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Perspective:

Parallel intelligent education with ChatGPT

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This paper presents a framework for parallel intelligent education that involves physical and virtual learning for a personalized learning experience. We especially focus on Chat Generative Pre-trained Transformer (ChatGPT) owing to its considerable potential to supplement regular class learning. We address the strengths and weaknesses of learning with ChatGPT. Finally, we discuss the challenges and solutions of the proposed parallel intelligent education with ChatGPT.

1 Introduction

With the introduction of new technologies and learning tools in the recent decades, the field of education has undergone constant revolution. Virtual reality, machine learning, reinforcement learning (RL), and metaverse are just a few examples (Gu et al., 2023; Hare and Tang, 2023; Liang et al., 2023; Shi et al., 2023). Most recently, ChatGPT has become a hot topic owing to its potential impact on the traditional classroom-based learning. Regular classes are often teacher-centered, with the instructor guiding the entire learning process. Face-to-face teacher–student interactions are expected to occur in such a classroom to offer students engagement and real-time feedback. However, physical constraints on instructors (e.g., class sizes, short class time, and limited resources) make it challenging, if not impossible, to provide personalized attention and tailored instruction to suit individual learning needs (Franzwa et al., 2014; Tang et al., 2020). ChatGPT offers a solution to personalized learning (Schulman et al., 2022).

ChatGPT is an artificial intelligence (AI) language model (Brown et al., 2020) that uses a type of deep learning algorithm called transformer models to generate human-like text responses to given prompts. Learning through ChatGPT involves interacting with an AI language model trained on a vast corpus of text. This mode of learning is self-paced. It provides students with the ability to ask questions and receive immediate answers. Through ChatGPT, a student can access a vast repository of knowledge and information anytime and anywhere. However, ChatGPT has its limitations, particularly to low-performing students who often lack comprehension on a topic to ask proper questions.

In this paper, we explore the concept of parallel intelligent education. This type of education involves physical learning in regular classrooms and technology-supported virtual learning, offering personalized learning experiences. Particularly, we discuss the benefits of using ChatGPT as one of the digital tools to supplement

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for regular class learning, the concept of parallel learning with ChatGPT, and its challenges and potential solutions.

2 ChatGPT: a supplement to regular class learning

By providing personalized and adaptive learning experiences, ChatGPT can potentially revolutionize learning. ChatGPT is a powerful tool that can generate natural language text in response to prompts. This tool enables students to ask questions and receive immediate feedback and guidance.

The early versions of the language model behind ChatGPT are GPT-1 (Radford et al., 2018), GPT-2 (Radford et al., 2019), and GPT-3, released in June 2018, Feb. 2019, and June 2020, respectively. GPT-3, particularly, has 175 billion parameters in its training model. The latest version of the model is GPT-4, released in Mar. 2023. ChatGPT can perform language translation, summarization, question answering, chatbot dialog, and even creative writing (Zhou et al., 2023).

2.1 Training mechanism

ChatGPT is a state-of-the-art natural language processing model developed by OpenAI (Brown et al., 2020). It is based on the transformer model architecture (Vaswani et al., 2017), a deep neural network architecture designed for natural language processing tasks. Through a technique called unsupervised learning, ChatGPT is pre-trained on large amounts of text data (Zhang YZ et al., 2020). This training mechanism is based on deep learning techniques, specifically neural networks (Hu and Wang, 2020; Zhang WJ et al., 2021). The pre-training and fine-tuning processes involve adjusting the weights of the neural network. In this way, the model's ability to predict the next word in a sentence or generate text in response to prompts is optimized. During pre-training, the model is exposed to massive amounts of text from various sources (e.g., books, articles, and websites). The pre-training process involves teaching the model to predict the next word in a sentence based on the context of the previous words. This helps the model learn language patterns and structures and understand the relationships between words and concepts.

Once pre-trained, ChatGPT can be fine-tuned on a specific task, such as generating text in response to prompts or answering questions. Fine-tuning involves further training the model on a smaller, more task-specific dataset. During fine-tuning, the model is trained to generate text coherent and relevant to the task while remaining consistent with the language patterns and structures learned during pre-training.

