Research on Generative Artificial Intelligence Empowering Instructional Design

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Abstract: The quality of instructional design directly affects the effectiveness of teaching activities. Traditional instructional design is generally plagued by multiple predicaments, such as over-reliance on subjective experience, being time-consuming and labor-intensive, severe homogenization, and difficulty in adapting to students' learning situations. Generative artificial intelligence has functions such as natural language understanding and cross-domain knowledge question-answering, which can provide teachers with teaching ideas and inspiration and empower the analysis, design, development, implementation, and evaluation of instructional design. It can, to a certain extent, break through the dilemma of traditional instructional design, reduce the burden on teachers and increase efficiency, and improve the accuracy, innovation, and adaptability of instructional design.

Keywords: Generative artificial intelligence; Instructional design; Reducing workload and increasing efficiency; Human-machine collaborative teaching

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1.Introduction

Instructional design is the process of analyzing, planning, and making specific arrangements for elements and stages such as instructional objectives, instructional content, and instructional strategies based on systematic scientific methods of instructional theory, learning theory, and communication theory[1]. Instructional design functions as the fundamental conduit that connects instructional objectives with instructional practice. The quality of instructional design has been demonstrated to directly impact the accuracy, relevance, feasibility, and appropriateness of instructional decisions, thereby influencing the educational outcomes of students. However, the conception and evaluation of traditional instructional design frequently depend on the subjective experience of individual teachers or teaching research groups. This approach is constrained not only by the allocation of human resources, time, and energy, making it difficult to achieve efficiency and refinement, but also by issues such as design deviations, severe homogenization, or disconnect from students' learning conditions due to a lack of data support and systematic analysis.

Currently, the digital transformation of education is accelerating, and generative artificial intelligence is having an increasingly significant impact on teaching. It features natural language understanding and cross-domain knowledge question-answering capabilities, providing teachers with teaching ideas and inspiration to empower the entire teaching design process. In addition, the system enhances the efficiency of teaching design analysis and optimization, thereby reducing teachers' workload while increasing efficiency. However, the current systematic research on how generative artificial intelligence can specifically empower the entire instructional design process still needs to be deepened. Teachers often face challenges such as "disconnect between technology and teaching" and "unclear empowerment paths" in practical applications. In light of this, this study focuses on the core issue of "how generative artificial intelligence can effectively empower the entire instructional design process to reduce teachers' workload and increase efficiency." Through analyzing its specific empowerment mechanisms in the five stages of instructional design—analysis, design, development, implementation, and evaluation—this study constructs an empowerment process framework and explores feasible methods for generative artificial intelligence to support

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instructional design analysis and optimization.

2.Generative artificial intelligence empowers instructional design process construction

Given that instructional design typically encompasses five key phases — analysis, design, development, implementation, and evaluation—the process of integrating generative artificial intelligence to enhance instructional design can be systematically constructed based on these five phases, as elaborated below.

2.1 Intelligent analysis of pre-class teaching tasks

The intelligent analysis of pre-class teaching tasks mainly involves two aspects: learning situation analysis and the construction of instructional objectives.

The first aspect is learning situation analysis. When teachers enter information, generative artificial intelligence automatically generates results and optimization recommendations through three steps: building a resource index library, accurately matching question requirements, and generating customized content. Teachers first convert it into quantitative attitude indicators through sentiment analysis or use keyword extraction technology to extract core information to preprocess multi-dimensional and unstructured text data such as academic data reflecting knowledge mastery, behavioral data reflecting learning habits and commitment, and subjective feedback providing qualitative information, and then input it into generative artificial intelligence. Generative artificial intelligence will generate accurate, structured, and visual student performance reports based on the data provided by teachers. It will quickly identify high-frequency error types and common learning issues in students' assignments and mistakes to generate personalized learning problem diagnosis and improvement plans. Additionally, it will generate systematic intervention strategies based on student behavioral data and self-learning experiences, as well as dynamically set classroom groups and differentiated teaching plans to help teachers reduce their workload and enhance efficiency[2]. For example, generative artificial intelligence will generate a student performance report consisting of six major parts, including basic student information, academic performance analysis, core issue attribution analysis, teaching reflection, improvement measures and recommendations, and expected goals, based on data provided by teachers such as subject, analysis object, analysis period, and core issues.

The second aspect is instructional objectives. The core essence of generative artificial intelligence lies in four key elements: curriculum standards, educational content, student learning situations, and instructional scenarios. It can automatically generate instructional objectives that are directional, targeted, and feasible through organic integration and dynamic adjustment of weightings. For example, teachers can provide accurate student learning data to generate different dimensions, match different curriculum requirements, solve learning problems, and measure layered instructional objectives to match the learning needs of different student groups.

