Enhancing constructivist learning: the role of generative AI in personalised learning experiences

Enhancing Constructivist Learning: The Role of Generative AI in Personalised Learning Experiences

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Abstract: This paper explores the transformative role of generative AI in enhancing constructivist learning, where students actively construct knowledge through meaningful experiences. By investigating the synergies between generative AI and constructivist learning, the study uncovers how AI fosters personalized educational experiences. The research underscores the profound influence of generative AI on constructivist learning, empowering students to become active, motivated, and lifelong learners by tailoring their education, fostering creativity and collaboration, and upholding ethical principles. The study advocates for the responsible and purposeful integration of generative AI, which would revolutionize education and prepare students for future challenges.

1 INTRODUCTION

Generative AI represents a tipping point in the development of AI with huge adoptions from various industrial users. It has the potential to change the way we interact with and leverage artificial intelligence in our daily life, revolutionising how we access information, use information, reshape the learning curve and solve problems.

In higher education, generative AI tools are widely adopted by students. Cassidy (2023) statistics shows that one-fifth of students using AI programs in assessment tasks just two months after Chat-GPT release. Another survey conducted in January 2023 (Intelligent, 2023) reported that over one-third were using Chat-GPT for assessment writing. Of these students, 75% thought it counted as cheating but did so anyway. Furthermore, over 40 per cent of universities are investigating students for using ChatGPT to cheat (Snepvangers, 2023). Based on the above research, it is apparent that ChatGPT has garnered significant adoption among college students and lecturers urged to review assessments in the UK amid concerns over the new AI tool (Weale, 2023). The question for universities is how to use generated AI tools safely, effectively, and appropriately, rather than ban them from students. Consequently, it becomes imperative to engage in a thoughtful discussion regarding the pedagogical applications of AI.

This paper will focus on the applications of generative AI in higher education, along with pedagogical methods, to explore how generative AI enhance teaching and learning.

2 CONSTRUCTIVIST LEARNING THEORY AND ITS SIGNIFICANCE IN HIGH EDUCATION

Constructivism is a learning theory that has significant implications for higher education. It emphasizes the learner's active role in constructing understanding and knowledge through meaningful experiences and interactions. In the context of higher education, constructivism shifts the focus from passive knowledge transmission to active engagement and critical thinking.

Key principles of constructivism in higher education:

- Active Learning: A subject process. Constructivism promotes active learning

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strategies such as discussions, problem-solving, projects, and hands-on experiences. Students are encouraged to explore and discover knowledge rather than passively receiving information.

- Prior Knowledge: Prior knowledge and experiences play a crucial role in the learning process. Educators recognize and build upon students' existing knowledge, integrating new information with their mental frameworks.
- Social Interaction: Social interactions and collaborative learning are essential in constructivist classrooms. Students engage in discussions, debates, and group work to co-construct knowledge through dialogue and shared experiences.
- Student-Centred Approach: Constructivism places students at the centre of the learning process. It tailors instruction to individual needs, interests, and learning styles, fostering a more personalized and meaningful learning experience.
- Reflection and Metacognition: Students are encouraged to reflect on their learning process and think metacognitively about their own thinking. Self-assessment and self-regulation of learning are integral to the constructivist approach.
- Real-World Relevance: Constructivist educators aim to connect classroom learning to real-world contexts and applications, making the learning experience more authentic and meaningful.

In line with the principles of constructivism, the learning process is viewed as a journey of knowledge construction. Through comprehending both the sign and its meaning, individuals can effectively apply the acquired knowledge (as shown in Figure 1).

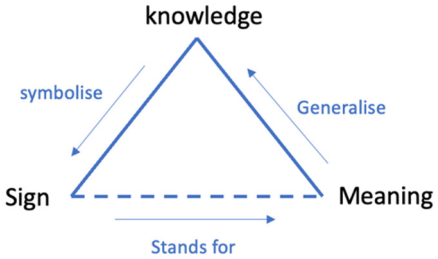

Figure 1: Learning as knowledge construction from semiotics (modified (Liu and Li, 2015)).

As knowledge construction is a subjective process, there must be a gap between the teacher and the learner. As shown in Figure 2, the learning process is a sense-making process navigated by prior knowledge. As the students have different knowledge contexts from their lecturers, the gap generates and hinders quality learning.

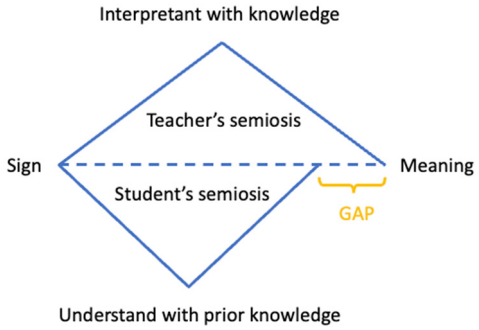

Figure 2: The gap between teacher and student knowledge understanding generated by different prior knowledge (modified (Liu and Li, 2015)).

Concerning the subjective nature of the learning process, generative AI tools serve as ideal adaptive assistants for students acquiring new knowledge, responding to their personalized questions with precision.

The next section explores the various approaches of integrating generative AI applications in educational settings.

3 INTEGRATING GENERATIVE AI IN HIGHER EDUCATION

Generative AI tools play a pivotal role in facilitating adaptive learning through personalised feedback, supporting research and data analysis, automating administrative service, and contributing to the development of innovative assessments (Rasul et al., 2023). This paper focuses on the following four specific tools: Chat-GPT(Rudolph et al., 2023), Bing Chat, Bard, Ernie (Teubner et al., 2023), with the objective of exploring the synergies between constructivist learning and generative AI.