2.2 A valuable supplement to regular classes

We believe that ChatGPT can be used to supplement classroom instruction. Students can use this tool to ask questions about the topics covered in class, seek clarification on concepts that they may not have fully understood, or find additional resources that can help them deepen their understanding of the material. Moreover, ChatGPT can be used to support self-directed learning. In addition to the topics covered in class, students can use ChatGPT to explore other areas of interest or access additional information and resources that can help them pursue their own learning goals. This latter application shares many similarities with flipped classroom learning (Reidsema et al., 2017). In this type of learning, students practice self-guided learning on instructor-provided material outside the classroom and then ask the instructor questions in the classroom.

Given the convenience of ChatGPT, it can be used to promote collaborative learning. Using ChatGPT, students can collaborate to generate questions, ideas, and solutions. They can then use those ideas to inform classroom discussions or group projects. ChatGPT can also provide personalized feedback and support. For example, students can use ChatGPT to practice skills (e.g., writing or problem-solving) and receive immediate feedback on their performance. This can help them identify areas where they may need to ask for additional support and tailor their learning accordingly. These features closely resemble those involved in the development of adaptive instructional systems (Liang et al., 2022).

Finally, and most importantly, ChatGPT can be used to promote creativity and innovation. Students can use ChatGPT to generate new ideas or explore different perspectives on a particular topic. This can help them develop their own creative solutions and approaches to learning. As an AI language model,

ChatGPT has been trained on a vast corpus of text. This includes literature, scientific research, and historical documents, allowing the model to provide users with a wide range of information and ideas. By interacting with ChatGPT, students can access this information and use it to develop their own creative ideas and solutions. Moreover, students can share ideas with the language model and receive feedback that can help them refine and develop their ideas. Such interactive processes are indeed vital to the generation of novelty viewed as a function of social structures (Burns et al., 2015).

Naturally, given the limits of ChatGPT as a large language model, it is difficult for students in vocational education and physical education—where hands-on experience is critical—to considerably benefit from using ChatGPT. However, students learning subjects in language arts, social studies, history, mathematics, and computer science, to name a few, can greatly benefit from using ChatGPT.

Notably, all these values assume that students are self-motivated, know what question to ask, and can properly use the answers provided by ChatGPT. Otherwise, using ChatGPT might become more problematic than beneficial. Table 1 provides a brief comparison of various learning models. ChatGPT is classified here as a virtual learning method that augments physical learning in traditional classrooms.

2.3 Common concerns about ChatGPT

Since its inception, ChatGPT has raised concerns from teachers. The most common concern is that students may become overreliant on ChatGPT for answers. Because of this, they may not develop their own critical thinking and problem-solving skills. Instead of actively engaging with the material and developing their own ideas, students may simply rely on ChatGPT to provide them with answers. This can hinder their ability to think independently and creatively.

ChatGPT itself is a considerable concern. Because it is trained only with resources that it can access, ChatGPT may not always provide accurate or appropriate responses to questions. As an AI language model, ChatGPT has limitations. Its responses are based on patterns and information it has learned from the vast corpus of text on which it was trained. Thus, students should be cautious about accepting ChatGPT's responses without verifying them with other sources. In other words, students should not rely on ChatGPT alone for important or complex information.

Table 1 Comparison between regular class learning and learning with ChatGPT

	Parallel intelligent education			
	Regular classroom learning*	Flipped classroom learning*#	Learning with instructional systems#	Learning with ChatGPT#
Settings	Classroom Instructor Students	Classroom + Internet access Instructor Students	Internet access Students	Internet access Students
Strengths	Guided and structured learning process Face-to-face interaction	Discovery-focused learning Self-paced Real-time feedback Personal engagement	Flexible content delivery methods Real-time feedback Learning anywhere and anytime Self-paced	Learn anywhere and anytime Self-paced Real-time feedback Almost unlimited resources
Weaknesses	Low flexibility Hard to cater to individual needs and preferences Limited resources	Semi-guided Dependent on student motivation Much preparation time required	Semi-guided High resources required to develop new systems/content Difficult to accurately predict student needs	Ad-hoc learning Unguided May be provided inaccurate information Dependent on student questions

* Physical learning; # virtual learning

Students may also become addicted to using ChatGPT, which can negatively impact their mental health and well-being. Spending excessive amounts of time using ChatGPT or any digital device can lead to decreased physical activity, disrupted sleep patterns, and social isolation.