2.2 Collaborative instructional design before class

In the process of digitization of education, generative artificial intelligence has gradually become a powerful assistant for teachers in instructional design. Especially for new teachers, sorting out curriculum design ideas in advance can help them quickly generate a clear curriculum framework and process with the help of generative artificial intelligence, thereby avoiding repeated modifications due to unclear expression of their own needs. This will significantly improve the efficiency of new teachers in planning their teaching work. For example, generative artificial intelligence will generate a curriculum outline based on the grade level, subject, unit class hours, and core competency objectives provided by the teacher, including the comprehensive design concept of the unit, analysis of student learning situations and instructional strategies, lesson plans for each class period, interdisciplinary practical activity design, and learning assessment and feedback. Teachers need to clarify the core elements of the curriculum framework and process before submitting generation requests to generative artificial intelligence. Broadly speaking, there are four core elements to the course framework and process. The first is curriculum objectives. Teachers must clearly understand what the new curriculum standards are for different curriculum objectives. The second is the

students' foundation. Teachers need to comprehensively assess the current academic foundation of their students and carefully consider whether the instructional content needs to be connected to the knowledge points learned in previous grades. The third factor is whether local educational needs require teachers to incorporate cultural examples with local characteristics into their instructional content. And finally, teachers should decide on the instructional format, such as project-based learning or gamification, to ensure that the resulting curriculum is consistent with the actual instructional scenario. Based on the core elements, in order to make the instructional framework and process generated by generative artificial intelligence more closely aligned with instructional requirements, teachers need to input precise AI prompts—the CRISPE prompt framework—to guide generative artificial intelligence to output a standardized instructional process that meets instructional requirements and includes content such as contextual introduction, new knowledge teaching, consolidation exercises, summarization and learning outcomes, and after-class assignments[3].

Teachers should conduct a multifaceted review and optimization of the generative artificial intelligence output in relation to universally applicable instructional issues through the three key aspects of calibrating difficulty, contextual localization, and filtering for safety, thereby enhancing the quality of the content. The focus is on reviewing the knowledge accuracy and logical consistency of the generated content, whether it meets the curriculum standards, and whether the difficulty level is adjusted according to the level of the students in the class. It is also necessary to supplement the differentiated instructional tasks with additional explanations and review whether they are successfully integrated into real-life examples, interdisciplinary elements, or localized examples, and whether discussions, experiments, or collaborative tasks are designed to enhance student engagement, to ensure that the content generated by generative artificial intelligence is unbiased and to design critical analysis sessions for students.

2.3 Intelligent Development of Pre-class Teaching

Teachers need to clarify their instructional needs, determine the specific knowledge points corresponding to the required instructional objectives and instructional resources, and combine the instructional scenario (introduction of new lessons, explanation of knowledge points...) with the students' learning situation to form a teaching objective framework. Teachers then use accurate and detailed instructions to "communicate" with generative artificial intelligence. Therefore, when preparing to use generative artificial intelligence to generate pre-class instructional resources, teachers should design prompts based on the instructional objectives and knowledge points, in accordance with the framework of "task (required) + role (optional) + context (optional) + output control (optional)," so that the generative artificial intelligence model can better understand the task objectives and generate instructional resources such as teaching pictures, audio files, videos, PPT, and mind maps that meet the format and content expectations. When evaluating and selecting generated instructional resources, teachers need to establish selection criteria based on multiple dimensions, such as instructional objectives, content quality, and technical compatibility, to ensure that the instructional resources meet the needs of the instructional scenario. Teachers should compare the curriculum standards of the subject being taught with the cognitive level of the students to confirm whether the teaching resources cover all teaching knowledge points and are suitable for different teaching stages, whether they include teacher-student interaction, and whether they contain any sensitive information. At the same time, teachers collect student feedback by having small groups of students try out the generated instructional resources, and optimize the logic and presentation of the instructional resources in conjunction with professional reviews from other teachers in the subject group.

2.4 Multi-subject implementation of teaching in class

Teachers need to arrive at the classroom early to set up the technical environment. Once the hardware equipment in the classroom is ready, teachers should open and log in to selected generative artificial intelligence programs such as ChatGPT and Doubao, and conduct rapid testing of core functions (a specific prompt library tailored to the learning situation is constructed in advance, and dialogue strategies are pre-set...). The core role of

generative artificial intelligence is to “empower teachers” to improve teaching efficiency and effectiveness. Generative artificial intelligence will participate in classrooms as a presentation assistant that generates clear and intuitive visual content. It can also be used as a question bank generator to quickly respond to teachers' instructions and generate structured, tiered practice questions based on the lesson objectives and students' proficiency levels. This can help reduce the burden on teachers of manually creating questions and searching for variations, or serve as a limited information verifier to quickly validate students' oral answers or reasoning, with teachers guiding the entire class in collectively determining the correctness of responses. Digital humans can also serve as providers of pre-set “triggers” for teacher-student interaction. They achieve this through short animations, interesting generated content, encouraging words, and simple questions pre-set by teachers before class or triggered in real-time during class. These elements help create a relaxed classroom atmosphere, capture students' attention, or serve as starting points for teachers to pose deeper questions, thereby supporting the overall classroom activities designed by teachers.