3.1 Personalised Learning with Generative AI

Personalised learning has the potential to address the longstanding challenges in education, such as addressing learning gaps, accommodating diverse learning styles, and promoting students' engagement. Through the utilization of generative AI embedding alongside adaptive learning algorithms, instructors have the ability to customize education, feedback, and

assistance to match the individual learning profile of each student. This component of the investigation will specifically examine three perspectives:

- Adaptive content generation and customised learning pathways
- AI-driven individualised feedback and support
- The role of generative AI in catering to diverse learning styles

3.2 Fostering Engagement and Creativity with AI-Generated Content

AI-driven creative content includes a diverse array of educational resources, such as interactive simulations, virtual reality experiences, adaptive learning modules, personalised quizzes and assessments, and AI-generated educational games and activities. These customised instructional resources can boost student motivation by offering individualised and engaging learning opportunities that captivate individuals' interests and cultivate their inherent drive to learn. In this section, the following three perspectives will be investigated.

- AI-Powered Creative Content and Its Impact on Student Motivation
- Using AI for Dynamic Simulations and Real-World Problem-Solving
- Augmented Reality (AR) and Virtual Reality (VR) Applications in Constructivist Learning

3.3 Collaborative Learning Empowered by Generative AI

Collaborative learning environments can enhance the effectiveness and efficiency of group-based/cohort-based learning activities. When generative AI can be applied into collaborative learning settings, the learning processes can be optimised for individual needs, and knowledge synthesis facilitated by AI can enhance the personalised learning experiences. This section will dive into the following three perspectives to explore the role of generative AI in project support, interaction and feedback, as well as problem solving activities.

- AI-Driven Group Formation and Collaborative Project Support
- Facilitating Peer Interaction and Constructivist Feedback
- Leveraging AI for Collaborative Problem-Solving Activities

3.4 Ethical Considerations and Challenges in AI Integration

As generative AI tools have been widely adopted by students in higher education, there is an urgent need to provide guidelines on how to use AI in their learning processes and to ensure equitable use of these technologies in educational environments. This section will explore the potential challenges of integrating AI into educational systems from the following three points.

- Ensuring Ethical Use of AI in Education
- Addressing Bias and Fairness in AI Algorithms
- Privacy and Security Concerns in AI-Driven Educational Environments

Challenges in Implementing Generative AI for Constructivist Learning

By examining the challenges, educators and researchers can identify potential barriers and obstacles that may hinder the effective implementation of Generative AI in constructivist learning environments. The challenges mainly come from the privacy and data security concerns and the ethical issues.

- Ethical Considerations and Bias in AI Algorithms
- Addressing Privacy and Data Security Concerns
- Empowering Educators to Leverage AI Effectively

4 A PILOT RESEARCH ON STUDENT USE OF GENERATIVE AI

Understanding the gaps in teaching and learning, as well as the difficulties students encounter in their learning process, is essential for formulating effective questions that promote personalised learning. Figure 3 depicts the implementation of the constructivist learning concept in practical teaching.

We are currently developing a tool designed to identify AI-generated content within students' essays. Due to privacy and ethical considerations, it is not feasible for educators to upload students' essays to third-party tools. This tool will serve to pinpoint sentences or paragraphs that have been generated by AI algorithms. By analysing this content, educators can gain insights into the challenges students face

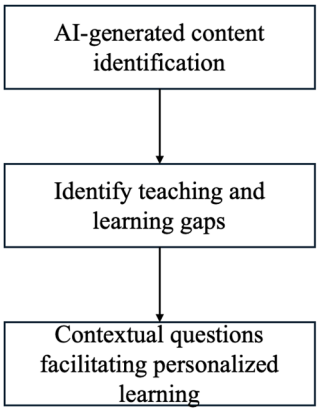

Figure 3: The process of applying constructivist learning.

when writing essays. For instance, students may struggle with defining concepts clearly or providing precise application scenarios. Additionally, the tool will aid in identifying areas where students may require further guidance or support in their writing process.

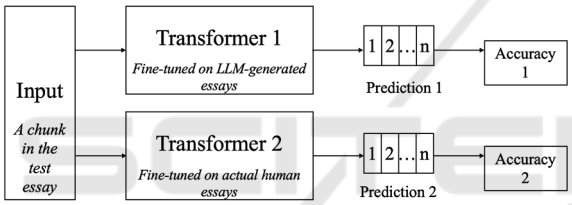

Figure 4: Content identification process.

As shown in Figure 4, a pre-trained text-generation transformer model, such as GPT-2 (Lysandre, 2023) can be fine-tuned separately with human essays and machine-generated essays. For a test human essay, the transformer trained on human essays should be able to predict words in the essay more accurately. Transformers can be further fine-tuned on a specific topic or author, giving more accurate results.

An example dataset is available on Kaggle (https://www.kaggle.com/competitions/llm-detect-ai-generated-text/data), containing human and LLM generated essays. Academic papers are widely available on the internet, while LLM essays can be generated with the ChatGPT API.

5 DISCUSSION AND CONCLUSIONS

Examining the adoption of generative AI tools in curriculum design reveals key findings that enhance understanding of the role of AI tools in teaching and learning activities. This contributes to achieving constructivist alignment by clarifying the needs of students with diversified backgrounds. Furthermore, exploring the implications and future applications of AI in higher education elucidates its potential to foster comprehensive and constructivist learning experiences.

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