Finally, ChatGPT also draws morality concerns from teachers because of the possibility that students will use it to cheat in their school work. This unfair advantage will not only cause harm to other students but also have ethical consequences on those who cheat.

All the concerns mentioned above are legitimate. However, they do not necessarily mean that ChatGPT is not a useful tool for teachers and students. With proper guidance and support, both students and teachers can use ChatGPT in ways that complement and enhance traditional learning methods rather than replace them.

3 Parallel intelligent education with ChatGPT

Parallel intelligent education presents a new type of learning that involves using multiple modes of instruction or resources simultaneously across multi-dimensional spaces to enhance the learning experience. For example, a student participating in a classroom discussion can also conduct online research to gather additional information and perspectives on the topic. This type of parallel learning was first discussed by Etheridge and Branscomb (2009). The idea was further enriched with the concepts of descriptive, predictive, and prescriptive learning (Li et al., 2017).

With technological advancement, many approaches have been developed to facilitate parallel learning. Parallel learning has already been heavily enabled by the Internet. Students often rely on YouTube videos, online courses from other professors, and online tutorials to fill knowledge gaps and improve their own understanding of classroom material. Beyond Internet resources, educational technologies such as serious games (Hare and Tang, 2022) and intelligent tutoring systems (Liang et al., 2022) provide new and engaging ways to present educational content and instructions to students. These instructional systems often present content through the view of real-world applications or through new methods that provide students with a different outlook on course topics. Furthermore, through AI and data analytics, these systems can provide adaptive support to students similar to an instructor (Liang et al., 2022).

ChatGPT is able to assist students in finding answers and obtaining accurate knowledge through natural human-like communication and explanations. Introducing similar functionality into intelligent tutoring systems and serious games can enhance the system's guidance for students more effectively. For example, if a student encountered content that they did not understand while engaging with a tutoring system, they can consult with ChatGPT instead of an instructor to receive immediate feedback and support. Intelligent tutoring systems and serious games can also use natural language methods to parse student responses, generate dialog from virtual humans, or provide hints that adapt to a student's performance.

Ultimately, parallel learning allows a student to access information from multiple sources and engages with the material in different ways. This can help students reinforce learning and promote a deeper understanding of the material. Using multiple modes of instruction or resources simultaneously, students can also customize their learning experience to suit their individual needs and preferences. Obviously, parallel learning can also be facilitated by technology. Technologies such as ChatGPT provide access to a variety of learning resources, including multimedia content, discussion forums, and interactive exercises.

By combining regular classes with ChatGPT and other technology-supported virtual learning, parallel learning can be a more effective and engaging learning experience. Some of the benefits of parallel learning include:

1. Customized learning: Parallel learning allows students to access and engage with learning resources customized to their individual needs and preferences. This can help students remain motivated and engaged with the material and can also help them achieve better learning outcomes.

2. Immediate feedback: Parallel learning with ChatGPT and/or other adaptive instructional systems allows students to receive immediate feedback and guidance on their learning. This can help them remain on track and identify areas where they need to improve.

3. Enhanced learning: By combining multiple modes of instruction (e.g., regular classes and ChatGPT), parallel learning can enhance the learning experience and promote a deeper understanding of the material.

4. Increased flexibility: Parallel learning allows students to learn at their own pace and on their own schedule. This can be particularly beneficial for students with busy schedules or other commitments.

Fig. 1 illustrates a framework for parallel learning. It is a continuously improving process. To safeguard our education, the key step is to establish the student comprehension model and improvement plan. The former incorporates various learning outcome assessment methods to gain a good understanding of students' knowledge states, including prior knowledge and underlying misconceptions. Examples of such outcome assessment include pre- and post-test evaluations, surveys and questionnaires, and specific work assignments. Regardless of the method used, designing appropriate assessment problems or questions is important. Based on accurate student profiling, the parallel intelligent education system will provide individualized scaffolding via an improvement plan.

