). To integrate such emerging technology effectively into educational settings, it is critical to understand the practical challenges and needs faced in classrooms and the complexities of teachers' roles, deeply rooted in the reality of teaching and learning (Han et al., 2024; Long et al., 2021).

Methods

We conducted co-design sessions with six primary school teachers in the United States. The co-design sessions took place individually via video conferencing due to geographical distances, with an average length of approximately one hour and a half for three days (i.e., once a week) between July and September 2023. Teachers were recruited through snowball recruitment as part of researchers' personal networks, with the only criteria for eligibility being that they were either current or former K-12 teachers. The teachers were classroom teachers from 1st to 8th grades, and their experience averaged 15.8 years (min=2.3 years, max=31 years).

On the first day of the co-design session, we sought to elicit teachers' current practices, their struggles, and their motivations when they teach writing to their students. Afterward, in the second session, we introduced GAI platforms (i.e., features and functionalities). We asked about their experiences and opinions about adapting it in educational settings specific to writing activities with their students. Then, co-developing logic models and sharing feedback and suggestions was discussed. Participants were compensated $25 for their time and effort. Our study was approved by the authors' institutions' institutional review boards (IRBs).

Data sources and analysis

We analyzed the qualitative data with a deductive approach from the co-design sessions. First, the interview data was automatically transcribed (Otter.ai) using the original audio and aligned with the transcript. The transcript was transferred to qualitative data analysis software (Atlas.ai) for the first round of coding. We conducted an deductive approach to analyze interview data (Azungah., 2018) from the logic model structure to identify *context*, *inputs*, *output*, and *outcomes*. We read the transcripts and identified relevant themes of the text. We categorized codes into four high-level themes (i.e., context, inputs, outputs, and outcomes) and 27 codes under each theme (see Table 1).

Findings

From the findings, we identified the context and users of the AI-powered story-authoring platform for struggling writers and low-level readers. The results revealed input stations in which what students do, what features are necessary in the platform encompass: providing playful literacy activities, text chats, selecting culturally responsive imagery, writing models, feedback, and translanguaging (Digital Promise, 2023). Drawing from teachers' interviews and synthesizing evidence-based research literature, we demonstrated effective strategies in

literacy instruction for youths as outputs of the logic model, which is about what students learn as follows, genre-specific writing strategies, fluent in spelling, typing, word processing, lexical diversity, and verbal reasoning (Graham et al., 2012). Lastly, we drew desired outcomes from interview data based on teachers' perspectives, such as improving students' self-efficacy and motivation in writing, as articulated by one teacher:

> I think that as a writing teacher, a lot of us want the students to feel curious, feel confident, feel motivated, feel activated as writers are encouraged. I think a lot of writing teachers will say 'I can work with the student whose writing is weak', but getting them to start, getting them to continue and finish, and then getting them to revise. Those are the psychological hurdles, right?

A teacher's goal is to support a student's writing activities by providing writers' tools through the platform, which we consider to be an input of the platform. What we provide as features includes providing age-appropriate and immediate feedback to students and scaffolding mentor text that is helpful to students in developing their own writing.

> We can ask students, do you want to use the thesaurus? Not only are you letting them have a choice, but you're reminding them of writers' tools. I think what you want your writers to do is to be able to improve their writing, by improving their workflow choices, their structure, sentence skills, organization, and so paragraphing.

Teachers are intrigued by the potential of generative AI (LLM) to offer customized mentor texts, catering specifically to students' needs, including varying vocabulary levels and phonics.

> It still is very time consuming to make sure that you're finding good and mentor texts that fit with what you're teaching to make sure you're hitting direct discrete skills that are real. Using mentor text is really a lot of teachers' work. That is one of the ways that we can use AI – to help us develop appropriate levels of writing models for each student in different states.

Our findings indicated teachers identified that the integration of gamification and culturally relevant imagery generation via Text-to-Image AI art generator (TTL) serve as effective strategies to augment engagement and motivation within writing activities.

> And it seems like it's absolutely a game that you can play with the AI. like, you write the description of the alien? you give the prompt, AI gives you the image.

Teachers highlighted the potential of utilizing AI art generators (TTL) to produce culturally relevant images, thereby amplifying student engagement during story creation.

> Who's your character? Are they white? Are they black? You know, so that now they can have something that represents them? Right? If they're a black kid, they want to see a story about a black kid, they don't want to see a white kid with blond hair all the time.

Consequently, we identified the following logic models: *Context/Users* (struggling writers and low-level readers), *Inputs/Activities* (playful literacy activities, text chats, culturally responsive imagery selection, writing models, feedback, translanguaging, and writing strategies***),*** *Outputs* (increased amount of time spent in writing, word count, genre-specific writing strategies), and *Outcomes* as fluent in spelling, typing, word processing, lexical diversity, syntax, and verbal reasoning, ultimately increase engagement and motivation in writing (see Table 1). These can be facilitated via the development of AI-powered story authoring platforms through conversational design, chatbot systems, and customizable editing stations.

Table 1
A Logic Model for AI-powered Story-authoring Platforms for Struggling Writers

Context & Users	Inputs & Activities	Outputs	Outcomes
Make writing more accessible for those struggling writers and low-level readers ELL Racial Minorities Low socioeconomic status households (SES)	Playful literacy activities Text Chats Selecting Culturally Responsive Images Writing Models Feedback Translanguaging Writing Strategies	Time spent in writing Word count Genre-specific writing strategies	Fluent in spelling, typing, and word processing Lexical Diversity Synthax, verbal reasoning Engagement (increased amount of time spent writing), Motivation in writing

Discussion

The study represents an initial step in navigating the emergence of AI tools that can be integrated into learning experiences by constructing a logic model for the design and development of AI-powered story-authoring platforms tailored for young learners. In order for AI-driven educational technology to be effective, it needs to resonate with educators' needs, concerns, and aspirations. We developed our logic model as a result of our collaborative efforts with K-12 educators and synthesized academic literature. Our approach underscores the importance of involving educators from the beginning, fostering informed perspective on the design of learning technologies.

Our findings emphasize that while Generative AI offers exciting new possibilities, its adaptation in K-12 educational settings should be approached thoughtfully. Key aspects include ensuring cultural relevance, amplifying student engagement, and nurturing learners' motivation and self-efficacy in writing. The teachers' perspectives illuminated the value of integrating gamified elements and culturally-responsive imagery, which not only elevates the writing experience but also validates and respects students' identities.

Furthermore, the discussion around mentor texts, especially the potential for AI to offer tailored writing examples, highlights the transformative potential of AI. This could alter the teacher's role from that of a content provider to a facilitator, offering students more autonomy in their learning journey and equipping them with tools that cater to their specific needs. However, as with any innovative technology, challenges remain. The concerns about authenticity, agency, and the potential for bias or misinformation underscore the need for rigorous testing, regular updates, and perhaps most importantly, ongoing dialogue with educators and stakeholders.

Conclusion

In conclusion, our study's contribution lies in not only providing a pathway for the design of AI-powered educational tools but also in emphasizing the value of a collaborative approach. By bridging the expertise of AI specialists with the lived experiences of educators, it is possible to ensure the development of tools that are both cutting-edge and grounded in real-world educational needs. Our proposed logic model should be implemented in diverse educational settings and the impact it has on student outcomes should be explored in future research.

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