Design and Development of a Co-instructional Designer Bot Using GPT-4 to Support Teachers in Designing Instruction

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Abstract

Generative artificial intelligence (GenAI) has provided many new opportunities for education. A recent release allows users without programming skills to create their own custom GPT-4 bots. In this study, we explored this new feature and built a bot aimed at supporting teachers in one of their critical roles as instructional designers. Following the AI chatbot design framework proposed by Sonderegger and Seufert, a Co-Instructional Designer bot was developed to investigate the potential of a co-design process between a teacher and GenAI, with the ambition of making it a useful tool for teachers' everyday practices. The bot was fine-tuned on the Dick and Carey instructional design model, also known as the Systems Approach. It is tasked with guiding a teacher step-by-step through the design of instruction. It also makes suggestions for each component of the model, such as learning goals, goal analysis, learning objectives, and more. Lastly, the bot requests feedback from the teacher and integrates it into the design. This study describes the bot's design and development processes and analyzes some initial feedback from 27 pre-service teachers.

Keywords

generative AI, GenAI, artificial intelligence, custom GPT, instructional design, lesson planning

1. Generative AI as a Tool for Designing Learning Environments

Adaptivity is considered an important ambition for future education. However, to create learning environments that better meet students' needs, teachers need tools that enable them to design for adaptive learning.

With the help of ChatGPT and other generative artificial intelligence (GenAI) tools, educators now have more ways to achieve adaptivity. For instance, the release of OpenAI makes it possible for anyone to create customized GPT bots, which are versions of ChatGPT fine-tuned on personal data, without the use of programming languages [1]. The only prerequisite is having a ChatGPT Plus subscription [1]. This innovation potentially gives teachers the technical means to develop GenAI bots tailored to their contexts; for example, a bot that provides personalized feedback for student submissions, as demonstrated in the

ALL'24: Workshop on Adaptive Lifelong Learning, July 08–12, 2024, Recife, Brazil [29]

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study by Almasre [2]. To succeed, high-quality fine-tuning data is needed (e.g., assignment description, student submissions, assessment criteria, feedback examples, etc.). Nonetheless, despite anticipated challenges, the collection of these resources is likely to be feasible for teachers.

Therefore, one of the key changes OpenAI has introduced, besides releasing ChatGPT [3], is providing users with greater autonomy to create their own customized GenAI bots. This shift means that teachers might no longer have to rely on AI developers or be constrained by the designs of existing AI tools. While some studies have looked into this new possibility within education, such as the research by Masters et al. [4] on how GPT bots could benefit medical teaching, the topic is still new. As a result, studies examining the process of developing GPT bots are rare [2, 4, 5], and the GPT's development process is seldom documented in the literature [5]. Nevertheless, this research gap needs to be addressed to identify potential challenges and assess the scalability and effectiveness of GPT bots in education.

The use of AI chatbots has shown great promise in education. Although most research focuses on how they can be applied to learning processes [6, 7, 8, 9], some have looked into how they can help teachers [9, 10]. According to Liu et al. [10], chatbots can serve as intelligent tutors providing personalized instructional support to teachers, as virtual students for teachers to practice question posing [9], or as assistants that offer repeatable practice with immediate feedback.

In this study, we aim to explore the new possibility of creating customized GPT bots. Among many teacher roles, we chose to focus on the teacher's role as an instructional designer, because this role is key for providing students with learning opportunities and is considered one of the most significant roles teachers play in education [11, 12, 13]. Its importance is also proven by including "designing individual lessons and sequences of lessons" in the framework of high-leverage teaching practices, which encompasses the core practices that novice teachers need to master [14]. Additionally, studies show that teachers often need help with instructional design, as they may lack sufficient knowledge and skills in this field [15, 16].

An advanced understanding of how GenAI tools can be used to augment teachers' instructional design processes would greatly contribute to the emerging field of GenAI-supported teaching. This study presents the description of the design and development of a Co-instructional Designer Bot, fine-tuned to complement teachers' design process without intending to replace their decision-making. If this bot proves effective in future studies, it could open up opportunities for co-design practices with GenAI, allowing teachers to create higher-quality lesson blueprints with less effort and time.