2.5 Personalized evaluation after class

Teachers can give full play to the advantages of generative artificial intelligence to develop evaluation scales, exercises, tests, and other materials for related teaching activities or works to improve the scientific nature and accuracy of teaching evaluation. Teachers and generative artificial intelligence work together to clarify evaluation objectives and requirements, such as the application of mathematical knowledge, creative design, layout, and writing standards. Generative artificial intelligence then generates a preliminary evaluation scale based on the designed instructions and evaluates different dimensions according to four levels: excellent, good, satisfactory, and needs improvement. For example, the specific manifestation of an excellent grade in the dimension of mathematical knowledge application is “the mathematical knowledge in the handwritten paper is completely correct, covering rich mathematical concepts, theorems, or interesting knowledge, and closely related to the fourth-grade mathematics learning content with appropriate expansion.” After receiving the generated results, teachers should adjust and optimize them based on actual instruction and student characteristics to ensure that the assessment scale better aligns with the needs of the activity. Human-machine collaboration in evaluating student work can fully leverage the efficient processing capabilities of artificial intelligence and effectively improve teacher productivity[4]. The evaluation can be divided into three steps. In the first step, teachers scan the students' submitted works into electronic documents and upload them to a generative artificial intelligence evaluation platform that supports image recognition and analysis, such as Doubao and ChatGPT. In the second step, teachers wait for generative artificial intelligence to conduct preliminary analysis and scoring of the works based on pre-designed evaluation indicators. In the third step, generative artificial intelligence will quickly generate a preliminary evaluation report for each student and mark their scores and any problems. Teachers then use the preliminary evaluation report generated by generative artificial intelligence as a reference and manually evaluate the students' work, such as determining the nature and extent of the error, evaluating creative design and layout, demonstrating how to optimize layout, and supplementing and refining evaluation content and modifying evaluation criteria scores for aspects that are difficult to assess, such as emotional attitudes and cultural connotations.

3.Conclusion

Generative artificial intelligence is emerging as a pivotal technology for promoting changes in instructional design and reducing teachers' workload while enhancing efficiency. Integrating it into the entire process of instructional design, including analysis, design, development, implementation, and evaluation, can, to a certain extent, solve the multiple difficulties of traditional models, which rely on subjective experience, are time-consuming and labor-intensive, are highly homogenized, and are difficult to adapt to learning situations. In terms of reducing workload, generative artificial intelligence can greatly free up teachers' time and energy by automatically processing academic data to generate academic reports and personalized diagnostic plans, integrating interdisciplinary multi-modal materials, and generating preliminary evaluation reports. It also uses a structured prompt word

framework to help new teachers quickly generate teaching materials such as course outlines and interdisciplinary integration plans, thereby lowering the threshold for professional design. In terms of efficiency, based on pre-class intelligent analysis of learning situations, real-time generation of visual content and interactive "introductions" during class, and post-class human-machine collaborative evaluation to optimize the scientific nature of evaluation scales, teachers are not only freed from repetitive work, but the accuracy, innovation, and adaptability of instructional design are also significantly improved.

Although generative artificial intelligence brings better value to instructional design in terms of reducing workload and increasing efficiency, if teachers fall into the trap of over-reliance during the application process, it will pose a potential threat to their professional growth and teaching quality[5]. When teachers routinely implement lesson plans and courseware developed by generative artificial intelligence without engaging in active internalization and deconstruction of the instructional content, their capacity for original instructional design gradually diminishes, and they may lose their aptitude for independently constructing teaching logic and innovative teaching methods. More profoundly, teachers may develop a sense of mental inertia, transitioning from actively contemplating the rationale behind instructional design and adapting it to the distinctive characteristics of the students in their respective classes to passively accepting standardized teaching plans. This shift can impede the ability to effectively respond to unanticipated situations in the classroom or to individualized teaching requirements[6]. Therefore, teachers must maintain a rational understanding of "human-machine collaboration." In other words, teachers should view generative artificial intelligence as a source of inspiration and an efficiency tool rather than a "fully automated solution" that replaces their own thinking. By keeping their own educational philosophy at the core, teachers can maintain their professional autonomy in the face of technological empowerment and achieve sustainable professional development.

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