4 Potential challenges

To maximize the learning outcome, two learning streams must be considered as an integrated process in parallel intelligent education (Fig. 1), instead of letting them run independently. Ultimately, a carefully designed student comprehension model with the outcome assessment component and plan generation and optimization mechanism is critical. One possible approach to this is to apply an RL model (Gu et al., 2023; Hare and Tang, 2023) to fulfill two tasks. RL allows continuous improvement of the quality of the student comprehension model and action plan design components through the system observing past outcomes and correcting bad behavior. By selecting what assistance to provide students through RL, improvements indicated by student data can become a reward to encourage or discourage certain behaviors. Naturally, RL is not the only method used to address the two tasks. As indicated in a recent literature survey (Liang et al., 2022), the creation of accurate student models to correctly capture student's areas of improvement remains a challenging research problem.

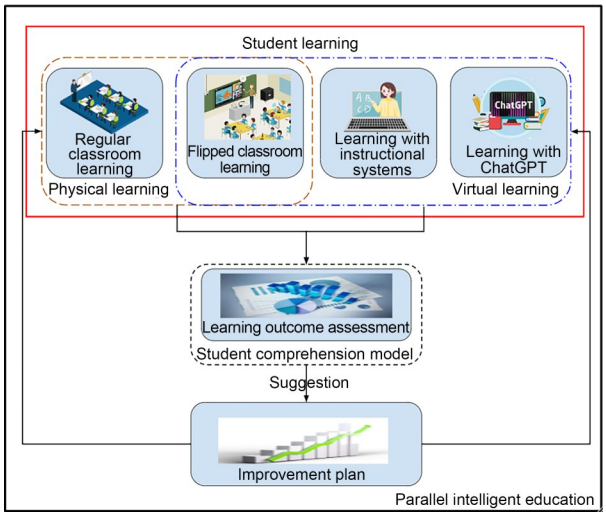

Fig. 1 Parallel intelligent education with ChatGPT

As ChatGPT provides an additional platform for students to learn, we can collect more data about student learning behavior and performance. Theoretically, the more data we can gather, the more accurate the student comprehension model becomes, resulting in better personalized learning experiences. Simultaneously, challenges arise with the increasing data dimensions and modalities (Liang et al., 2022; Molenaar et al., 2023).

When ChatGPT provides inaccurate information to students, we cannot expect that all students will be able to detect and correct them. Thus, more research is needed to address the challenge of misinformation and to design better and more robust parallel learning systems. Hence, the system overall is more resilient to such uncertainty and unreliability. Finally, the integrity of using ChatGPT (Anders, 2023) is another challenge that we must address as we integrate it with a parallel learning system.

Once all of these challenges have been addressed, the parallel learning system with ChatGPT will essentially measure student performance in the same way that a human instructor would (Nižnan et al., 2015). Ultimately, parallel learning approaches and ChatGPT for education both emphasize the need for more accurate and in-depth student models and more useful assessment tools. With detailed and in-depth assessment, system guidance can be improved. Meanwhile, student metaknowledge of their own learning

can be improved. This allows them to more effectively use tools such as ChatGPT to advance their learning.

Notably, such a coherent parallel learning and evaluation system can prevent students from overly relying on ChatGPT for learning. This will help and ensure that students allocate adequate time to learning from digital tools.

5 Conclusions

Parallel intelligent education with regular classes, ChatGPT, and many other virtual learning tools offers a unique and powerful approach to learning that can enhance the learning experience and promote a deeper understanding of materials. By leveraging the strengths of different modes of instruction, parallel learning can provide a more personalized, engaging, and effective learning experience for students. Although potential challenges to using this approach exist, with careful implementation and planning, parallel learning can potentially transform education and help students achieve their learning goals.

ChatGPT creates a new venue for virtual learning, similar to flipped classes and learning with other instructional systems. As ChatGPT gradually opens its application program interfaces (APIs), we will integrate it with our current intelligent game-based learning (Liang et al., 2023) in the future.

Contributors

Jiacun WANG, Ying TANG, and Ryan HARE drafted the paper. Fei-Yue WANG revised and finalized the paper.

Compliance with ethics guidelines

This paper is to be included in a special feature for which Ying TANG is a guest editor. Fei-Yue WANG is an editorial board member of *Frontiers of Information Technology & Electronic Engineering*. Ying TANG and Fei-Yue WANG were not involved with the peer review process of this paper. Jiacun WANG, Ying TANG, Ryan HARE, and Fei-Yue WANG declare that they have no conflict of interest.

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