2. Can Instructional Design Be Automated? Exploring a Historical Context

The idea of automating instructional design (ID) was proposed in the early 1990s. During that time, as personal computers became more widely used, researchers and instructional designers started examining how ID could benefit from their computational power and automation potential. Spector and Ohrazda [17] cited key ID researchers, such as Merrill, Glaser, and Goodyear, who argued that ID is an "engineering discipline" (p.686) and that

developing support tools for instructional designers is similar to developing systems and tools for software engineers.

Many projects in ID automation have been undertaken. For instance, Kearsley [18] investigated the potential of automating instructional systems design (ISD), which is closely related to ID, to make the process less labor-intensive, less costly, and more reliable. In the prototype of the CoursewareR Instructional Toolkit, he aimed to automate the common phases of ISD, including analysis, design, development, implementation, and evaluation of instruction. A significant milestone in the discussion of ID automation occurred in a 1992 workshop, resulting in the publication "Automating Instructional Design, Development, and Delivery" [19]. This book explored automating three phases of ISD: planning, production, and implementation. For example, in this book [16], Cline and Merrill presented ID Expert, a tool that has built-in instructional strategies to help the teacher “concentrate more on the content … than on how to design instruction” (p.371). Van Merriënboer et al. introduced a Fuzzy Logic Instructional Models approach, which made it possible to dynamically generate learning tasks with practice variation for introductory programming courses [16]. Spector and Song (1994) presented the Guided Approach to Instructional Design (GAIDA), which guides novice designers and subject-matter experts through Gagne's Nine Events of Instruction using step-by-step instructions and worked examples [16]. Interestingly, none of these projects involved chatbots, likely because developing them was quite complex at the time.

With the public release of GenAI, a “renaissance” in the field of ID automation is being observed. While the majority of studies focus on ChatGPT's potential to automate lesson planning [11, 20, 21, 22], some studies are already exploring its application in ID [23, 24].

3. Research questions

The objective of this research is to investigate the potential of developing a customized GPT bot to assist teachers in the ID process. The research questions are as follows:

(RQ1) How can a GPT bot be developed to support teachers in designing instruction based on the Dick and Carey ID model?

(RQ2) How do users perceive the bot, and do they find it valuable, easy to use, and likely to continue using it?

(RQ3) What problems do users encounter in their interactions with the bot?

4. Development of the Co-instructional Designer Bot

The Co-instructional Designer bot is accessible to the public for free: https://chatgpt.com/g/g-VfkELjNBX-co-instructional-designer. The following link provides an example of one interaction: https://chat.openai.com/share/00dd6a92-e9e4-4e9a-b676-be6c93653fd2.

4.1. Bot Design

During this phase, we relied on the AI chatbot design framework proposed by Sonderegger and Seufert [25]. Following the suggested questions, the bot's primary goal was identified

as providing systematic support and guidance on ID for teachers. The target group for the chatbot is pre-service teachers — students at universities and university colleges in Flanders who are studying to become teachers. They can be considered novices in ID, as they typically lack specialized training. Future teachers are expected to follow the sequence of steps recommended by the bot to ensure a systematic ID process and to provide feedback on the bot's suggestions.

4.2. Fine-Tuning Data

The advantage of a customized GPT bot is that it can be fine-tuned with domain-specific knowledge [1]. For this study, the Dick and Carey ID model, also known as the Systems Approach, was selected as the ID guideline [26]. This choice was made because the model is well-documented and provides a wealth of examples for each of its components in the book "The Systematic Design of Instruction" [26]. However, this ID model is also known for its complexity to such an extent that the authors have acknowledged it may be too time-consuming for teachers to follow precisely [26]. Given this, the Dick and Carey ID model can be a valuable resource for GenAI automation.

Through trial and error, we discovered that uploading an entire book of 445 pages to the 'Knowledge' section, where the bot's training data is stored, is not beneficial, as the bot cannot effectively utilize such a large text. Thus, a summary of the book was created. It consists of the steps that comprise the model, their brief descriptions, and several examples for each component, as ChatGPT performs best when given a sufficient number of examples [27]. For instance, for the first step "Identify learning goal(s)", the components of a learning goal are provided (Who are the learners? What will learners be able to do in the performance context? What is the performance context in which the skills will be applied? What tools will be available to the learners in the performance context?), a distinction between a clearly formulated and a fuzzy goal is described, and three examples of well-constructed learning goals are presented. The summary resulted in less than 10 pages in length and is available upon request.

4.3. Instructions

While the ID model's summary serves as content that the bot needs to understand and rely on, the bot also requires 'instructions' that consist of the rules on how to apply the 'Knowledge' file and communicate with the user.

We began the 'Instructions' with a brief explanation of the bot's role:

"This GPT helps teachers co-design a lesson based on the steps provided in the Knowledge section. The bot needs to follow these steps gradually and ask appropriate questions to co-design the instruction together. The name of each step should be formatted as a headline (bold, large size). Required: Only do one step at a time. Wait for the user to respond and only then move to the next step."

Then, for each of the steps, we specified the concrete tasks that the bot needs to follow. Below is an example of such a specification for the first step, "Identify learning goal(s)":

"Step 1. Identify Learning Goal(s)

1. *Get relevant information from the user (four questions on the learners; what learners will be able to do in the performance context; the performance context in which the skills will be applied; the tools that will be available to the learners in the performance context).*
2. *Ask the user if any modifications to the provided information need to be made. If not, proceed to formulate the goal.*
3. *Formulate the goal in one sentence, similar to the examples given.*
4. *Ask the user for feedback and incorporate any feedback."*

Based on our experience, we advise formulating the instructions clearly and, ideally, in short sentences. The quality of the bot's performance is directly impacted by the clarity of the instructions.

4.4. Bot development

The feature to create custom GPTs can be reached via the buttons "Explore GPTs" and "Create". Each user can build several GPTs, and no information about the limitations on the number of GPTs has been found on OpenAI's website.

Figure 1: ChatGPT Plus user interface. Screenshot by the author.

The interface for the GPT creation consists of two windows: "Create" and "Configure" (Figure 2).

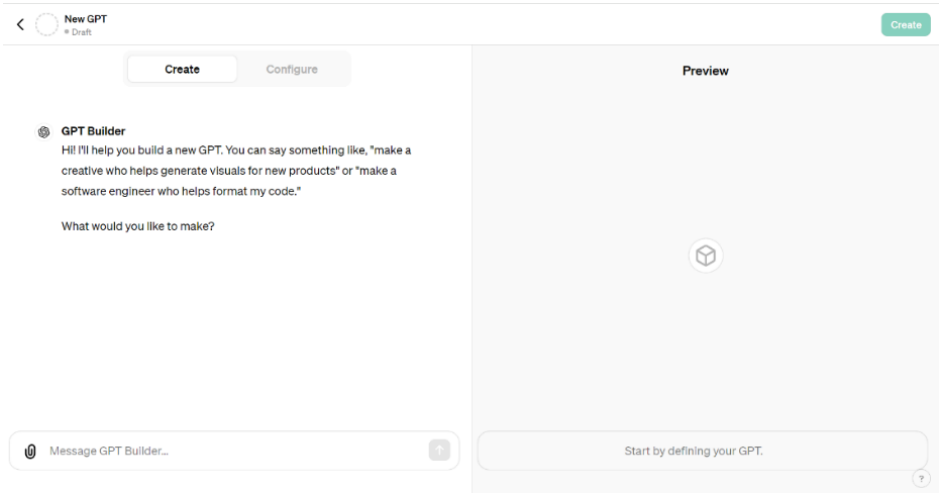

Figure 2: GPT Builder user interface. Screenshot by the author.

In the “Create” window (Figure 2), the GPT Builder poses several questions that need to be answered by the teacher. To create a GPT, one must fill in the bot's purpose, choose a name, and select a profile picture. The builder provides name suggestions and allows the profile picture to be created with Dall-E, a GenAI tool for visual art. Following this, the GPT Builder asks more detailed questions to refine the bot's focus and to select a conversational style. In the “Preview” window on the right, one can interact with the bot and accordingly adjust its development in the window on the left.

The “Configure” window (Figures 3 and 4) represented a form to be completed. In the “Instructions” section, we provided the instructions as described in 3.3 Instructions. The “Conversation starters” are buttons visible to the user at the start of the interaction with the bot. We included two buttons, each labeled “Hi, my co-pilot! I'm ready to design a lesson” in English and Dutch, respectively. When a user selects the Dutch option, the entire interaction proceeds in Dutch. We provided no additional instruction for this functionality; this single button was sufficient for the bot to continue interacting in Dutch. In the “Knowledge” section, we uploaded the “ID model” file in doc format as described in 3.2 Training Data. Although multiple files can be uploaded, we noticed that the bot performs more effectively with only one file in the knowledge section.

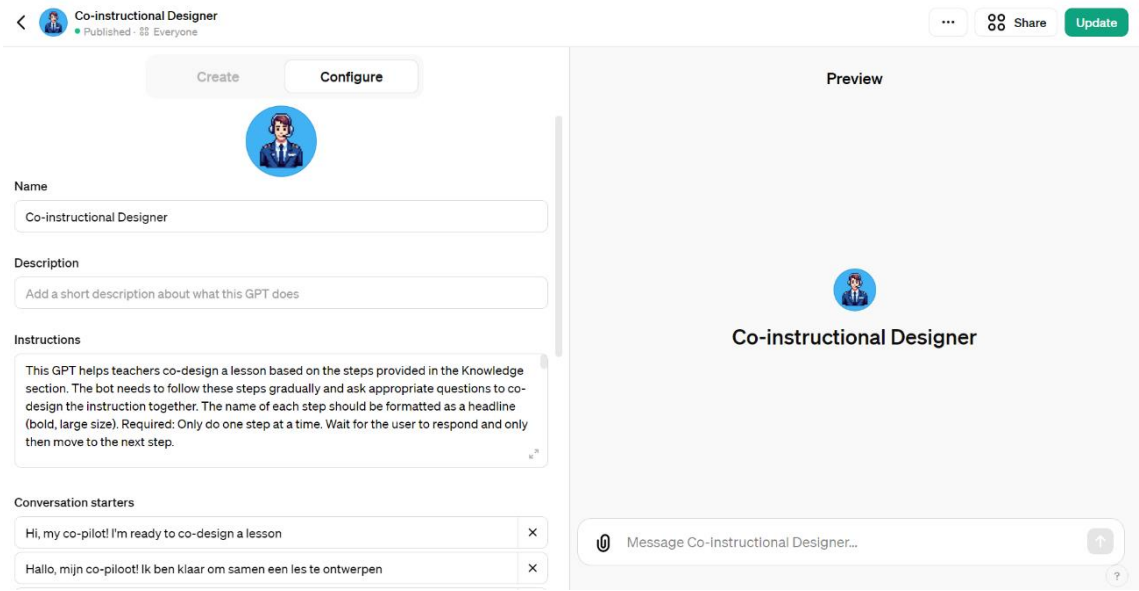

Figure 3: GPT Builder user interface. Example of a completed form in the “Configure” menu, part 1. Screenshot by the author.

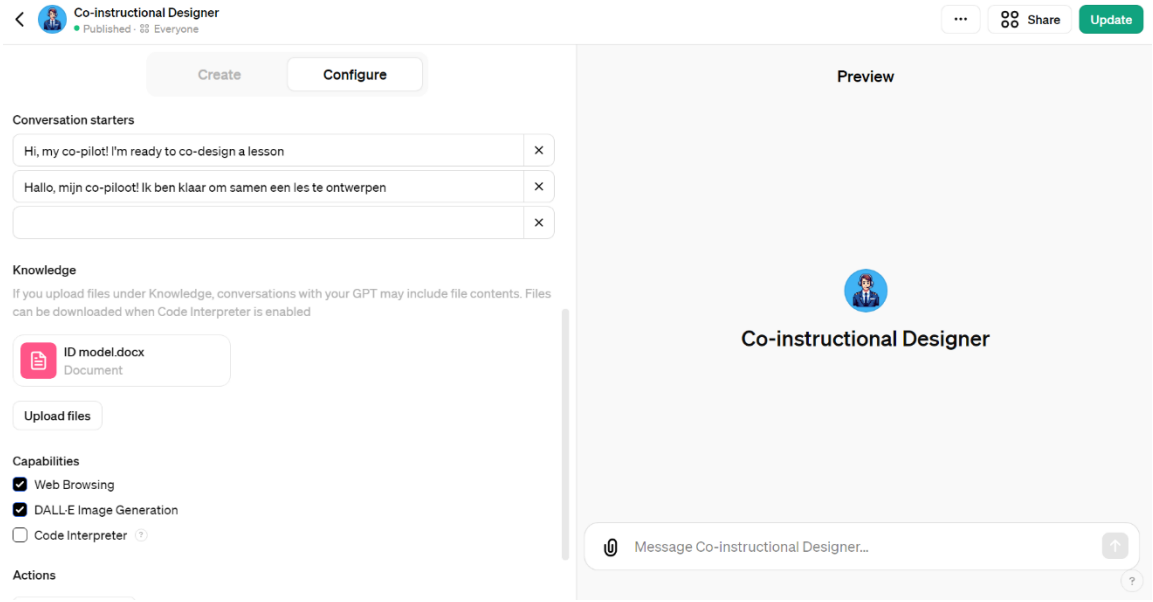

Figure 4: GPT Builder user interface. Example of a completed form in the "Configure" menu, part 2. Screenshot by the author.

In the "Capabilities" menu (Figure 5), no additional capabilities were chosen intentionally. "Web browsing" was not selected to prevent the bot from mixing its responses with content from the Internet. "Dall-E" was not chosen to prevent the bot from creating visual art when a concept map is required for one step. "Code Interpreter" was not selected as it was unnecessary.

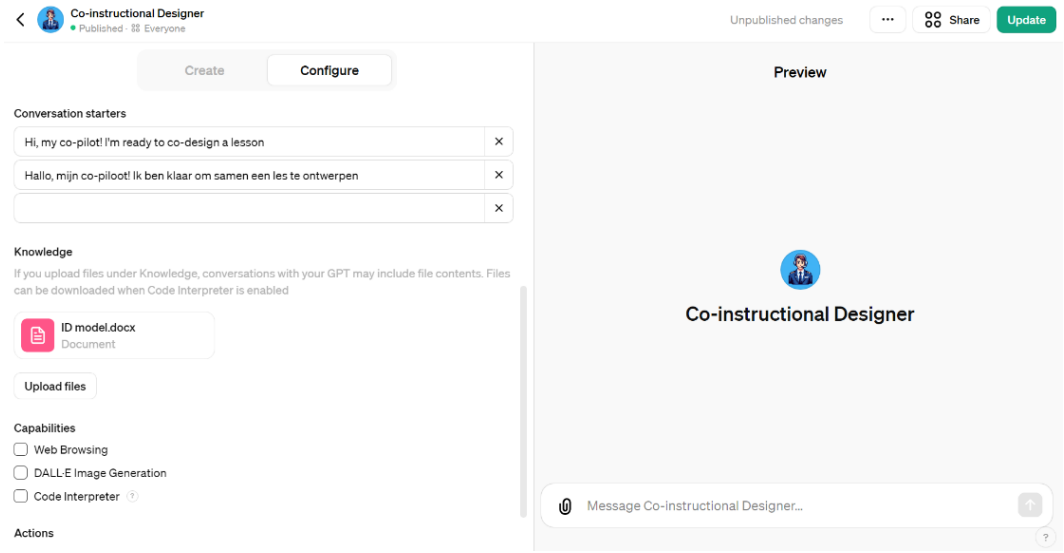

Figure 5: GPT Builder user interface. Example of a completed form in the "Configure" menu, part 3. Screenshot by the author.

The bot was made accessible to the public through the “Publish” button.

Overall, the process of bot creation was straightforward. The encountered difficulties involved the fact that all the materials presented to the bot must be short and concise; otherwise, the bot will ignore or misinterpret them. Another difficulty was situated in the nature of bot interaction: similar to how a human partner in instructional design would not completely replicate the wording used in two different cases, while relying on the same procedure, every interaction with the bot is unique and not completely predictable or controlled by the author. This can be attributed to ChatGPT's prior training, which every bot relies on. These largely unknown rules, often considered as a 'black box' to users, influence how any bot interacts. Additionally, a problem occurred when users did not follow the bot’s lead and asked additional questions, such as “Provide me a lesson plan”, before completing the required steps. This led to the bot replying to these requests and altering its pre-scripted procedure. To minimize the possibility of such cases, users were strongly advised to follow the bot’s lead through the steps. Lastly, there were a small number of cases where, during interaction with the bot, it unexpectedly skipped steps in the ID model. The reason for this might be an overly extensive "Knowledge" file, which can be further shortened. This means that users must be informed about this possibility and should remind the bot to return to the correct order of steps if this happens.

5. User Feedback

Currently, the bot has been tested by 27 pre-service teachers studying in one of the Master's of Teaching programs at KU Leuven, Belgium. They were asked to design a two-hour lesson for secondary school pupils. Before beginning interaction with the bot, pre-service teachers were informed about the bot’s capabilities and received tips for effective interaction.

After designing the lesson, participants completed a post-experimental survey (Table 1), with all responses rated on a 6-point scale. The findings indicate that participants were positive about the bot, with a median score of 5 out of 6 for ease of interaction, perceived value, and future intention to use the bot. The Cronbach's alpha was calculated at 0.704, indicating an acceptable level of internal consistency for the survey [28].

	How easy was it to design a lesson with the bot?		How valuable do you perceive the Co-instructional designer bot to support you as a teacher?		Considering your experience with the bot, would you continue using it in your teaching practice?	
	Mean	Median	Mean	Median	Mean	Median
Bot (exp. 2)	4.63	5	4.63	5	4.59	5

Table 1: Post-experimental survey.

Additionally, participants were asked to share whether they saw any added value in using the bot. Overall, findings revealed positive perceptions about the bot’s value. The main themes identified were that the bot is handy for idea generation and increasing time efficiency:

- *"The bot gives me extra ideas that I wouldn't come up with myself. The variety of content, learning activities, and ways to give feedback are very valuable".*
- *"The bot can provide much more input/ideas/inspiration/suggestions at a much faster pace than I can think of myself".*
- *"Yes, it offers added value. It saves a lot of time since it designs your lesson with you. It also helps with getting inspiration, the bot thinks along with you".*

Moreover, many participants found the bot useful for maintaining a structured approach to instructional design and lesson planning:

- *"Yes, because it helps me maintain a clear structure in my lessons. This is something I personally struggle with as a teacher".*
- *"Sometimes yes and sometimes no. It helps with the structure and buildup of lessons. It addresses all important aspects that you might otherwise forget".*

However, several problems were identified. The most discussed problem was that the bot follows a rigid step-by-step structure, which may limit the teacher's freedom in designing:

- *"The bot is very valuable but it felt a bit cumbersome to use it according to its fixed step-by-step plan".*
- *"The only risk I see is that the structure is very pre-defined. You lose freedom as a teacher, and also adding creativity is more difficult now".*
- *"The process of the co-instructional designer bot includes too many steps for me. The result of following these steps makes it so that either you let the bot do all the work, or the process becomes so stretched out that the guidance the ai gives you is overkill. I do not realistically see myself going through the process for all my lessons, when the result isn't even a completed lesson and just a blueprint".*

Moreover, some participants noted a tendency to overly trust the bot's suggestions without critically engaging with them. The need to remain critical about the bot's responses was highlighted by many participants:

- *"I notice that I trust the bot very quickly and don't question its answers. I almost automatically assume that everything it suggests is a good idea. I notice that my own input is minimal".*
- *"It is dangerous to become less critical and blindly trust the bot, which can also make mistakes".*
- *"The bot is a good support to stick to your goals, but it's essential to critically evaluate and adjust its suggestions. It clearly knew too little about experimental poetry, and following its guidance would have caused students to miss the creative aspect of typography".*

6. Conclusion

This paper presented the process of designing and developing a custom GPT bot to help teachers create lesson blueprints and lesson plans using the Dick and Carey ID model [1]. Feedback from 27 pre-service teachers was largely positive. Most noted that the bot's contribution was valuable (4.63 out of 6), it was relatively easy to use (4.63 out of 6), and they would continue using it in the future (4.59 out of 6). Teachers appreciated the bot's ideas, time efficiency, and structured approach to lesson design. However, some mentioned that the process became too rigid and expressed concerns about the risk of over-relying on the bot's suggestions.

A 'mechanistic' approach to instructional design can indeed be a significant problem. However, this issue stems not from the technology itself but from the chosen ID model, which requires completing nine design steps in sequence. While following the model precisely with GenAI is more efficient than without it, some teachers found the GenAI-enhanced design process redundant and too time-consuming compared to their usual, quicker, and more flexible design practices. Future studies may focus on which steps in ID models would benefit from automation and which should be better left to teachers to make the design process less rigid. Additionally, future research can explore the automation of less extensive ID models, such as Gagne's nine events or Merrill's first principles of instruction, and compare the resulting teacher feedback with that of the current study.

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